

Optimizing the Nutritional Composition of a Meat Substitute Intended to Replace Meat in Observed Diet Results in Marked Improvement of the Diet Quality of French Adults

Marion Salomé,¹ H  l  ne Fouillet,¹ Marie-Charlotte Nicaud,² Alison Dussiot,¹ Emmanuelle Kesse-Guyot,³ Marie-No  lle Maillard,² Jean-Fran  ois Huneau,¹ and Fran  ois Mariotti¹

¹Universit   Paris-Saclay, AgroParisTech, INRAE, UMR PNCA, France; ²Universit   Paris-Saclay, INRAE, AgroParisTech, UMR Say-Food, France; and ³Sorbonne Paris Nord University, Inserm, Inrae, Cnam, Nutritional Epidemiology Research Team (EREN), Epidemiology and Statistics Research Center—University of Paris (CRESS), Bobigny, France

Objectives: While consumers' demand is growing, meat substitutes have much varied composition, raising questions about their nutritional interest. We aimed to identify the composition of a meat substitute that would best improve diet quality, and analyze the impact on nutrient adequacy.

Methods: We aimed at maximizing the overall diet quality of an average individual representing the nutrient intake of the French adult population (INCA3, $n = 1125$) by modeling the composition of a meat substitute intended to replace meat, using non-linear optimization (using SAS, proc optmodel). The diet quality was assessed using the PANDiet scoring system, which assesses the probability of adequate nutrient intake. Nutritional constraints were applied in order to not increase the risk of overt deficiency for 12 nutrients. A list of 159

ingredients was used to compose the meat replacer and technological constraints were defined so as to take into account the feasibility of the formulation. The impacts on diet quality of the modelled meat substitute were analyzed and compared with those of 43 meat substitutes on the market.

Results: The optimized meat substitute was composed of 13 ingredients (such as coco bean, yellow sweet pepper, rapeseed oil, dried shiitake mushroom, wheat bran and thyme) and this formulation proved to be relatively robust to variations in the model constraints, as shown by a sensitivity analysis. Meat substitution with this optimized meat substitute largely increased the PANDiet, by 5.5 points above its initial value before substitution (73.7/100). In particular, it led to better adequacies for nutrients that are currently insufficiently consumed (e.g., alpha-linolenic acid, fiber, linoleic acid). It also allowed to compensate for loss of some nutrients partly provided by meat (e.g., vitamin B6, potassium and, to a certain extent, bioavailable iron), but was not sufficient to compensate for bioavailable zinc and vitamin B12. The optimized meat substitute proved to be dramatically more nutritionally efficient than the available meat substitutes, whose individual impact on the PANDiet ranged from -3.1 to $+1.5$ points.

Conclusions: We proved that it is possible to select appropriate ingredients resulting in a meat substitute that could be a fairly good nutritional lever when substituting meat.

Funding Sources: Partly funded by a PhD fellowship from Terres Univia.