Paper P6-1 **_Proximate Methods and Modes of Expression: Variability as a Harmonization Issue_**
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PROXIMATE METHODS AND MODES OF EXPRESSION: VARIABILITY AS A HARMONIZATION ISSUE

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ABSTRACT

Large numbers of methods of analysis and conventions for expressing food components have been developed for measuring and reporting ostensibly the same or similar nutritional entities. However, many of these methods are known to produce results that are not comparable. These incompatibilities frequently show up with some of the most commonly presented nutrients such as protein, fat, carbohydrate, fibre and energy. The factors contributing to the problem include non-prescription of methods, permitting use of different methods in different laboratories or from analyst to analyst within the same laboratory; different agencies within a country with different responsibilities prescribing different methods; and internationally, different labeling requirements with different methodological prescriptions. Two serious problems have been identified as resulting from the lack of standardization, or harmony or compatibility. First, it leads to expensive, time consuming and redundant analyses. And secondly, it leads to ambiguity and misinterpretation of nutritional information. A survey showing incompatibilities between proximate nutrient analyses and nutritional information requirements within countries and between countries was undertaken and the problems and potential problems are discussed. Adoption of INFOODS tagnames that define the nutrient entity, specify methods of analysis where different methods are known to produce different results, and incorporate the unit of measure, is identified as a useful step in addressing the problem of ambiguity, while high level and extensive international consultation is required to address the problem of harmonization and standardization as it relates to labeling of foods.

INTRODUCTION

Food composition is an area of research beholden to the inflexibilities and limitations of chemistry and the contingencies of biology. In an attempt to satisfy both, a large number of methods for food component analysis and expression have been proposed, adopted and used. They can represent rigorous or unapologetic chemical measurements <FATCE[1]>, chemical measurements with conversion factors to account for a biological or physiological context <PROCNT[2]>, physiological methods in animal models <PER[3]>, and calculations based on hope and optimism <CHOCDF[4]>. For some nutrient components, the different methods or expressions represent

[1]<FATCE>, Fat, total, by analyses using continuous extraction

[2]<PROCNT> Protein, total, calculated from total nitrogen

[3]<PER> Protein efficiency ratio

[4]<CHOCDF> Carbohydrate, total; calculated by difference

different fractions or aggregations of the nutrient, while the common terms may be identical. For example, there are five commonly used methods for measuring and/or expressing carbohydrate, each of which would be represented by a different "correct" value for the same food (Monro & Burlingame, 1996). These methods each have protagonists and antagonists in laboratories and in regulatory agencies around the world. It is not surprising, therefore, that disharmony and incompatibility exist. What may be surprising, however, is how frequently these incompatibilities show up. The most readily examined components are those most commonly analysed and presented on food labels and in food composition tables: protein, fat, carbohydrate, fibre and energy. In a single country, disharmony and incompatibility in measuring and/or expressing a food component can exist between analysts within a laboratory; between different laboratories undertaking nutrient analyses for the same purpose; and between agencies where one is responsible for setting nutrition labeling requirements and another is responsible for developing and maintaining the national food composition data base. Disharmony also exists between countries/regions, where there are different methods of analysis and presentation formats prescribed in food legislation for nutrition labeling.

Standardization of nutrient analysis methods for the purpose of harmonizing nutrition labeling and food composition data bases nationally should be a reasonable goal. And given the implications for regional and international food trade, and international research projects that depend on food composition data, harmonization beyond national borders should also be a reasonable goal. Acknowledging that few countries have achieved even a national goal of harmonization, compatibility or standardization it seems unlikely that international or regional goals can be achieved in the near future. A practical, immediate, realisable goal should therefore be to eliminate ambiguity and misinterpretation of food component information by adopting and using INFOODS tagnames (Klensin *et al*., 1989). Tagnames identify a food component unambiguously, and incorporate method of analysis/expression where different methods would give different numeric values, and include the unit of measure.

