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Challenges in Health Risk Assessment of Food Factors

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ABSTRACT

Food factors (FF) are nutrients and other related substances present in processed foods for special dietary uses related to health promotion and disease prevention. Due to the nutritional and other favorable effects of FF, their health risk assessment is more complex than the established food safety risk assessment (FSRA) that addresses excessive intakes of food additives and contaminants. For FF, risk assessment adds a new dimension to also address risks posed by inadequate intake of these food constituents, and is referred to as nutritional risk assessment (NRA). NRA consists of the four standard steps of FSRA: hazard identification, hazard characterization, intake assessment and risk characterization. The added challenges in NRA of FF include: 1) identification of target chemicals for assessment, 2) availability of data on critical biological activities, 3) occurrence of FF in total diet, and 4) information on lower limits and upper limits of daily intakes. Resveratrol, an extensively marketed red wine antioxidant, is used as an example to illustrate the complexity and challenges in the health risk assessment of a FF in a functional food product.

Key words: food safety risk assessment, nutritional risk assessment, food factors, functional food product

INTRODUCTION

Foods are composites of chemicals. Based on the principles of toxicology⁽¹⁾, “the dose makes the poison”; any chemical in food may pose a health risk if its intake exceeds a tolerable level. This level is known as tolerable daily intake⁽²⁾, or TDI, in the unit of mg per kg-body weight per day (mg/kg-bw/day), implying that in a chronic exposure scenario, if one receives daily intake of the chemical below TDI, there will be no added risk of a specified health effect in one’s lifetime through consumption of foods. In assessment of health risk due to excessive exposure, the chemical is known as a hazard. Typical examples of hazards are food contaminants such as pesticides and heavy metals and food additives such as preservatives and emulsifiers.

FOOD SAFETY RISK ASSESSMENT

The above statement immediately brings up some questions: why a particular chemical in food is regarded a hazard? What specified health effect whose risk is being addressed to? How to assess the daily intake of the hazard which is distributed in a wide variety of foods? What are the daily consumption rates of all the food items that contain the hazard, and what are the average body weight and lifetime of a population of concern?

To answer these long-existing questions scientifically, the process of food safety risk assessment, or FSRA, has been developed in the past few decades and practiced worldwide by such food safety authorities as the Codex Alimentarius Commission of Joint World Health Organization and UN Food and Agriculture Organization (CAC)(3), United States Food and Drug Administration (USFDA), European Food Safety Authority (EFSA), to

name but a few.

The established FSRA process consists of four steps. They are:

1. Hazard identification: to identify the hazard of interest such as melamine in milk and the associated critical health effect of concern such as bladder stone formation.
2. Hazard characterization: to determine the quantitative relationship between the dose of the chemical received and the incidence of the specified health effect in a population, and to determine the TDI of the chemical.
3. Intake assessment: to determine the average daily dose or ADD of the chemical through consumption of diets including drinking water.
4. Risk characterization: to ascertain whether the value of ADD exceeds the TDI of the chemical, and to calculate the concentration of the chemical permitted in individual food items for regulatory purposes.

Given the expectation that FSRA is a scientific exercise, it must be evidence-based. The validity of the result of assessment depends strongly on the scientific information available. Some major data needs for each of the four risk assessment steps are shown in Table 1.

Table 1. Four standard steps of food safety risk assessment and their respective data needs

Step	Data needs
1. Hazard identification	Agents of interest as hazards, critical toxic effects of interest
2. Hazard characterization	Dose-response relationships, no-observable adverse effect level (NOAEL)
3. Intake assessment	Concentration distribution in foods, exposure factors such as body weight, average daily consumption rate of a food item, lifetime duration
4. Risk characterization	Safety reference values such as TDI, reference concentrations of the agent in different food items (RfC)

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NUTRITIONAL RISK ASSESSMENT

To assess health risk of a chemical in food as a food factor (FF), rather than a food contaminant, the process becomes more complex. Because FFs such as nutrients are either biologically essential or potentially beneficial to health, their risk assessment adds a new dimension of having to also address risks posed by inadequate intake of these food constituents. The process is then known as nutritional risk assessment⁽³⁾, or NRA.

According to the CAC Procedural Manual⁽³⁾, NRA also consists of the same four steps as in FSRA. The data needs of NRA compared with those of FSRA are shown in Table 2, displaying the added complexity of NRA. The comparison between risk assessment of food contaminants and risk assessment of food factors can be represented by Figure 1⁽⁴⁾. The FSRA for food contaminants only deals with the right-hand side of the dose-response curves, whereas NRA for a FF would need to address both sides of the curves for situations of both excessive and inadequate intakes.

Table 2. Comparison of data needs between FSRA and NRA

FSRA	NRA
Hazardous Agents of interest, toxic effects of interest	Active agents of interest, toxic & nutritional effects of interest, risk of deficiency
Dose-response relationship in 1 direction (increasing dose)	Dose-response relationship in 2 directions (increasing and decreasing dose)
Concentration distribution in foods, exposure factors	Concentration distribution in foods, exposure factors
Safety reference values, e.g. TDI, RfC	Safety reference values, nutritional reference values

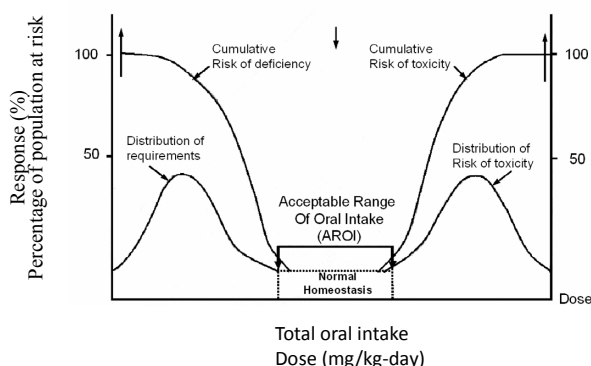


Figure 1. Dose-response curves for a food factor (nutrient) in a human population.

AN EXAMPLE

Taking the anti-oxidant FF, resveratrol found in red wines⁽⁵⁾, as an example, to assess its health risks as an ingredient of a dietary supplement product using the currently available risk assessment methodology, one would need information on the following areas in order to produce a reasonably valid result.

1. The number of congeners present in a food and their relative anti-oxidant potencies and toxic potencies.
2. The bioassays to be used to generate data on these claimed biological activities.
3. The distribution of the naturally occurring resveratrol in the total diets of an average consumer as his/her background exposure.
4. The consumer's average daily consumption rates of all the food items that may contain resveratrol in order to calculate the ADD of this factor.
5. The TDI values based on a specified adverse health effect.
6. The minimal requirement of this factor to maintain the health of the consumer based on a set of health criteria.

These are all extremely challenging areas of information to be explored. And the uncertainties of any obtainable data are expectably very high.

INVESTIGATIONAL CONSIDERATIONS

In the wake of a rapidly growing industry of functional foods that contain a wide range FFs, a risk assessment practitioner is at present facing some formidable challenges that need urgent, critical investigational considerations.

1. The current methodology of FSRA seems inadequate to achieve the objective of NRA for a FF in a product.
2. An innovation in paradigm and approach seems warranted.
3. There are many information gaps that would need an array of high throughput bioassays to generate the needed data.
4. For the time being, the precautionary principles may be applied to the consumption of FF containing food products.
5. It is advisable that functional foods be taken in moderation with discretion.

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