Individual diet optimization on French adults shows that plant-based "dairy-like" products may complement dairy in sustainable diets

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Online Supplementary Material

Supplemental File S1. Mathematical description of the objective functions and constraints applied to all models (main and sensitivity analysis)

This supplemental file presents the objective functions and constraints that were applied in both main analysis and sensitivity analysis aiming to assess to what extent adding as decision variables only PBDL products to the list of foods already consumed by the individual could help to achieve nutritional adequacy with a 30% carbon impact reduction.

In the main analysis, the following objective function was used.

Objective function used in the main analysis

$$Min\ F_i = \sum_{j=1}^{N=214} \left| Q_{ij}^{opt} - Q_{ij}^{obs} \right|$$

Q_{ij}^{opt}= Optimized quantity of food item *j* for individual *i*

Q_{ij}^{obs}= Observed quantity of food item *j* for individual *i*

In the sensitivity analysis, two additional diet optimization models were run: one allowing only access to foods already consumed by the individual (Model NO_NEW_FOODS) and the other allowing foods already consumed by the individual plus PBDL products (Model_PBDL_ONLY). All the other parameters (constraints and variables) of the original model were kept unchanged.

Objective function of NO_NEW_FOODS model

$$Min\ F_i = \sum_{j=1}^{Ni} \left| Q_j^{opt} - Q_j^{obs} \right|$$

Ni = total number of foods consumed by individual *i* in his/her observed diet

Q_j^{opt}= Optimized quantity of food item *j*

Q_j^{obs}= Observed quantity of food item *j*

Objective function of PBDL_ONLY model

$$Min\ F_i = \sum_{j=1}^{Ni} \left| Q_j^{opt} - Q_j^{obs} \right|$$

Ni = total number of foods consumed by individual *i* in his/her observed diet plus PBDL that were not consumed in his/her observed diet

Q_j^{opt} = Optimized quantity of food item *j*

Q_j^{obs} = Observed quantity of food item *j*

Constraints (strictly the same in both main and sensitivity analysis)

Constraints applied in sensitivity analysis are strictly the same as what is described in "Variables and objective function of the model" section. The following depict their mathematical forms.

Nutrition

$$\boldsymbol{min\ reco^n \leq optimized\ intake_i^n \leq max\ reco^n}$$

Where *optimized intake*$_i^n$ is the optimized intake in nutrient *n* for individual *i*. *Max reco*^{n} corresponds to upper bound for nutrients *n*. *Min reco*^{n} corresponds to minimum imposed intake for nutrient *n*. This minimum intake corresponds to lower bound for macronutrients and estimated average requirement (EAR) or observed intake (OI) or recommended dietary allowance (RDA) for micronutrients (see Supplemental S3 Table 3). The minimum levels imposed were as follows: at least the estimated average requirement (EAR) when OI was lower than the EAR, at least the RDA when OI was greater than the RDA, and greater than or equal to OI when OI was between the EAR and RDA.

Environment

$$\boldsymbol{optimized\ carbon\ impact_i \leq observed\ carbon\ impact_i \times 0.7}$$

Where *optimized carbon impact*$_i$ is the carbon impact associated with optimized diet of individual *i* and *observed carbon impact*$_i$ *is the* carbon impact associated with observed diet of individual *i*.

Acceptability

$$\boldsymbol{Optimized\ amount\ food_i^f \leq p\_95\_consumer^f}$$

Where *optimized amount food*^f_i is the optimized amount of food *f* for individual i. *p_95_consumer*^{f} is the level of consumption of food *f* corresponding to the 95th percentile observed in the sex-specific population of consumers of the food *f*. The 95th percentile of soy-based drinks was applied as a maximal amount for almond-based drinks and oat-based drinks, as these two foods were not present in observed diets.

If *f* is part of liver, foie gras, oyster, bottled waters or fortified sweetened and breakfast cereals food items and $\boldsymbol{Observed\ amount\ food_i^f = 0\ then\ Optimized\ amount\ food_i^f = 0}$

Where *observed amount food*$^f{}_i$ and *optimized amount food*$^f{}_i$ are observed and optimized amounts of food *f* for individual *i* respectively.

$$\boldsymbol{Optimized\ amount\ food\ group_i^g \leq p\_95\_whole\_pop^g}$$

Where *optimized amount food group*$^g{}_i$ is the optimized amount of food group *g* for individual i. *p_95_whole_pop*^{g} is the level of consumption of food group *g* corresponding to the 95th percentile observed in the sex-specific population for the consumption of food group *g*. Unlike to the 95th percentile estimated to set a constraint on foods, the 95th percentile estimated to set a constraint on food group *g* included non-consumers of food group g.

$$\boldsymbol{Optimized\ amount\ food\ subgroup_i^s \leq p\_95\_whole\_pop^s}$$

Where *optimized amount food subgroup*$^s{}_i$ is the optimized amount of food subgroup *s* for individual i. *p_95_whole_pop*^{s} is the level of consumption of food subgroup *s* corresponding to the 95th percentile observed in the sex-specific population for the consumption of food subgroup *s*. Unlike to the 95th percentile estimated to set a constraint on foods, the 95th percentile estimated to set a constraint on food subgroup *s* included non-consumers of food subgroup *s*. There was no maximal amount constraint for PBDA subgroup. P_95_whole_pop^s was set to 200g per week for food subgroup *s* "Fish and seafood" in order to take toxicological risk into account, as recommended by ANSES.