Evaluation of the chemical safety of edible insects and insect-based food intended for human consumption. A Belgian pilot study

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Due to the rapid increase in world population, the use of alternative and more environmentally sustainable food sources is strongly encouraged. In this perspective, the opportunity for insects to represent a valuable alternative to main animal food sources (e.g., meat and fish) is remarkable. However, despite their high nutritional properties and more environmentally sustainable production, edible insects are generally perceived as an unappealing food source, especially among Western countries. The chemical safety of edible insects can thus contribute to the process of acceptance of insects as an alternative food source. In response to the recommendations expressed in a recent scientific opinion adopted by EFSA (2015) on the "risk profile related to production and consumption of insects as food and feed", the present study aimed to provide a comprehensive overview of the residual levels of different chemical compounds (including brominated and phosphorous flame retardants - BFRs, PFRs; polychlorinated biphenyls - PCBs; organochlorine compounds – OCPs; dioxins and dioxin-like PCBs; pesticides; metals - As, Cd, Co, Cr, Cu, Ni, Pb, Sn, Zn) in four species of edible insects (*Galleria mellonella, Locusta migratoria, Tenebrio molitor, Alphitobius diaperinus*) and four insect-based food items currently commercialized in Belgium. Our results pointed out a general low chemical contamination of the analyzed samples. In particular, the levels of PCBs ranged from 26.5 pg/g ww to 2,065 pg/g ww, with an average mass fraction of 743 (±745, SD) pg/g ww. Among the various OCPs examined, HCB, DDT and HCHs were detected in almost all the analyzed samples, with total levels ranging between 46.3 and 368 pg/g ww. Total BFR levels were generally < LOQ and never exceeded 35.5 pg/g ww, while the total levels of PFRs were generally higher (from 783 to 23,786 pg/g ww). The total levels of dioxin compounds measured in the analyzed edible insects ranged from 0.05 to 0.28 pg WHO-TEQ/g ww. Cu and Zn were consistently the most abundant metals, with mass fractions ranging from 0.85 to 9.12 mg/kg ww and from 6.44 to 58.60 mg/kg ww, respectively. Lower levels were measured for Co (<0.05 mg/kg ww), Cd (<0.06 mg/kg ww), Cr (<0.24 mg/kg ww), and Ni (<0.28 mg/kg ww), while As, Pb, and Sn were consistently < LOQ. The pesticide suspect-screening revealed the presence of vinyltoluene, tributylphosphate, pentafluoropropionic acid, and some pesticides (e.g. methoprene, empenthrine, pirimiphos-methyl), but it was not possible to identify a clear contamination pattern between the insects and the insect-based food. In addition, the chemical levels measured in edible insects were compared with

those found in other studies reporting contamination levels in meat, fish and seafood, and eggs at levels considered safe for human consumption. Overall, our results support the possibility for humans to consume these insect species with no additional hazards in comparison with commonly eaten animal products, and indicate that the analyzed insect food could be considered a valuable alternative to common sources of proteins.