A Comparison of Nutrient Density Scores for 100% Fruit Juices

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ABSTRACT: The 2005 Dietary Guidelines for Americans recommend that consumers choose a variety of nutrient-dense foods. Nutrient density is usually defined as the quantity of nutrients per calorie. Food and nutrition professionals should be aware of the concept of nutrient density, how it might be quantified, and its potential application in food labeling and dietary guidance. This article presents the concept of a nutrient density score and compares nutrient density scores for various 100% fruit juices. One hundred percent fruit juices are popular beverages in the United States, and although they can provide concentrated sources of a variety of nutrients, they can differ considerably in their nutrient profiles. Six methodologies were used to quantify nutrient density and 7 100% fruit juices were included in the analysis: apple, grape, pink grapefruit, white grapefruit, orange, pineapple, and prune. Food composition data were obtained from the USDA National Nutrient Database for Standard Reference, Release 18. Application of the methods resulted in nutrient density scores with a range of values and magnitudes. The relative scores indicated that citrus juices, particularly pink grapefruit and orange juice, were more nutrient dense compared to the other nonfortified 100% juices included in the analysis. Although the methods differed, the relative ranking of the juices based on nutrient density score was similar for each method. Issues to be addressed regarding the development and application of a nutrient density score include those related to food fortification, nutrient bioavailability, and consumer education and behavior.

Keywords: diet, Dietary Guidelines for Americans, fruit juice, nutrients, nutrient density

Introduction

Individuals are regularly encouraged to consume "healthful" foods and a "healthful" diet. However, there is no consensus or established definition to define a healthful or nutritious food (Lackey and Kolasa 2004; Drewnowski 2005). The 2005 Dietary Guidelines for Americans (DGA) state that Americans should consume a variety of nutrient-dense foods and beverages within and among the basic food groups (U.S. HHS 2005). Nutrient density is a measure of nutrients provided per calorie of food or the "ratio of the amount of a nutrient in foods to the energy provided by these same foods" (Zelman and Kennedy 2005). Nutrient-dense foods have been described as those that provide substantial amounts of vitamins and minerals (micronutrients) and relatively fewer calories (U.S. HHS 2005). Given the increasing rates and prevalence of overweight and obesity, the consumption of nutrient-dense foods could provide a way for people to get the nutrients they need while remaining within calorie needs, thereby enhancing diet quality and overall health.

Current guidance on choosing nutrient-dense foods includes selecting a variety of foods within all food groups, focusing on fruits, vegetables, and whole grains, choosing the lower-fat varieties of foods from each food group (for example, low- or no-fat dairy, lean cuts of meat), and choosing foods free of added sugars (U.S. HHS 2005). However, at this time consumers and practitioners have few resources (Lachance and Fisher 1986; Scheidt and Daniel 2004; Drewnowski 2005) to help them determine which foods, particularly within the same food group, may be more nutrient dense. There have been several proposed methodologies to quantitatively describe the nutrient profiles of individual foods (Sorenson and others 1976; Guthrie 1977; Lachance and Fisher 1986; Mojduszka and others 1999; Scheidt and Daniel 2004). However, none of these methods has been widely used as a tool to help consumers identify nutrient-dense foods. The Food and Drug Administration has expressed some interest in including a nutrient density score on the food label (FDA 2004a), prompting a coalition of food and nutrition experts to explore the development of a nutrient density score that could help consumers select foods to maximize nutrient intake while staying within energy needs (Drewnowski 2005; Zelman and Kennedy 2005).

In light of the heightened focus on nutrient density, it is important for food and nutrition scientists and professionals to be aware of the concept of nutrient density, how it might be characterized quantitatively, and its potential importance to the food industry, health and nutrition practitioners and educators, and consumers. The purpose of this article was to compute and compare nutrient density scores for various 100% fruit juices and compare various methods developed to define the nutrient density of a food. One hundred percent fruit juices were selected because they are commonly consumed in the United States and are thought to be convenient and concentrated sources of a wide variety of vitamins, minerals, and phytochemicals. However, the nutrient profiles of various 100% fruit juices may vary. A focus of this analysis was to rank diverse types of 100% fruit juices and determine if the juices would be ranked differently by specific methods. To the author's knowledge, this study represents the 1st investigation comparing nutrient density scores for foods within a similar food category. The effect of nutrient fortification on a juice's nutrient density score also was evaluated and key issues surrounding the development and application of a nutrient density score are discussed.

