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HEALTH AND ENVIRONMENTAL BENEFITS OF THE DESIGN OF A NOVEL HYBRID FOOD MIXING MEAT AND MUSHROOM

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I. INTRODUCTION

Several studies suggest the involvement of toxic food-born contaminants in various human pathologies. Meat products are particularly concerned by the generation of process-induced toxicants (PITs) with mutagenic and carcinogenic properties which are now more than ever targeted by health safety agencies [1]. Along with these public health considerations, FAO projections for 2030 predict an increase in protein demand of around 40%, which cannot be covered only by animal protein. Scientists therefore agree that it is necessary to increase the proportion of plant proteins in our diets, but many obstacles remain before we get there. In this context, the MixMeat project aimed to show that it is possible to formulate new types of hybrid foods guaranteeing a low rate of PITs generated during cooking while maintaining a good essential proteins and nutrients intake. To do this, the project took advantage of both the antioxidant and nutritional properties of button mushrooms to offer an innovative hybrid food that is healthier and in line with the need for food transition. The aim of the project was to develop a new mitigation method for PITs and to investigate the mitigation mechanisms involved, as well as the environmental impact that would result from formulating such a food.

II. MATERIALS AND METHODS

Hybrid food preparation. Beef meat (semi membranous) and fresh button mushroom were grounded separately than mixed together in different proportions to form hybrid foods. The different samples were cooked in a stainless-steel frying pan (17 cm diameter) on a controlled-temperature induction hob (Bosch Electroménager, Saint-Ouen, France) to simulate well-done meat. Temperatures at the core of the meat and at the bottom of the pan were monitored by thermocouples (RS Components, Beauvais, France). Microwaved minced steak and hybrid foods have also been formulated to serve as references.

PITs analysis. Heterocyclic aromatic amines (HAAs) and polycyclic aromatic hydrocarbons (PAHs) were first extracted from the matrix by different QuEChERS protocols then analysed by UHPLC-ESI-MS/MS and UPLC-FID, respectively.

Inhibition study. The inhibition of HAAs by antioxidants present in mushroom was studied in a model medium by reacting PhIP precursors (phenylalanine, creatitine and glucose) with various fungi antioxidants, either pure or in a mixture, for 2h30 at reflux in H_2O/diethylene glycol (1/4).

LCA analysis. An LCA-type impact study was carried out, taking into account raw materials (their production), transformation processes (energy consumption, input materials, waste products and their treatment, co-products, etc.) and nutritional criteria. The proposed LCA was both attributional and consequential, in order to assess potential impacts under current production conditions (attributional) and to capture the environmental impact of changes in formulation and induced changes in the food market over the next few years (consequential). Cross-referenced indicators of risk to human health and LCA-type indicators were proposed in a multi-criteria analysis, to better define the benefits of the new food. The method ReCiPe Midpoint was applied.

III. RESULTS AND DISCUSSION

HAAs analysis. The method used to assess HAA levels in the different hybrid foods was already validated for pure beef samples [2]. The study of the matrix effect showed a difference in response between the different extracts (beef, mushroom, beef + mushroom). Therefore, different dilutions had to be used for different samples. The 16 HAAs most frequently found in cooked meat were measured in the samples and mixed inhibition results were found, raising questions about formulation and composition, in particular.

PAHs analysis. The method for PAHs analysis was development and validated in term of linearity, extraction yield, repeatability, reproducibility, LOD, LOQ. LOD ranged from 0,04 to 0,14 ng/mL & LOQ ranged from 0,15 to 0,48 ng/mL. The level of the 4 PAHs regulated by the EU [3] was assessed in the different samples. None of the samples studied here failed to meet the European legislation which sets maximum levels of 5 µg/kg cooked meat for benzo[a]pyrene and 30 µg/kg cooked meat for the sum of benzo[a]pyrene + benzo[a]anthracene + benzo[b]fluoranthene + chrysene and was in line with the European legislation.

Inhibition study. The flavonoids present in button mushrooms (myricetin, quercetin & catechin) had the ability to inhibit the formation of PhIP in model system (figure 1). These results confirmed the value of this type of antioxidants in limiting the formation of PITs during meat cooking.



Figure 1. Reaction conditions in a model environment for studying the inhibition of PITs by the antioxidants of button mushroom. Case study on PhIP.

LCA analysis. In order to implement the LCA methods (figure 2), a mixed product providing the same protein intake as a minced steak was modelled in order to guarantee the same nutritional function. It included 51g of beef (in order to qualify as a 'meat-based preparation'), 32g of button mushroom, and 17g of whey. The LCA taking into account the impacts on the climate change category showed that the hybrid product had 1.5 to 2 times less impact than minced steak.



Figure 2. The different stages of the LCA study

IV. CONCLUSION

This work has demonstrated the value of developing a new hybrid food mixing meat and mushroom for the dietary transition to more plant-based diets and with recognised environmental benefits (GGE…)

The inhibitory effect of button mushroom on the formation of process-induced toxicants needs to be further investigated, in particular by considering formulation, raw material variability and storage issues.

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