

A feedlot diet for Americans that results from a misspecified optimization algorithm

White and Hall (1) suggest that removing animals from US agriculture would create a food supply incapable of supporting the US population's nutritional requirements and increase nutritional deficiencies compared to the current food system. However, their analysis suffers from an uncritical use of nutritional values and optimization algorithms, and a highly unrealistic and narrow scenario design.

In constructing their dietary scenarios, White and Hall use a linear-programming algorithm that optimizes diets to meet nutrient constraints at lowest cost. This approach is problematic; since 1945, it has been recognized to result in highly unrealistic and monotonous diets if not properly constrained (2), e.g., by realistic serving sizes or deviation from current diets (3). White and Hall's algorithm is particularly nonsensical as exemplified by what they term plant-based diet scenarios: an 'optimised' energy intake twice that of an average adult (>4700 kcal/d), with 2500-3500 kcal/d (51-74% of energy, 700-1000 grams per day) coming from corn alone and 4100-4400 kcal/d (84-93% of energy, ~ 1200 g/d) from total grains (see their supplementary code (SC) and Fig.4 in their paper). According to their data (Fig.3 and SC), much more diverse diets, e.g., including recommended intakes of vegetables (>400 g/d), fruits (>200 g/d), nuts and seeds (>40 g/d), and plenty of legumes would be possible in their no-animal scenario without trade. Unfortunately, all other results are based on their implausible scenarios and therefore cannot represent realistic examples of plant-based systems.

The assumptions made regarding the inputs used in the optimization algorithm are similarly problematic. White and Hall assume that the distribution of crops in US agriculture cannot change, despite plentiful examples otherwise (4). That assumption results in a food supply that is significantly higher in corn and other animal feeds – this is not desirable from health and environmental perspectives given their high carbohydrate content and predominant food use as high-fructose corn syrup, and the high fertilizer inputs to corn production (whose emissions might be double-counted though as they are already included in the life-cycle estimates used).

Further, White and Hall misuse and misinterpret the nutritional reference values. All of the nutrients that they suggest would be deficient in their plant-based scenarios are either not essential (arachidonic acid, EPA+DHA) or can be readily obtained in sufficient quantities in realistic plant-based diets (calcium, vitamin A) and lifestyles (vitamins B-12 and D) (Table 1). Contrary to what they imply, total nutrient supply is actually higher in their plant-based scenarios (Fig.2 in their paper) at half the price (Fig.4 in their paper). That said, nutritional adequacy is a poor marker for healthiness. Many of nutrient recommendations are old, based on a few short-term studies with few participants, and generally have not been subject to the same academic quality standards as applied to current medical research practices (5). Long-term studies clearly indicate that consumption of red and processed meat is associated with higher incidence of several chronic diseases and total mortality, despite its nutritional content (6), and that a higher proportion of healthy plant-based foods is associated with lower risks (7).

References

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Table 1. Comments on nutrients suggested to be deficient in White and Hall’s modeled plant-based diets.

Nutrient	Comment
Arachidonic acid	Arachidonic acid is not essential and readily synthesized endogenously from plant-derived linoleic acid.
Omega-3 fatty acids	Out of the omega-3 fatty acids, only the largely plant-derived alpha-linolenic acid (ALA) is considered essential; ALA can be endogenously converted to EPA or DHA, and DHA can also be obtained from algae.
Calcium	The U.S-recommended intake for calcium (1000-1200 mg/day for adults based on very short-term studies) is likely overstated (500 mg/day is considered adequate by the WHO) (8). Further, there is no evidence that calcium intake from milk and dairy lowers or prevents the risk of bone fractures (9). Hip fracture rates are lowest in countries with little or no consumption of dairy foods (8)
Vitamin A	Vitamin A can be fully obtained from carotenoids in plants as part of realistic diets, such as from a cup of carrots, sweet potatoes, or butternut squash, among others (see, e.g., USDA nutrient reference values).
Vitamin B-12	Vitamin B-12 is a key nutrient that would be low in all predominantly plant-based diets, but it can be readily obtained from existing fortified foods, such as many non-dairy milks (10), or can easily be added by fortification at minimal cost, similar to folate and other micronutrients.
Vitamin D	Food intake, either from plants or animal sources, are not a major source of Vitamin D, which is synthesized in sufficient quantities in the skin following sun exposure. In addition, supplements and foods fortified with vitamin D are readily available (10).