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Materials and Methods

Selection of fruit juices for evaluation

Only 100% fruit juices that are purchased to be primarily consumed as stand-alone beverages, are readily available to and commonly consumed in the United States (USDA 2005a), and are included in the USDA National Nutrient Database for Standard Reference (USDA 2005b) were included in the analysis. Beverages excluded from the analysis included fruit-flavored drinks, beverages, or cocktails that are not 100% juice, blended products that are 100% fruit juice but contain more than a single juice, and fortified juices (except for a secondary analysis). Based on these criteria, cranberry juice was not included because it is most often sold as cranberry cocktail (less than 30% fruit juice) or blended with other 100% fruit juices. Tomato juice was not included because it is primarily marketed as a vegetable juice. Food composition data for each juice were obtained from the USDA National Nutrient Database for Standard Reference, Release 18 (USDA 2005b). With the exception of products listed as infant foods, all types or forms (for example, raw, canned/bottled, from concentrate, and so forth) of the selected fruit juices reported in the USDA database, that is, with a unique Nutrient Databank (NDB) number, were included in the analysis. If data were missing for a particular nutrient, the nutrient-specific value for a similar product was used to replace the missing value.

Methodologies used to calculate nutrient density scores

Nutrient density was quantitatively evaluated using 6 methodologies. Four of the methodologies have been published previously (Lachance and Fisher 1986; Scheidt and Daniel 2004; Zelman and Kennedy 2005) and have been statistically validated for their ability to predict a nutrient-rich diet (Zelman and Kennedy 2005). In addition, 2 ad hoc methods were included in the analysis. To account for the lack of representation of certain nutrients in published methods, an ad hoc method was developed that takes into account all micronutrients (plus dietary fiber) for which a daily value (DV) has been established. To evaluate the efficacy of a food type-specific method, a 2nd ad hoc method was developed that uses the 10 nutrients consistently found in higher amounts in the fruit juices considered in this analysis.

Nutrient density scores were calculated for each 100% fruit juice and for each type or form of that juice found in the database with a unique NDB number. For each equation presented below, the "%DV" is the percent of the DV contributed for that nutrient. The DV reference standards used on the Nutrition Facts panel and based on the Reference Daily Intakes were used for all methods in this analysis (FDA 2004b) and are presented in Table 1.

The following methodologies were used to assess nutrient density:

Method 1: Nutrient for calorie. Known as the Naturally Nutrient Rich score, this methodology was developed by Drewnowski (2005) and is computed as an average percent DV for 14 food components based on 2000 kcal of the food:

Nutrient for calorie = (%DV protein + %DV thiamin + %DV riboflavin + %DV folate + %DV vitamin B12 + %DV vitamin C + %DV vitamin A + %DV vitamin D + %DV vitamin E + %DV calcium + %DV iron + %DV zinc + %DV potassium + %DV monounsaturated fat)/14.

The nutrients included in this score are based on nutrients tracked by the Women, Infants, and Children program, or are deemed to be important by the National Cancer Inst. or the Food and Agricultural Assn. (Drewnowski 2005).

Method 2: Calorie for nutrient. This methodology was developed by Lachance and Fisher (1986) and is computed by dividing the total calories by the average percent DV for 13 food components as defined by the Nutrition Labeling and Education Act. This methodology originally included evaluation of 9 nutrients but was recently expanded to 13 (Zelman and Kennedy 2005). This methodology characterizes the number of calories consumed to obtain the nutrients provided by the food and, therefore, lower scores would be indicative of a food with higher nutrient density. All values are based on 100 g of the food:

Calorie for nutrient = kcal/[(%DV protein + %DV thiamin + %DV riboflavin + %DV niacin + %DV folate + %DV vitamin B6 + %DV vitamin B12 + %DV vitamin C + %DV vitamin A + %DV calcium + %DV magnesium + %DV iron + %DV zinc)/13].

