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Limitations of the Food Compass Nutrient Profiling System

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67034-35118), the Turner Institute of Ecoagriculture, Applegate LLC, and the Greenacres Foundation during the conduct of the study. SvV reports financial remuneration for academic talks, but does not accept honoraria, consulting fees, or other personal income from food industry groups/companies. ML is a Board member of Food Standards Australia New Zealand (FSANZ) and the views he expresses in this commentary are his alone and not necessarily those of FSANZ. FL reports financial support of the Research Council of the Vrije Universiteit Brussel, including the SRP7, IOF3017, IRP11, and IRP21 projects. FL is a board member of various academic non-profit organizations including the Belgian Association for Meat Science and Technology (president), the Belgian Society for Food Microbiology (president), and the Belgian Nutrition Society. On a non-remunerated basis, he also has a seat in the Scientific Board of the World Farmers' Organization. The views he expresses in this commentary are his alone and not necessarily those of the aforementioned organizations.

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Abbreviations:

ASF: Animal-source food

NCD: Noncommunicable disease

NPS: Nutrient Profiling System

UPF: Ultra-processed food

Abstract

1 Nutrient Profiling Systems provide frameworks to assess the healthfulness of foods based on
 2 food composition and are intended as inputs into strategies to improve diets. Many Nutrient
 3 Profiling Systems are founded on a reductionist assumption that the healthfulness of foods is
 4 determined by the sum of their individual nutrients, with no consideration for the extent and
 5 purpose of processing and its health implications. A novel Nutrient Profiling System called Food
 6 Compass attempted to address existing gaps and provide a more holistic assessment of the
 7 healthfulness of foods. We propose that the chosen algorithm is not well justified and produces

results that fail to discriminate for common shortfall nutrients, exaggerate the risks associated with animal-source foods, and underestimate the risks associated with ultra-processed foods. We caution against the use of Food Compass in its current form to inform consumer choices, policies, programs, industry reformulations, and investment decisions.

Key words: Food Compass, nutrient profiling system, food rating system, micronutrient deficiencies, ultra-processed foods

Unhealthy diets are a leading cause of death and disease (1). A common strategy to attempt to improve diet quality is using Nutrient Profiling Systems (NPSs)—which are designed to assess the healthfulness of foods based on food composition—to inform front-of-package labeling, industry reformulations, company ratings, policies, programs, and investments (2). NPSs can vary widely and may include nutrients and food groups to encourage or limit (3), but typically do not consider the level of processing. The application of NPSs is limited because health is not determined by the consumption of single nutrients or foods but rather by overall diet quality interacting with unique individual and contextual factors (4). Furthermore, NPSs largely depend on a reductionist paradigm that the healthfulness of a given food is determined by the sum of its individual nutrients, with little consideration for the extent and purpose of processing, which the evidence suggests has important implications for food quality and health (5). Food processing is an essential element of food systems, and it significantly contributes to global food and nutrition security by improving access to safe and nutritious foods; increasing food affordability; diversifying diets; and reducing food loss and waste (6,7). Continued advances in processing technologies will be crucial to nourishing the rapidly growing and increasingly urbanized global population, while scaling up sustainable production practices and staying within planetary boundaries (7).

However, food processing is not invariably benign and can be used to produce foods that are deleterious to health (5). While acknowledging there is a large variation in the health effects of different types of ultra-processed foods (UPFs) and that there remains debate about the mechanisms linking UPFs to ill health in the nutrition community (discussed more below), higher shares of UPFs in the diet are generally associated with an increased risk of non-communicable diseases (NCDs) (8). Moreover, a randomized controlled trial found that diets high in UPFs led to substantial overeating and weight gain compared to unprocessed food diets, even though meals within both diets were matched for presented calories, macronutrients, sugar, sodium, and fiber (9). The higher consumption and weight gain could have been due to multiple factors, including higher non-beverage energy density of the UPF meals and snacks and disrupted gut-brain signaling in UPFs (9). As the evidence suggests that how foods are processed impacts their healthfulness independently of nutrient profiles (5,9), processing is important to consider when making food-based recommendations. More generally, the health issues may not only be related to the degree of “processing” beyond a threshold (and how this results in the breakdown of the food matrix), but also to how UPFs are “mostly constructed from a narrow range of cheap, extracted, refined and fractionated ingredients” (10), typically generated by transnational corporations “to create branded, convenient (durable, ready-to-consume), attractive (hyper-palatable) and highly profitable (low-cost ingredients) food products often designed to displace all other food groups” (11). Their health impact therefore may run much deeper than what conventional nutrient-centric views would suggest, as they fundamentally impoverish the experience of shared traditional meals to the mindless (over)eating of individualized ready-made products (12).

