Nutrient profiles : do they favour dietary and nutritional balance ?

Comparative analysis of various systems of nutrient profiling : Studies of their agreement and modelling of compatibility with nutritional recommendations. Work by IFN Task Force

Executive summary :

As part of a study on nutrient profiles, the work of GT IFN has investigated the notion of categorising foods and their specific nutritional properties (cf. progress report, March 2007). Also, the group is trying to compare the eligible/ineligible classifications obtained from different systems of nutrient profiling. Of the various possibilities envisaged, the group has chosen to explore certain ones in more detail.

Different tests were done from six pre-existing systems of nutrient profiling based on different algorithms and operating on a database of 700 food products sold in France:

1-The classifications obtained from different systems were compared by mathematical concordance analysis. Depending on the system chosen, eligibility varied greatly according to groups and categories of foods. These tests attempt to evaluate the compatibility of a system with the notion of a varied and balanced diet (by excluding or including certain categories of foods).

2- The capacity of each of these systems to respond to one of the objectives, namely to favour the attainment of a better nutritional balance, was tested by using modelling of dietary rations by linear programming (theoretical approach). We have suggested various hypotheses to analyse the nutritional suitability of a given system and to propose possible adaptations. None of the systems tested in their present form was able to satisfy all the hypotheses.

In view of the impact which the chosen system might have in the context of regulation 1924/2006/CE on the nutritional and dietary balance (based on groups and categories of food), it is desirable to pursue and refine this work and the methods to be able to respond to the question posed.

European regulation EC/1924/2006 stipulates in its article 4 that food products or certain categories of food products should conform to specific nutrient profiles in order to claim nutritional or health benefits. The main objective of the law is to moderate the promotional effect of the claims and to help the consumer to make dietary choices beneficial to health, whilst favouring the reformulation and development of innovative products.

Scientific advice was issued by EFSA in January 2008, and the Commission and Member States are currently working on different scenarios, incorporating the advice of EFSA and also considering « non-scientific » aspects, such as ease of use by the operators and the authorities, the stimulating effect of reformulating products and the cost/effectiveness ratio.

On the fringe of this work carried out by the authorities, numerous private and public bodies have proposed various systems of nutrient profiling during the last two or three years, able to classify foods as « eligible » or « ineligible ». These systems differ from one another by the choices made for various key methodology questions, such as:

- whether to take into account food categories, rather than a global approach for all food products.
- the nature and number of nutrients to take into account.
- the basis of reference (weight, energy or portion).
- the method of calculation (a threshold for each nutrient or a combined score).
- the determination of limiting values (thresholds or scores) separating « eligible » from « ineligible » foods.

The IFN (French Nutrition Institute) set up a task force[1] in July 2006 on the subject of « nutrient profiles ». The group decided that it was unnecessary to propose a new system and preferred to take as its objective to provide elements of responses to questions about certain principles of profile elaboration, within a context of European regulation on nutrition and health claims. This is based on consideration, both scientific and pragmatic, of how to evaluate as objectively as possible the nutritional quality of foods, by taking account of their nutritional characteristics and their place in the diet, with the aim of justifying access to bear claims, both nutritional and health-related.

Firstly, the working group considered the **notion of food categories, and tried to gather data on the specific features of different food categories as regards intrinsic nutritional characteristics, the value and place in the diet, the potential for optimisation and the possible consequences on nutritional supplies, and regulatory considerations.** This initial work clarified the perception of specific features associated with food categories and shows that it is necessary to devise a system of nutrient profiling which is able to preserve or optimise the contribution of each category to the nutritional intakes. A progress report presenting this first stage was submitted to the authorities in March 2007.

Next the group continued its work by a **thorough analysis of several systems of nutrient profiling.** The aim of the present work has been to compare the results of classifications (i.e. eligible vs ineligible foods) obtained from different profiling systems and to test the suitability of these systems to correctly identify foods according to their capacity to favour the general nutritional balance. Six pre-existing systems using various approaches (systems developed by the FSA (UK Food Standards Agency), by the CIAA (Confederation of the Food and Drink Industries in the EU), by Unilever and the Food-Profiler, SAIN LIM and LIM systems) were evaluated. It should be noted that some of the nutrient profiling systems used in this work were not originally devised as part of the objectives of EC regulation 1924/2006, and/or were applied with slightly different rules than those favoured by their designers for methodological reasons. It would therefore be wrong to draw conclusions from this work as to the particular value of each system.

The data table used mainly in this study is issued from the initial work of the IFN Task Force. Unlike the other tables available, it presents the composition of **foods actually sold** (n=743), available on the French market, and not just that of « generic foods » which usually are of average composition[2]. This table was not build to be representative of foods patterns (in quantity and quality).

[1] This task force is original in its composition as it includes representatives of the agro-food industries, food federations, and scientists concerned by the topic; the French administration was involved, and associations of consumers were informed.