Method 3: Ratio of recommended to restricted (RRR) nutrients. This method was developed by Scheidt and Daniel (2004) and calculates a ratio of the average of the percent DV of 6 recommended food components to the average of the percent DV of 5 food components that are suggested to be restricted in the diet by an upper limit. The nutrients include those that are listed on the Nutrition Facts panel. All values are based on a serving of the food (240 mL for the 100% fruit juices considered in this analysis):

RRR = [(%DV protein + %DV dietary fiber + %DV calcium + %DV iron + %DV vitamin A + %DV vitamin C)/6]/[(%DV kcal + %DV sugars + %DV cholesterol + %DV saturated fat + %DV sodium)/5].

Percent DV for energy (kcal) is based on a DV of 2000 kcal, which is the standard energy level reference for the Nutrition Facts panel. To prevent the RRR from having extreme values, especially those attributable to artificial fortification, the percent DV for any nutrient is truncated to a maximum of 100% (Scheidt and Daniel 2004).

Table 1 — Daily values used to calculate nutrient density scores

Nutrient or food component	Daily value[a]
Energy	2000 kcal
Protein	50 g
Fat	65 g
Saturated fat	20 g
Monounsaturated fat	20 g[b]
Carbohydrate	300 g
Dietary fiber	25 g
Sugars	50 g[c]
Cholesterol	300 mg
Calcium	1000 mg
Iron	18 mg
Magnesium	400 mg
Phosphorus	1000 mg
Potassium	3500 mg
Sodium	2400 mg
Zinc	15 mg
Copper	2 mg
Vitamin C	60 mg
Thiamin	1.5 mg
Riboflavin	1.7 mg
Niacin	20 mg
Vitamin B6	2 mg
Folate	400 μg
Vitamin B12	6 μg
Vitamin A	5000 IU[d]
Vitamin E	20 mg[e]
Pantothenic acid	10 mg
Vitamin D	400 IU

[a]Reference: (FDA 2004b) except where otherwise noted.
[b]There is no established daily value for monounsaturated fat. The value listed is based on approximately 10% of total daily calorie intake (2000 kcal).
[c]There is no established daily value for sugars. The value listed is a World Health Organization recommendation for sugar intake for a 2000-kcal diet.
[d]IU = International Units.
[e]Daily value is 30 IU and has been converted to mg to match USDA National Nutrient Database for Standard Reference units. Conversion is IU $\times$ 0.67 = mg.

Method 4: Nutrient for calorie (subtracting for certain nutrients). This method was developed by Fulgoni (Zelman and Kennedy 2005) and computes a nutrient-for-calorie ratio based on the average percent DV for a total of 14 nutrients, of which 2 (saturated fat and sodium) are subtracted because it is suggested that they be limited in the diet. All values are based on a serving of the food (240 mL for the 100% fruit juices considered in this analysis):

Nutrient for calorie (sub) = [(%DV protein + %DV vitamin B12 + %DV vitamin C + %DV vitamin A + %DV vitamin E + %DV calcium + %DV iron + %DV zinc + %DV potassium + %DV magnesium + %DV phosphorus + %DV dietary fiber – %DV saturated fat – %DV sodium)/14]/kcal per serving.

Method 5: Nutrient for calorie (ad hoc 1). This method is a nutrient-for-calorie method and is computed as an average percent DV for all micronutrients for which a DV has been established, with the exceptions of vitamin D, biotin, and iodine, to present a wider range of nutrients not accounted for by any single previously published method and demonstrate how the inclusion of more nutrients may affect the score. There were no vitamin D values in the USDA database for any of the fruit juices evaluated and iodine and biotin are not reported in the USDA database. No macronutrients were considered with the exception of dietary fiber, which has been listed as a nutrient for concern in the DGA (U.S DHHS 2005). A total of 18 nutrients are considered. All values are based on 2000 kcal of the food:

Nutrient for calorie (ad hoc 1) = (%DV dietary fiber + %DV potassium + %DV vitamin A + %DV vitamin C + %DV thiamin + %DV riboflavin + %DV niacin + %DV calcium + %DV iron + %DV vitamin E + %DV vitamin B6 + %DV folate + %DV vitamin B12 + %DV phosphorus + %DV magnesium + %DV zinc + %DV copper + %DV pantothenic acid)/18.