Recently, a novel NPS called Food Compass attempted to address the concerns of an overly reductionist approach by comprehensively assessing 54 food attributes across nine health-relevant domains, including additives, processing, and phytochemicals, among others (2). The individual domain scores were combined into a Food Compass Score ranging from 1 (unhealthiest) to 100 (healthiest) for over 8,000 foods and beverages reported in NHANES/FNDDS 2015–16. We propose that the chosen algorithm and weighting of various components is not well justified and produces results that do not account for shortfall nutrients, exaggerate the risks associated with animal-source foods (ASFs), and underestimate the risks associated with UPFs. There are other potential issues with Food Compass, though we chose to focus on these three areas as we believe they represent the greatest threat to public health, should the system be implemented as intended.

A key feature of Food Compass is that it applies the same scoring principles to all foods, aiming to increase objectivity, avoid arbitrary food categories, allow for direct comparison across items, and facilitate the assessment of mixed dishes. However, since healthy diets can be achieved in various ways through combining disparate quantities of different food groups—each playing a specific role—assessing the healthfulness of all foods based on a single scale may not be appropriate. Food Compass was initially validated for content, face, and convergent and discriminant validity, and recently has been validated against the Healthy Eating Index, cardiometabolic health markers, and all-cause mortality (13). While the cardiometabolic health markers and all-cause mortality validation were based on observational data, the analysis adjusted for several potential confounders and suggests Food Compass would help improve upon the average US diet. However, this is not particularly noteworthy, as the average US diet is highly unhealthy, and only 12% of adults are metabolically healthy (14). Thus, there is

substantial scope for many types of nutrition interventions to be associated with and validated against improvements in cardiometabolic health outcomes, and there are numerous ways to achieve a healthy diet. For example, randomized controlled trials have demonstrated cardiometabolic benefits of low-carbohydrate diets low in legumes and low-fat diets low in nuts (15), as well as Mediterranean diets high in unprocessed lean red meat (16); and a prospective cohort study suggests a Paleolithic diet high in meat and eggs and low in legumes can have cardiovascular benefits (17). These diets contain regular consumption of foods that score poorly on Food Compass (e.g., meat and eggs) or limit foods that score highly on Food Compass (e.g., legumes and nuts) but are still healthy diets because they consist of minimally processed whole foods low in UPFs.

We propose that a primary limitation of Food Compass is that the weighting of attributes and domains does not represent a balanced reflection of available evidence and sometimes appears arbitrary and insufficiently transparent. For instance, EPA and DHA are weighted the same as ALA, despite the inefficient conversion of ALA to EPA and DHA, and the more convincing evidence on health benefits of EPA and DHA (18). Other nutrients such as iron and vitamin C, whose abundance in the food supply varies considerably and deficiencies of which have very different public health significance (19,20), are also weighted equally.

The NOVA classification is only one of 54 attributes, contributing <5% to the overall score, which fails to sufficiently recognize the impact of food processing on the quality of the food matrix and its crucial role in health and disease (5,8,9,21). In our view, the type of processing should be attributed substantially more weight given the extensive evidence linking UPFs with negative health outcomes (5,8,9,21), as well as broader societal impacts associated with aggressive marketing and *nutri-washing* of UPF (11). While the Food Compass authors

originally misclassified UPFs, as highlighted in the Matters Arising article (22) that led to an author correction (23), standardized methods for classifying UPFs using the NOVA system have been recently developed (24). While more research is needed to understand the mechanisms by which UPFs cause disease (25–27), we propose that the overwhelming evidence on the health risks from UPFs using the NOVA system is sufficiently robust to warrant its prominent role in any food rating system that assesses the healthfulness of foods.

Other aspects of Food Compass illustrate its limited consideration of the food matrix. For instance, while UPFs are assigned negative points, unprocessed foods do not receive any positive points, which does not valorize food matrix quality. Moreover, no distinction is made between minimally processed and reconstituted whole grains, or between fortified and naturally occurring nutrients. However, reconstitution and fortification cannot fully replicate the potential benefits of the food matrix in unprocessed and minimally processed foods, which go beyond their individual nutrients (28).

Another limitation is lack of adjustment for differences in bioavailability of iron and zinc, which varies widely across foods depending on factors such as the proportion of heme to non-heme iron, phytate, and vitamin C content (29,30). Also, anti-nutrients (e.g., phytate and oxalate) are not incorporated into the scoring, despite their important role in nutrient absorption (30,31).

Finally, Food Compass gives plant-based protein-rich foods (nuts, seeds, and legumes) positive scores for being healthy food ingredients as well as for their fiber and protein content, without any adjustment for protein quality, which is generally much lower for plant-based foods than ASFs (32). This bias would be particularly problematic if implemented in low- and middle-income countries, where inadequate protein intake and deficiencies in essential amino acids are common, due in part to low intake of ASFs (33,34).