DISCUSSION

Incompatibilities within and between organizations, countries and regions

It is not uncommon for one organization in a country to have the responsibility for determining nutrition labeling requirements, and another to have the responsibility for that country's food composition programme, as shown in Table 1. The most familiar example is the United States, with the United States Department of Agriculture (USDA) having food composition data responsibilities and the US Food and Drug Administration (FDA) having most of the nutrition labeling responsibilities (Food and Drug Administration, 1993). The far right column of Table 1 shows that the incompatibility between these two agencies is with the food component "fat". The USDA determines fat by a solvent extraction and gravimetry procedure, while the FDA's NLEA requires fat to be expressed as the sum of the analysed individual fatty acids, calculated as triglyceride equivalents.

Up until July 1, 1996 in New Zealand, the Ministry of Health was responsible for operating the Food Standards Committee that drafts and gazettes food legislation. The New Zealand Institute for Crop & Food Research, a Crown Research Institute, is responsible for developing and maintaining the country's food composition data base and coordinating the nutrient analysis programme. Harmonizing nutrition labeling with nutrient analyses nationally is not difficult. New Zealand's nutrition labeling legislation, contained in the *Food Regulations 1984 and Amendments* (Department of Health, 1992), is reasonably flexible. With the exception of "special purpose" foods, and foods for which a claim is made, nutrition labeling is voluntary. There is only one prescriptive methodology, AOAC Prosky dietary fibre (Official Methods of Analysis, 1990). The far right column of Table 1 shows that this is the component for which there is incompatibility between food composition data base and food labeling. The routine method used for the Food Composition Database is Englyst soluble and insoluble non-starch polysaccharides (Englyst and

Hudson, 1987). No other methods of analysis are specified in New Zealand's food regulations. However, non-prescription of methods can be even more problematic because a range of "correct" results is possible, and the information is usually supplied without the understanding or documentation of method.

Table 1 shows that Australia is unusual among the countries listed, in that the same agency, the National Food Authority (NFA)[5], is responsible for both activities. NFA was created in 1991 for the purpose of consolidating these various food-related activities. Even so, there are still some areas of incompatibility between methods used in the food composition work and methods prescribed for nutritional labeling shown as carbohydrate and fibre in the far right column. For instance, crude fibre <FIBC> is a labeling requirement for breads, and Prosky AOAC fibre <FIBTG> is presented in the food tables/data files. The carbohydrate values in the food tables are “available” carbohydrate obtained by summation of sugars, starch, glycogen and other related compounds <CHOAVL> (NFA, Composition of Foods, Australia, vol 6., General Appendix 2) (note: in the tables the term used is “Carbohydrate, total”) and on food labels it is total carbohydrate obtained by difference (i.e., 100g minus the grams of water, protein, fat and ash) <CHOCDF>.

Table 1: Organizations with the major (but not exclusive) roles in food labeling and food composition data, and nutrient incompatibilities.

COUNTRY	**ORGANISATION RESPONSIBLE FOR FOOD LABELLING**	**ORGANISATION RESPONSIBLE FOR FOOD COMP DBASE**	**NUTRIENT INCOMPATIBILITY**
USA	FDA	USDA	Fat, Energy
UK	MAFF	Royal Society	Carbohydrate, Protein, Energy, Vit A
NZ	Ministry of Health	NZ Institute for Crop & Food Research	Fibre
Australia	National Food Authority	National Food Authority	Fibre

Another example of a country where food labeling and food composition data base development reside with different agencies is Canada where Agriculture and Agri-Food Canada has the responsibility for food labeling, and Health Canada has the responsibility for the national food composition database.

Regional and international organizations further compound the issue by their involvement in regulations. For example, the EC Directive and FAO's Codex Alimentarius both have labeling regulations and guidelines, as do many individual European countries.