Method 6: Nutrient for calorie (ad hoc 2). This method is a nutrient-for-calorie method and considers the 10 micronutrients that consistently are found in the highest amounts (based on percent DV) in the fruit juices included in this analysis. This method was developed to address how a nutrient density score that included only those nutrients supplied in the highest amounts in a particular food group or food category (in this case, 100% fruit juices) would compare to other methodologies. To determine the nutrients present in the highest amounts, each micronutrient for each fruit juice was ranked (from 1 to 19) based on its percent DV contribution. For juices with multiple product types in the database, an average DV was computed for all product types and used for the ranking so that juices with multiple product types did not unduly contribute to the rankings. For each juice, the micronutrient contributing the highest DV was given a ranking of 1, the next highest DV a ranking of 2, and so on. Nutrients with the same DV (to 2 decimal places) were given the same ranking number, which only happened in the case of nutrients contributing zero %DV. Ranking values for all juices were then added to provide a total ranking score (value) for each nutrient. The 10 nutrients with the lowest total ranking score (thus representing the highest %DV based on the ranking score) were selected for inclusion in the nutrient density calculation. All values are based on 2000 kcal of the food:

Nutrient for calorie (ad hoc 2) = (%DV potassium + %DV vitamin C + %DV vitamin B6 + %DV magnesium + %DV thiamin + %DV copper + %DV iron + %DV riboflavin + %DV folate + %DV phosphorus)/10.

Statistical analysis

For juices with more than 1 product type reported in the database (that is, multiple NDB numbers), a mathematical mean ± SD based on all as well as the individual product types was reported for that juice. Means and SD were calculated using Microsoft Excel.

Results and Discussion

Nutrient density scores

A total of 16 product types representing 7 different 100% juices were included in the analysis (Table 2). Table 3 presents the nutrient density scores calculated for each juice product. For each method, a mean value was calculated for juices with more than 1 product type in the database (that is, apple, white grapefruit, orange, and pineapple juice). Application of the 6 methods resulted in nutrient density scores with various magnitudes and ranges of values. Nutrient density scores (means) ranged from 28 to 322 (method 1); 5.7 to 70.2 (method 2); 0.1 to 2.2 (method 3); 0.01 to 0.16 (method 4); 35 to 281 (method 5); and 53 to 437 (method 6), with citrus juices consistently having the highest calculated nutrient density scores. Methods 1, 5, and 6 produced higher scores compared to the other methods because the data and score were based on 2000 kcal, which elevated the overall magnitude of the values. The higher magnitudes resulted in the ability to better discriminate between scores for the different juices. Using method 1, Drewnowski (2005) scored and ranked 365 foods included on the Fred Hutchinson Cancer Research Center food frequency questionnaire. Scores ranged from a low of 2 (soda) to a high of 1000 (spinach). Similar to the present analysis orange juice ranked well above grape juice, while the results for other 100% juices were not noted. The scores for method 2 represent a calorie for nutrient score, which differs from the other methods in that lower rather than higher scores represent a more nutrient-dense beverage because the "cost" in calories is lower to obtain a given amount of nutrients. This scoring system may not be as intuitive compared to the other methods and may be more misleading as individuals are more apt to relate lower score to a food with lower nutrient density. Using method 2, Lachance and Fisher (1986) assigned a "quality of

Table 2—One hundred percent juice products included in the nutrient density analysis

Product description	NDB[a] number
Apple juice, canned or bottled, unsweetened, without added ascorbic acid	09016
Apple juice, frozen concentrate, unsweetened, diluted with 3 volume water, without added ascorbic acid	09018
Grapefruit juice, pink, raw	09404
Grapefruit juice, white, raw	09128
Grapefruit juice, white, canned, sweetened	09124
Grapefruit juice, white, frozen, concentrate, unsweetened, diluted with 3 volume water	09126
Grapefruit juice, white, canned, unsweetened	09123
Grape juice, canned or bottled, unsweetened, without added Vitamin C	09135
Orange juice, raw	09206
Orange juice, California, chilled, includes from concentrate	09406
Orange juice, canned, unsweetened	09207
Orange juice, chilled, includes from concentrate	09209
Orange juice, frozen concentrate, unsweetened, diluted with 3 volume water	09215
Pineapple juice, canned, unsweetened, without added ascorbic acid	09273
Pineapple juice, frozen concentrate, unsweetened, diluted with 3 volume water	09275
Prune juice, canned	09294

