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Proposal for a dietary "phytochemical index"

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Summary There is ample reason to believe that diets rich in phytochemicals provide protection from vascular diseases and many cancers; direct antioxidant activity as well as modulation of enzyme expression or hormone activity contribute to this effect. Phytochemicals derived from diverse foods presumably can interact additively and (possibly) synergistically; thus, the total dietary load of phytochemicals may have important implications for health. As a means of very roughly quantifying this load, a "phytochemical index" (PI) is proposed, defined as the percent of dietary calories derived from foods rich in phytochemicals. Calories derived from fruits, vegetables (excluding potatoes), legumes, whole grains, nuts, seeds, fruit/vegetable juices, soy products, wine, beer, and cider – and foods compounded therefrom – would be counted in this index. Partial credit could be given for antioxidant-rich extra virgin olive oil. Other added oils, refined sugars, refined grains, potato products, hard liquors, and animal products – regrettably, the chief sources of calories in typical Western diets – would be excluded. Although the PI would provide only a very rough approximation of the quantity or quality of phytochemical nutrition, it nonetheless could aid epidemiologists in exploring the health consequences of diets high in phytochemical-rich plant foods, and could also help clinical nutritionists in their efforts to improve the phytochemical nutrition of their clients.

Health protection conferred by phytochemical-rich foods

There is a broad and growing consensus that many phytochemicals found in whole plant foods can provide versatile health protection; in particular, these compounds are believed to help preserve vascular health and diminish cancer risk. Direct antioxidant activity, as well as modulation of detoxifying enzyme expression or activity (e.g. upregulation of phase II and/or inhibition of certain phase I enzymes) may mediate much of this benefit, although other mechanisms are likely involved [1–4]. Modulation of hormone activities may play a role: flax lignans, as well as isoflavone-rich soy protein, have recently been reported to downregulate hepatic IGF-I production in rats [5,6], lycopene can interfere with IGF-I signaling in vitro [7,8], and the possible impact of dietary phytoestrogens on estrogen function continues to spark controversy [9–11].

In prospective cohort studies, as well as case-control and a few ecologic studies, reduced risk for coronary disease and for ischemic stroke has been linked to relatively high intakes of fruits and vegetables [12–23], legumes [24–27], nuts [28–33], and whole grains [34–41]. Among whole plant foods commonly consumed, only potatoes – a poor source of phytochemicals notable for a very high glycemic index – emerge as non-protective in this regard [15,16,26]. Of related interest are studies correlating high flavonoid intakes with reduced

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vascular risk [42—48]. In many of the cited studies, statistical corrections for animal product or saturated fat intake have been included in the analyses; thus, the observed protection is not merely a trivial function of the fact that whole plant foods have displaced fatty animal products in the diet. It is evident that whole plant foods promote vascular health in ways that are independent of phytochemical content — such foods tend to be low in saturated fat, and are often good sources of potassium, vitamins, minerals, soluble fiber, and plant protein — but there is reason to believe that these factors are not wholly responsible for the observed protection. Promotion of healthful vascular endothelial function via antioxidant activity may mediate much of the vascular protection associated with phytochemical-rich diets [4,49,50].

High intakes of fruits and vegetables have also been linked to reduced cancer risk in many epidemiological studies, as summarized in pertinent reviews [1,51,52]. Cruciferous vegetables, rich in phase II-inducer glucosinolates, may have particular merit in this regard [53]. Other studies conclude that whole grains are also likely to decrease cancer risk [54]. Although some case-control or prospective cohort studies associate high legume intake with lower cancer risk (as cited previously) [55], this possibility is not as well established, perhaps because legume consumption in Western society tends to be fairly low. One would expect a diet rich in legumes to be protective if only because these foods are distinguished by a very low glycemic index, owing in part to the presence of phytochemicals that slow their digestion [56,57]; the fact that most of the carbohydrate in typical Western diets has a high glycemic index may play a role in the induction of certain common cancers [55,58—60]. There is suggestive but inconclusive evidence that soy product consumption may reduce cancer risk, perhaps in part owing to the isoflavone phytoestrogens in these products [61—64]. The impact of nut consumption on cancer risk appears to have received little attention. Plant foods in general — as opposed to animal products — may have lower cancer promotional activity, as there is reason to believe that dietary plant protein boosts growth factor activities — such as IGF-I and insulin — less substantially than animal protein does [65—67]. In international ecologic epidemiology, diets composed primarily of plant foods are associated with far lower risk for so-called "Western" cancers [68—78].

Despite growing enthusiasm among health scientists for the protective potential of phytochemical-rich plant products, the diets currently consumed in Western society tend to be notably deficient in this regard. This reflects the fact that the majority of dietary calories are supplied by animal products, white flour, white rice, potato products, and added refined sugars and oils — all notably low in phytochemicals and fiber.

Definition and utility of a "phytochemi-cal index"

In recognition of the key role of phytochemicals in health promotion, I propose that diets be characterized by a "phytochemical index" (PI), defined as that percentage of dietary calories supplied by foods typically high in phytochemicals: fruits, vegetables (not including potatoes, but including other tubers), legumes, nuts, seeds, whole grains, and foods compounded therefrom. Fruit and vegetable juices, although lacking fiber and some of the phytochemical content of rinds or peels, are often rich in phytochemicals, and thus should be counted in the index. Similarly, wine, beer, and cider qualify in this regard, but not distilled hard liquors. Soy protein, though evidently not a whole food, is usually a good source of isoflavones, and thus should be counted. Extra virgin olive oil is relatively rich in absorbable antioxidants [79] and thus might be given "partial credit", but most other oils used in cooking, although containing some fat-soluble phytochemicals, are low in phytochemicals on a per-calorie basis, and thus should be excluded from the index.

The practical utility of such a PI would be twofold. Epidemiologists could use PI as a very rough index of total dietary phytochemical content, and attempt to correlate PI with health outcomes. It is evident that the phytochemicals derived from a variety of foods can interact in additive and perhaps sometimes synergistic ways to modulate physiological function; this principle would be acknowledged by the use of PI in epidemiological investigations. (By way of analogy, the innovative concept "glycemic load" has been introduced recently into epidemiological analysis to characterize another global property of diets, giving rise to some provocative findings [59,60,80—83]). PI would also be of use to clinical nutritionists, as a tool for analyzing the quality of their clients' diets, for encouraging their clients to eat more phytochemical-rich foods, and for quantifying the extent of their clients' progress in this regard.

As a quantitative measure of phytochemical intake, PI has some evident weaknesses. For one thing, it does not acknowledge the contribution made by consumption of green or black tea, since these are non-caloric. Nor does it take into consideration the fact that the phytochemical-to-calorie ratio of plant foods varies a great deal. Furthermore, it is doubtless true that the health-promoting utility of certain phytochemicals is greater than that of others; the PI does not take this into account. Thus, two diets with identical PI ratings could have very different health outcomes owing to marked differences in the quantity or quality of their phytochemicals. Nonetheless, despite these shortcomings, PI can be viewed as a useful tool for aiding assessment of the health impacts of diets high in phytochemical-rich plant foods, and for encouraging the consumption of such diets.

Theoretically, a vegan diet that excluded refined grains, potato products, hard liquors, and added sugars and oils could have a PI of 100. Sadly, the PI of most current American diets would be unlikely to be as high as 20 — which means that there would be quite ample room for improvement. And striving for such improvement would have the ancillary advantage of increasing intakes of potassium, fiber, vitamins, trace minerals, and plant protein, while decreasing those of animal fat and animal protein.

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