Naturally functional foods – challenges and opportunities

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Whilst it is a truism that all foods are functional, the term ‘functional foods’ has come to be associated with those foods that contain specific ingredients with proven physiological effects. These can be particularly useful in providing fortified common foods such as cereals, bread, dairy products and margarine, both to combat potential vitamin and mineral deficiencies and to help in management of e.g. cholesterol levels, blood pressure etc. This molecule-based approach is also followed by the supplement industry and brings with it the benefit of clarity of communication when specific molecules can be linked to useful outcomes.

On the other hand, it is also well established (particularly from epidemiology) that diets rich in e.g. vegetables, fruits, grains and fish, augmented by lean meat, dairy/soy and certain oils are associated with sustained health benefits. A benefit of this whole food approach is that there is a heritage of successful use in diverse communities around the world. In some cases, there are clear connections between the whole food approach and the specific molecule approach e.g. in oil quantity/quality or complex vs simple carbohydrates. However, in many cases it is difficult to be precise about the molecular origins for whole food benefits, as intervention studies with specific molecules have not shown convincing effects e.g. fruits and vegetables vs vitamin/mineral supplements.

Taking fruits and vegetables as a case in point, it could be argued that the failure to reproduce ‘expected’ benefits via intervention with vitamins/minerals is due to some combination of (a) underestimation of the role of as yet unrecognized health-benefiting molecules and/or (b) the importance of the native cellular structure of plants in providing the matrix from which molecules are released during digestive processing. The science is now in place to tackle these possible causes, utilising post-genomic biology of food raw materials to better define molecular composition (“metabolomics”), and exploiting modern spectroscopic and microscopic methods to define the effect of food structure on molecular release.

In order to provide compelling evidence for cause-and-effect relationships between food composition and health outcomes, much more knowledge is needed on the molecular mechanisms of action, not just of individual molecules in isolation but also of complex mixtures delivered from the often hierarchical structures of food matrices. A ‘holy grail’ vision would be to reduce the response to food intake of specific receptors/cells/tissues/ organs in the human body into a manageable number of in vitro assays. This is not an impossible goal, but depends on the level of validation that can be achieved for specific in vitro assays, and the consequent level of predictability when results are taken forward to clinical and other trials. This proposition has some parallels to the advances achieved over the last decade in the in vitro assessment of toxicology, where there has been a concerted drive to replace animal models. There is general agreement that a satisfactory assessment of risk can now be obtained from such cellular and molecular assay systems. Can a similar level of credibility be obtained for in vitro assessment of nutritional effects? One point of distinction might be the high level of interaction between cellular processes that are affected by nutritional factors. A second could be the molecular (metabolomic) complexity inherent in natural foods. However, the opportunities of (a) carrying out large numbers of experiments and (b) identifying multiple effects of (mixtures of) food components in cellular and molecular assay formats make the approach a highly attractive one. A particular benefit of addressing the complexity of foods and in-body responses at an in vitro level is that it provides a potentially tractable way of tackling nutrition for sustained health and well-being through addressing multiple small effects simultaneously. This is in contrast to the pharmaceutical-inspired approach of looking for ‘one molecule – one effect’ that has been successful in specific instances, but is unlikely to succeed where effects are more subtle e.g. in unraveling the molecular mechanisms underpinning the perceived benefits of a ‘balanced diet’ rich in natural foods.