[a]NDB = Nutrient Databank number used in the USDA National Nutrient Database for Standard Reference, Release 18 (USDA 2005b).

nutrient profile" (based on the number of RDA nutrients in a serving of the food and the balance of the provided nutrients) for several foods and reported orange and grapefruit juice as "very good" and grape and apple juice as "poor," although the standard used for assigning these attributes was not discussed. Neither pineapple nor prune juice was included in this analysis. For method 3, Scheidt and Daniel (2004) explain that a nutrient-for-nutrient score is based on a standard of 1, with scores greater than 1 indicating foods with higher nutrient values and scores lower than 1 representing foods with lower nutrient values. Using these guidelines for the present analysis, only citrus juices would be defined as having higher nutrient value. Method 4 includes punitive treatment for saturated fat and sodium. The juices included in this analysis contain little or no saturated fat or sodium, and therefore subtracting these nutrients had no appreciable effect on the relative scores. Method 4 resulted in scores that were low in magnitude and sometimes indistinguishable between the different juice types. Overall, the methods that included more nutrients in the equation or were based on a single serving of food tended to produce lower scores compared to methods based on fewer nutrients or a higher energy basis (for example, 2000 kcal as in methods 1, 5, and 6). Scores higher in magnitude tend to have more discriminating power, which would be desirable when attempting to rank or categorize the nutrient density of various foods.

Relative ranking of juices

For each method, the juices were ranked from the highest (rank of 1) to the lowest (rank of 7) nutrient density based on the calculated scores (Table 4). Pink grapefruit had the highest nutrient density score based on all methods except method 6, where orange juice had a slightly higher nutrient density score. For all methodologies, citrus juices ranked either 1st, 2nd, or 3rd, with pineapple juice typically ranking 4th, prune juice 5th, and apple and grape juices 6th or 7th. Despite the differences between the methodologies, including the number or types of nutrients considered, there was a fair amount of consistency between methods with regard to the relative ranking of the juices.

Based on the food composition data for each juice, the ranking produced expected results. Orange and grapefruit juices have the highest %DV for vitamin C, and with the exception of prune juice, have the highest %DV for potassium compared to other 100% fruit juices. Orange juice contained the highest amount of folate, and along with pineapple juice, is the only juice in this analysis to supply 10% or more of the DV for the natural form of this vitamin. Citrus juices tended to be equal to or higher in vitamin A, thiamin, and phosphorus compared to the other juices included in the analysis. All of the fruit juices were very low in sodium and fat. With the exception of prune juice, which provided just over 10% of the DV for fiber, all of the juices were low in fiber. The other major factor contributing to higher nutrient density scores for citrus juices is energy content. Citrus juices, particularly grapefruit juice, were lower in calories on a per serving basis compared to other juices. The energy content for 240 mL of orange and grapefruit juice (white and pink) ranged from 105 to 112 and 94 to 115 kcal, respectively, compared to 112 to 117 kcal for apple juice, 130 to 132 kcal for pineapple juice, 154 kcal for grape juice, and 182 kcal for prune juice. Nutrient density scores can be affected by nutrient content, energy content, or both, and taken together the nutrient and energy content of citrus juices accounted for their higher nutrient density scores.