[2] For each food, the « IFN » table gives energy value and 11 nutrients (proteins, fats, SFA, carbohydrates, sugars, fibres, vitamin C, vitamin D, calcium, iron, sodium), reference portion standard and eligibility for each tested nutrient profiling system

The analysis of systems of nutrient profiling was carried out in two independent and complementary stages:

- Firstly, **the classifications obtained from the different systems were compared using statistical techniques such as concordance analysis.** This analysis showed in particular the effect of choice of a system on eligibility for different groups and categories of food.

- Secondly, the capacity of each of the systems to **favour the attainment of a better nutritional balance** was tested by making use of **modelling of food rations by linear programming.** We tested the classifications obtained from the different systems according to the following 4 hypotheses:

H1. By eating only the foods considered eligible by this system, is it possible to have a balanced diet (EL-EQ) ?
H2. By eating only the foods considered eligible by this system, is it possible to have an unbalanced diet (EL-DESEQ)?
H3. By eating only the foods considered ineligible by this system, is it possible to have a balanced diet (NEL-EQ)?
H4. By eating only the foods considered ineligible by this system, is it possible to have an unbalanced diet (EL-DESEQ)?

Theoretically[3] an adequate system should be capable of responding to all these hypotheses as follows:

	Expected feasibility
H1 : EL-EQ (eligible food/balanced diet)	YES
H2 : EL-DESEQ (eligible foods/unbalanced diet)	NO
H3 : NEL-EQ (ineligible foods/balanced diet)	NO
H4 : NEL-DESEQ (ineligible foods/unbalanced diet)	YES

It is a theoretical and maximalist approach, deliberately far from reality, but that should logically be achieved by a nutrient profile system.

Each of these 4 hypotheses was tested for each of the six selected systems by using the IFN composition table and the nutritional recommendations for the reference nutrients.

The robustness of the results was then assessed using so-called « alternative » models intended to verify the effect on the results of some of the model characteristics:
A : type of nutritional constraints (based on recommendations or on observed intakes)
C : choice of composition table (the IFN table of commercially available foods vs generic foods from the Lavoisier table)
D : number of nutritional constraints introduced into the models (ca. 15 vs ca. 30).

[3] The task force is aware of the theoretical character of this approach, that doesn't suggest that the ideal diet would have to be composed only of eligible foods.

- **Main results**

1- Eligibility and agreement

Eligibility

The analysis of **global eligibility**, i.e. for all foods of the table, indicated that the SAIN LIM and Unilever systems were the most restrictive, as they refuted claims for 71% and 61% respectively of the foods in the IFN table.
The CIAA and FoodProfiler systems on the other hand appeared to be less restrictive as they only refuted claims for 21% and 36% of the foods respectively.
The FSA and LIM systems appeared to be intermediate as they refuted eligibility to rather more than half the foods in the diet (52% and 59% of the foods respectively).

Large disparities were observed for the different systems as regards **eligibility within groups and sub-groups of foods.** For example:

- within the *Seasonings* group, the SAIN LIM, LIM and FSA systems excluded all the foods, whereas the FoodProfiler, CIAA and Unilever systems only excluded 25%, 34% and 56% respectively.

- within the sub-group *Refined starchy foods* group, most (97%) of the foods were classified as ineligible according to the SAIN LIM system and a minority (8%) by the FoodProfiler system.

The additional analysis of the **eligibility within categories of foods** belonging to certain sub-groups (refined starchy foods and predominantly sugary products) also showed wide variability, with percentages of ineligible products ranging from 0 to 100% in certain cases (for example pasta).

It is also worth noting that a system which was in general very restrictive was not necessarily so for all the groups and categories of food, and conversely, a generally more permissive system could nevertheless prove to be restrictive as regards certain groups or categories.

Concordance

The concordances calculated for all the foods varied according to the system from 46% (between CIAA and SAIN LIM) to 91% (between FSA and LIM) for foods classified the same way (eligible/ineligible) between two systems.

The concordances **within groups of foods or even within categories** varied according to the pairs of systems and the food groups (or categories) considered.

This variability increased as the category considered became more precised, hence doubtless nutritionally more uniform, which probably exacerbated the effects of the choices (methodological and conceptual) applied by the different systems.

However high concordances were observed between all the systems for
- *predominantly sugary products*, mostly classified as ineligible by all the systems (except the CIAA system which does not take account of sugars' content) ;
- *fruits and vegetables,* mostly classified as eligible by all the systems (although the SAIN LIM system excluded 25% of fruits)

The system most often in agreement with the others as regards the classification of foods as eligible or ineligible within each sub-group was LIM, and the system which differed most clearly from the others was CIAA.

2- Modelling and compatibility with nutritional recommendations

All the systems tested, without exception, resulted in a balanced diet by only consuming eligible foods (by conforming with H1). Similarly, for all the systems, **it was possible to have an unbalanced diet by only eating ineligible foods (by conforming with H4).** This first level of verification indicates that **all the systems used therefore offered a classification generally in agreement with « nutritional common sense ».** The constraints of realism imposed on the modelling system led to dietary rations potentially achievable in everyday life.