5 On 1 July 1996, the agency became known as The Australia New Zealand Food Authority.

Description and quantification of the differences in values with the different methods of analysis/expression

Some of the differences in nutrition information requirements are trivial, while others are significant. Some differences involve different calculations, while other involve different methods of analysis for reporting basically the same nutrient entity.

Units of presentation

Energy

The requirements can involve different factors in the simple calculations; for example energy in kilojoules in most countries, sometimes with kilocalories as an optional addition, versus kilocalories exclusively as in the USA. Many conventions are in use, most commonly by calculation using factors with energy-yielding components. Some conventions specify the same factor for each component, e.g., 4 X g total protein; while others use a range of different factors for each component.

Factors to calculate energy contributed by protein can range from a low of 1.82 for bran, to a standard value of 4 for all foods, to a high of 4.36 for eggs.

Factors to calculate energy contributed by fat can range from a low of 8.37 for most grains, to a standard value of 9 for all foods, to a high of 9.02 for eggs.

Factors to calculate energy contributed by carbohydrate can range from a low of 1.33 for chocolate, to a standard value of 3.75 for available carbohydrate in monosaccharide equivalents <CHOAVLM> and 4 for total carbohydrate <CHOCDF> for all foods, to a high of 4.12 for distilled spirits.

Protein

Protein is rarely analysed directly. The most common method for expressing protein is by direct analysis of nitrogen, and multiplication of this value with a selected nitrogen conversion factor. This is not straightforward. The nitrogen values used can be total nitrogen <NT>, amino nitrogen <NAM>, and protein nitrogen <NPRO>. The nitrogen conversion factor can be the standard conversion factor 6.25, or specific factors as used and/or recommended by FAO (1970), Jones (1941), and USDA (1994).

Protein calculated as nitrogen times the standard 6.25 is dictated by the EC Directive, whereas Codex Alimentarius prescribes calculation with at least one different reference nitrogen conversion factor, that is 5.7 for durum wheat semolina and durum wheat flour.

A typical food technologist or nutritionist could easily take basic laboratory data and satisfy all these different market requirements.

Fat

In the United States, since the enactment of the Nutrition Labeling and Education Act (NLEA) (Food and Drug Administration, 1993) the lack of harmonization, compatibility and standardization has presented some problem.

The most problematic of the nutrients is fat, as defined by the NLEA as triglyceride equivalents of fatty acids. The differences between values obtained by the NLEA methods and an extraction/gravimetric method can be significant for many reasons, including the presence of fatty acids from non-triglyceride lipids and the unavailability of standards for identifying/quantifying all known fatty acids.

The NLEA is often described as a non-tariff trade barrier, particularly when exporters calculate the cost of the nutrient analyses. In most commercial laboratories, the cost of a gravimetric fat analysis is about 25% of the cost of a comprehensive fatty acid analysis, which is needed for determining fat as the triglyceride equivalent of fatty acids. This cost, together with those for total nitrogen, individual mono- and disaccharides, starch, fibre, sodium, calcium, iron, vitamins A and C, and cholesterol, for the "short" form of the NLEA label, represents a substantial cost for each food analysed.

CONCLUSIONS

It is not the point of this paper to make recommendations regarding the “best” method of analysis, or the solution to standardizing the world’s nutrition information. Rather, the point is to demonstrate the need for eliminating ambiguity and striving for harmonization.

The potential for ambiguity resulting from different methods of analysis has been avoided in several food composition data bases by the use of INFOODS tagnames to identify the food components. These include the data bases in regional data centres of OCEANIAFOODS, ASEANFOODS, and LATINFOODS; and in many countries in these regions and beyond, including the United States with Standard Reference 11. This eliminates ambiguity in the identification of food components, within the country by providing appropriate documentation in the data base, and between countries when interchanging data.

A greater problem is harmonization of methods of analysis with a multiplicity of overseas labeling requirements for export products. This problem is compelling for food exporting countries like New Zealand when each food must comply with the labeling legislation in each of its export markets. Although straightforward analytically, it is burdensome and expensive to the food industries.

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