Table 3—Summary of nutrient density scores for select 100% fruit juices

Product	NDB number[a]	Method 1 nutrient for calorie[b]	Method 2 calorie for nutrient[c]	Method 3 nutrient for nutrient[b]	Method 4 nutrient for calorie[b]	Method 5 nutrient for calorie ad hoc 1[b]	Method 6 nutrient for calorie ad hoc 2[b]
Apple juice							
Canned/bottled, unsweetened	09016	32	63.6	0.2	0.01	37	56
From concentrate, unsweetened	09018	25	78.7	0.1	0.01	32	49
Mean ± SD[d]		28 ± 4	70.2 ± 10.7	0.1 ± 0.03	0.01 ± 0.0003	35 ± 4	53 ± 6
Grape juice							
Canned/bottled, unsweetened	09135	30	50.1	0.1	0.01	40	60
Pink grapefruit juice							
Raw	09404	322	5.7	2.2	0.16	281	432
White grapefruit juice							
Raw	09128	292	6.3	1.8	0.14	257	432
Canned, sweetened	09124	189	9.8	1.5	0.09	168	283
From concentrate	09126	239	7.6	1.7	0.12	214	361
Canned, unsweetened	09123	238	7.8	1.9	0.11	209	353
Mean ± SD		237 ± 42	7.8 ± 1.4	1.7 ± 0.2	0.12 ± 0.02	210 ± 36	354 ± 61
Orange juice							
Raw	09206	356	5.2	2.1	0.16	306	505
Chilled, California	09406	322	5.7	2.1	0.14	278	461
Canned, unsweetened	09207	278	6.5	2.1	0.13	253	410
Chilled	09209	256	72	2.0	0.11	226	375
From concentrate	09215	298	6.3	2.0	0.13	258	430
Mean ± SD		303 ± 39	6.1 ± 0.8	2.1 ± 0.06	0.14 ± 0.02	265 ± 30	437 ± 50
Pineapple juice							
Canned, unsweetened	09273	94	17.2	0.8	0.04	102	166
From concentrate, unsweetened	09275	102	16.9	0.7	0.04	108	175
Mean ± SD		98 ± 6	17.1 ± 0.3	0.8 ± 0.03	0.04 ± 0.003	105 ± 4	170 ± 6
Prune juice							
Canned	09294	62	22.6	0.5	0.04	92	132

[a]NDB = Nutrient Databank
[b]Higher values represent a more nutrient-dense beverage.
[c]Lower values represent a more nutrient-dense beverage.
[d]SD = standard deviation

Effect of vitamin C fortification

Juices such as apple, grape, and pineapple are naturally lower in vitamin C and often are fortified with this vitamin. To determine how vitamin C fortification would affect the nutrient density score, scores were computed for vitamin C-fortified apple, grape, and pineapple juices using data from the USDA nutrient database (data not shown). Depending on the method, fortification with vitamin C resulted in substantial, in some cases several-fold, increases in the nutrient density scores for these juices. Despite these increases, the nutrient density scores for (nonfortified) orange and pink grapefruit juice remained higher than for the vitamin C-fortified juices. Vitamin C-fortified pineapple juice ranked equal to or higher than white grapefruit juice based on several of the methods, although not higher than orange juice or pink grapefruit juice. Therefore, vitamin C fortification alone was not able to elevate the nutrient density scores of apple, grape, and pineapple juices above citrus juices, which contain higher amounts of other key nutrients. However, this demonstrates that fortification with only a single nutrient can have a dramatic effect on the nutrient density score.

Nutrient density scores for other select foods

In order to provide a relative comparison to 100% fruit juices and further evaluate the consistency of ranking among methods, nutrient density scores for 4 foods from other (nonfruit) food groups (for example, grains, vegetables, meat, and dairy) were computed and are presented in Table 5. Note that scores were not calculated using method 6 because this method was based on nutrients most commonly found in 100% fruit juices. The magnitude of the resulting scores varied widely based on the calculation method. Broccoli consistently had higher nutrient density scores compared to other foods. This is expected as broccoli provides significant amounts of vitamin C, vitamin A, folate, and dietary fiber yet is relatively low in calories. Similar to the analysis for 100% fruit juices, the relative ranking of the foods based on the nutrient density score was comparable regardless of the method used.

Issues related to a nutrient density score

There are several matters to be addressed related to the development and use of a nutrient density score. Current methodologies to quantify nutrient density have not adequately addressed issues regarding nutrient fortification, nutrient bioavailability, or weighting of nutrients based on their potential contribution to good health (Drewnowski 2005). A limitation of current nutrient density approaches is that the phytochemical content of foods is not considered in any methodology. With regard to the present analysis, natural fruit juices contain a wide range of phenolic compounds, including anthocyanidins in purple grape juices and flavanones in citrus juices. These food and beverage components have demonstrated antioxidant capabilities in vitro (Wang and others 1996; Leonard and others 2002; Proteggente and others 2002; Lichtenthaler and Marx 2005) and may confer many health benefits. However, more complete nutrient databases and intake reference standards would need to be established in order to successfully incorporate the phytochemical content into a nutrient density score. Other key issues related to the development of a nutrient density score include:

- Components of a nutrient density score: which and how many nutrients or food components should be included in a score? Should certain nutrients receive punitive treatment in the score?
- Nutrient bioavailability: how could a score account for nutrients that are more bioavailable in one food compared to another food?
- Mathematical weighting of nutrients: should nutrients be weighted based on their distribution in the food supply, importance to human health, or bioavailability?