The intermediate hypotheses or « crossover hypotheses » (H2 : impossibility of having an unbalanced diet with eligible foods and H3, the impossibility of having a balanced diet with ineligible foods) **turned out to be more critical, so that** none of the systems verified the expected results for all the four hypotheses tested.

This difficulty in conforming with all four of the hypotheses envisaged suggests that all the systems tested had their weak points. In other words, certain foods, no doubt different in each case, were probably wrongly classified. In fact the results showed that the most restrictive systems in terms of overall eligibility (SAIN LIM, LIM, Unilever and FSA), could indicate a balanced diet with ineligible foods (thus not in conformity with H3). They could therefore be considered too severe since they classified wrongly certain foods as « ineligible ». On the other hand, the least restrictive systems in terms of access to claims (CIAA and FoodProfiler) could indicate an unbalanced diet with eligible foods (not conforming with H2). They could therefore be considered as too permissive because they wrongly classified certain foods as « eligible ».

It was only by using the longest list of constraints with an alternative model, that conformity with all four hypotheses could be demonstrated, but with only two systems (LIM and FoodProfiler). On the other hand, the list of foods used (« generic » or « on sale », with over- or under-representation of certain food categories) seemed to have little effect on the results. Likewise, the conclusions were not altered according to whether the nutritional constraints were based on the recommendations or on the observed intakes.

- **Conclusion**

The objective of this latest work was not to award prizes for the different systems but rather to provide information on the classifications made by these systems and to explore their capacity to favour a global nutritional balance.

As expected, the classifications proved to be more or less restrictive from one system to another (21-71% of products classified as ineligible). **We were able to show that the classifications made by the different systems present a correct level of general agreement ;** however this was mainly due to the food categories for which the nutritional evaluation is fairly simple and often consensual (for example fruits and vegetables). The agreement between systems was poorer when considering complex products whose nutritional evaluation is more difficult, involving eligible/ineligible classifications varying from one system to another for certain categories of products. **The choice of system will therefore have different impacts on groups of foods and also on the categories within these food groups; hence the importance of studying carefully the results of the system which is to be chosen in regulatory terms for** access to **nutritional and health claims.**

The results of the modelling have clearly shown the **compatibility of all the systems tested with nutritional « common sense »** since all of them allowed one to have both a perfectly balanced diet by only using eligible foods (conforming with H1) and a completely unbalanced diet by only eating ineligible foods (conforming with H4). Nevertheless the results show that there is still room for improvement for each of the systems, in that they barely conform with H2 and H3, and since **no system appeared capable of an optimal classification** (i.e. conforming with all four hypotheses simultaneously) in the basic models. However, by refining the models, and notably by including additional nutritional criteria to better specify the notion of nutritional balance, certain systems were found to be more suitable than others for a correct classification.

The modelling approach developed in the present study had as its sole objective to study the compatibility between a given profiling system and a series of nutritional constraints based on nutritional recommendations. The modelling results appear relatively robust as they were not greatly altered by changes in certain characteristics of the models such as the list or type of foods and the type of constraints. However not all of the numerous possible variations in the parameters were explored and they could offer prospects for investigation and improvement.

- **Prospects**

The modelling of rations by linear programming can contribute to the validation of systems of nutrient profiling. However it only seems to be genuinely discriminatory when a large number of nutritional constraints are introduced. If this theoretical approach had to be used to detect and compare different systems or to examine one of them in more detail, it would be necessary to have available sufficiently precise and detailed nutritional composition data. **This point is particularly important and implies that, even if one wishes to study a simple system involving only a small number of nutritional criteria, it is necessary for this validation to have available reliable data on a considerable number of nutrients and foods.**

A good agreement was found between the descriptive part of the results (eligibility and concordance) and the analytical part (modelling). Notably it was fairly clear that the most restrictive systems perhaps wrongly excluded certain foods from entitlement to claims, whereas

the least restrictive systems perhaps wrongly classified certain foods as « eligible »: **an interesting development of this work would therefore be to identify, for each system, the « wrongly classified » foods.**

In fact, if a system leads to a balanced diet by only eating products classified as ineligible, it means that certain so-called ineligible foods have in fact real nutritional qualities as they are capable of « rebalancing » the nutritional « defects » caused by the other foods, which really are ineligible. It therefore appears probable that the foods which should have been classified as eligible have wrongly been deemed to be ineligible. The opposite reasoning is able to detect systems for which foods classified as eligible should have been classified as ineligible.

In spite of the current limitations of its conclusions and of certain methodological aspects, this work opens up some interesting prospects. **It was carried out using French data, but its principle is applicable to data from various sources, notably European. The work presented in this report indicates that the approach using modelling can be used as an element of validation for all types of « eligible/ineligible » classification,** making it possible to detect classification errors which might affect the nutritional balance of the consumer. From this point of view, it might prove useful and interesting to use the approach to examine the classification arising from the system which will be proposed as part of regulation 1924/2006/CE. In this way one may be able to identify possible classification errors in an objective and realistic way and propose either modifications of the system or else specific derogations.