Several elements in the scoring algorithm are unfavorable towards ASFs, regardless of their processing level. First, no distinction is made between red and processed meat, although available evidence shows that the consumption-associated risk and benefits differs substantially between the two (35,36). Second, red meat is always attributed negative scores, even when unprocessed or minimally processed, despite dietary guidelines stating that moderate intakes contribute to healthy diets (36,37). Indeed, unprocessed red meat, especially ruminant meat, is a top source of bioavailable nutrients commonly lacking in diets globally, including iron, zinc, and vitamin B₁₂, and essential amino acids (20,30,33,38). Further, lean red meat can support healthy aging, including benefits to muscle health and protection against sarcopenia (39), and has been found to be compatible with good metabolic health in multiple randomized clinical trials when consumed as part of high-quality diets sufficiently high in fruits, vegetables, and fiber (40). Third, dietary cholesterol is always scored negatively despite its limited influence on plasma cholesterol (41), inevitably penalizing ASFs. Finally, seafood and yogurt are the only two ASFs in the list of healthful food-based ingredients, while other nutrient-dense ASFs that make a significant contribution to diet quality worldwide (e.g., eggs and milk) are not included. The excessive penalization of ASFs could have implications for nutrient adequacy in all contexts, but especially in Sub-Saharan Africa and South Asia, where ASF intake is generally low, and the burden of nutrient inadequacies is high, particularly for iron, zinc, folate, calcium, vitamins A, B₁₂, and D, and essential amino acids and fatty acids (18,20,38). Deficiencies in some of these nutrients are also widespread in high-income countries, especially among population groups at greater risk for malnutrition such as young children, women of reproductive age, pregnant and lactating women, and older adults (20,42).

While there are many justified scores, the above-mentioned limitations of Food Compass (among others not covered in this Perspectives paper) result in numerous unjustified scores. For example, kale receives the same score as watermelon, despite the large difference in nutrient density and fiber between the two foods (**Figure**). Surprisingly, Frosted Mini Wheats, Honey Nut Cheerios, nonfat frozen yogurt, sweet potato fries, calcium-fortified orange juice, and chocolate-covered almonds all receive top scores (≥ 70 , “to be encouraged”). In contrast, foods such as millet, whole wheat bread, skinless chicken breast, boiled eggs, and whole milk, are assigned lower scores (31–69, “to be moderated”), which are comparable to those of sweet potato chips, Lucky Charms, canned pineapple in sugar syrup, almond M&M’s, and ice cream cones with nuts. Moreover, all the aforementioned items score higher than ground beef, cheddar cheese, and whole eggs fried in butter (≤ 30 , “to be minimized”).

Although a variety of NPSs have been developed, currently there is no universally accepted gold standard, as all existing NPSs face technical and conceptual limitations. Food Compass represents a novel effort to develop a more comprehensive and objective NPS. However, we propose that its algorithm and structure needs to be redesigned. If used as intended to inform consumer choice, policies, programs, reformulations, and investment decisions, Food Compass scores could result in certain dietary improvements, such as increased consumption of minimally processed plant-based foods, but may have unintended adverse consequences for nutrient adequacy in essential commonly lacking nutrients and reinforce the consumption of UPFs.

Competing Interests statement

TB, SN, MK, and FO have nothing to disclose. SMP reports grants from US National Dairy Council, Roquette Freres, and Dairy Farmers of Canada during the conduct of the study; non-

financial support from Enhanced Recovery, outside the submitted work. In addition, SMP has a patent Canadian 3052324 issued to Exerkine, and a patent US 20200230197 pending to Exerkine but reports no financial gains. SvV reports grant support from USDA (2020-38640-31521; 2021-67034-35118), the Turner Institute of Ecoagriculture, Applegate LLC, and the Greenacres Foundation during the conduct of the study. SvV reports financial remuneration for academic talks, but does not accept honoraria, consulting fees, or other personal income from food industry groups/companies. ML is a Board member of Food Standards Australia New Zealand (FSANZ) and the views he expresses in this commentary are his alone and not necessarily those of FSANZ. FL reports financial support of the Research Council of the Vrije Universiteit Brussel, including the SRP7, IOF3017, IRP11, and IRP21 projects. FL is a board member of various academic non-profit organizations including the Belgian Association for Meat Science and Technology (president), the Belgian Society for Food Microbiology (president), and the Belgian Nutrition Society. On a non-remunerated basis, he also has a seat in the Scientific Board of the World Farmers' Organization. The views he expresses in this commentary are his alone and not necessarily those of the aforementioned organizations.

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FO and TB designed the study. FO, MK, ML, FL, SN, SMP, SVV, and TB wrote the manuscript. TB had responsibility for the final content. All authors read and approved the final manuscript.

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Figure legend

Figure. Illustrative examples of limitations of Food Compass scores (non-exhaustive list).