Table 4—Ranking of select 100% fruit juices based on nutrient density scores

Rank[a]	Method 1 nutrient for calorie	Method 2 calorie for nutrient	Method 3 nutrient for nutrient	Method 4 nutrient for calorie	Method 5 nutrient for calorie ad hoc 1	Method 6 nutrient for calorie ad hoc 2
1	Pink grapefruit	Pink grapefruit	Pink grapefruit	Pink grapefruit	Pink grapefruit	Orange
2	Orange	Orange	Orange	Orange	Orange	Pink grapefruit
3	White grapefruit	White grapefruit	White grapefruit	White grapefruit	White grapefruit	White grapefruit
4	Pineapple	Pineapple	Pineapple	Pineapple, prune[b]	Pineapple	Pineapple
5	Prune	Prune	Prune	Apple, grape[b]	Prune	Prune
6	Grape	Grape	Apple, grape[b]		Grape	Grape
7	Apple	Apple			Apple	Apple

[a]Ranked from most nutrient dense (rank of 1) to least nutrient dense (rank of 7).
[b]Products listed together have the same nutrient density score.

Table 5—Summary of nutrient density scores for select foods

Product	Serving size	NDB[a] number	Method 1 nutrient for calorie[b]	Method 2 calorie for nutrient[c]	Method 3 nutrient for nutrient[b]	Method 4 nutrient for calorie[b]	Method 5 nutrient for calorie ad hoc 1[b]
Chicken, broilers or fryers, breast, meat only, cooked, roasted	86 g[d]	05064	94	10.7	1.3	0.05	122
Broccoli, cooked, boiled, drained, without salt	78 g[e]	11091	861	2.1	20.8	0.40	805
Yogurt, fruit variety, nonfat	240 mL	43261	91	20.2	0.5	0.04	89
Cereals, oats, regular and quick and instant, unenriched, cooked with water, without salt	234 g[f]	08121	60	27.1	3.1	0.04	82

Method 6 (nutrient for calorie ad hoc 2) was not included because it was based on the nutrients most commonly found in 100% fruit juices and would therefore not be applicable to other foods.
[a]NDB = Nutrient Databank.
[b]Higher values represent a more nutrient-dense food.
[c]Lower values represent a more nutrient-dense food.
[d]Approximately 1/2 chicken breast, bone, and skin removed.
[e]Approximately 1/2 cup, chopped.
[f]Approximately 1 cup.

- Food fortification: should fortified foods be evaluated in the same way as foods that are naturally nutrient rich?
- Diet quality: will selecting a diet based on nutrient-dense foods and a nutrient density score correlate to indicators of overall diet quality?
- Food label: how would a nutrient density score be incorporated into the food label?

Important and broader issues include successfully incorporating the concept of the nutrient density score into prevailing dietary advice, effectively educating practitioners and consumers about how the nutrient density score could be used in selecting a healthful diet, and evaluating whether labeling food items and menus would affect food choice behaviors. Finally, and no less important, is the need to address and ensure the affordability of nutrient-dense foods for individuals in lower socioeconomic groups.

Conclusion

Quantitative nutrient density scores were calculated for various 100% fruit juices using methodologies that differed in several ways, including the quantity reference basis for each approach (for example, calories, food weight, serving size), which and how many nutrients were included in the formula, and punitive treatment of some nutrients. Although the various methods produced scores that differed in magnitude and scale, they were fairly consistent in how the juices and other foods were ranked relative to one another and the results suggest that citrus juices are more nutrient dense compared to other commonly consumed 100% fruit juices. Scores higher in magnitude and range would allow for more discriminating power when categorizing the nutrient densities of a variety of foods. Many issues remain to be resolved regarding the development of a nutrient density score for use on food labels and in providing dietary guidance. However, nutrient density is expected to remain at the forefront of nutrition policy and guidance in the ongoing effort to enhance diet quality and overall health.

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