Influencing Consumer Behavior: A case for nutrient profiling?

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Director, Center for Obesity Research
University of Washington

Influencing consumer food behavior
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Toward a nutrient density score

The beginning....
Consumer applications of nutrient density: the US

The 2005 Dietary Guidelines:

- Americans advised to “select nutrient dense foods” rather than discretionary calories
- Nutrient-dense foods were defined as those providing ‘relatively more’ nutrients than calories
- DGAs called for a scientific definition of nutrient density of foods.
- There is also a need to convey the concept of nutrient density to the consumer.
- The FDA held hearings in September 2007 on front-of-pack food labels that would convey this at a glance.

Regulatory applications of nutrient profiling: the EU

- European Commission’s proposal 1924/2006 imposed strict conditions on the use of nutrition or health claims
- Foods must have favorable profiles in order to qualify
- Article 4 states that nutrient profiles should be based on
  - The quantities of certain nutrients and other substances in the food, such as fat, saturated fatty acids, trans-fatty acids, sugars and salt/sodium.
  - The role and the importance of the food (or of categories of food) and the contribution to the diet of the population or of certain risk groups incl. children.
  - The overall nutritional composition of the food and the presence of nutrients that have been scientifically recognized as having an effect on health.
**EU Regulation 1924/2006**

**what it contains**

**Nutrition Claims**
- Content claims
- Comparative claims
- Dietary Guidelines claims

**Health Claims**
- Function claims
  - Based on generally accepted scientific data
  - Based on newly developed scientific data

- Reduction of disease risk claims
  - and claims referring to children’s development and health

- **“rich in calcium”**
- **“calcium is good for bones”**
- **“calcium can lower the risk of osteoporosis”**

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**EU Regulation overview**

**Nutrition Claims**

**Health Claims**
- Health claims other than those referring to the reduction of disease risk
- Reduction of disease risk claims and claims referring to children’s development and health

**Nutrient Profiles (Art. 4)**

**Restrictions on the use of certain health claims (Art. 12)**
- based on generally accepted scientific data
- based on newly developed scientific data and/or protected data

**Community list of permitted claims (Annex)**
**Community list of permitted claims (Art. 13)**
**Authorization procedure through EFSA**

**COMMUNITY REGISTER**

Adapted from: European Advisory Services – Sept 2006; and Theo Ockhuisen IDF
The Nutrient Rich Foods Coalition

From food rating to food guidance

Nutrient profiling is the science of ranking or classifying foods based on their nutrient composition*

Each food is assigned a unique score that reflects its nutrient quality

Nutrient profiles must be:

- **Objective** - based on accepted nutrition science and labeling practices
- **Simple** – based on published daily values and meaningful amounts of food
- **Balanced** – based on nutrients to encourage and on nutrients to limit
- **Validated** – against measures of a healthful diet
- **Transparent** – based on published algorithms and open-source data
- **Consumer-driven** – likely to guide better food choices and more healthful diets

*Defined by the UK Food Standards Agency, FSA

The Nutrient Rich Foods Index is:

- **Objective** - based on 2005 Dietary Guidelines; 2005 MyPyramid and other expert panel data
- **Simple** – based on FDA percent Daily Values and FDA serving sizes and on USDA nutrient data sets
- **Balanced** – based on nutrients to encourage and on nutrients to limit
- **Validated** – against 2005 Healthy Eating Index (HEI)
- **Transparent** – algorithms published in peer-review journals
- **Consumer-driven** – research on helping consumers to build healthier diets is in progress


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The Nutrient Rich Foods Index

**Nutrients to encourage:**
Protein, fiber, vitamins A, C, E, calcium, iron, potassium, magnesium

**Nutrients to limit:**
saturated fat, added (or total) sugar, sodium

**The NutriScore algorithm**

\[ 	ext{NRF } 9.3 = \sum_{i=1,9} (\%DV/RACC) - \sum_{i=1,3} (\%MRV/RACC) \]

Difference between sum %DV per reference amount of food

Follow these steps

Select nutrients to encourage

*Use simple and objective criteria*

- **The 2005 Dietary Guidelines seven**
  - Fiber, vitamins A, C, E, Ca, K, Mg
- **The Food and Drug Administration six**
  - FDA defines “healthy” foods as those that contain $\geq$10% DV of protein, fiber, vitamins A, C, Ca, or Fe
- **Additional nutrients for special population needs**
  - Zn, Fe, folate, vitamins D, B$_{12}$
# Select nutrients to encourage

<table>
<thead>
<tr>
<th>Nutrient profile model</th>
<th>Macronutrients</th>
<th>Vitamins</th>
<th>Minerals</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>NR5</td>
<td>Protein, fiber</td>
<td>Vit C</td>
<td>Ca, Fe</td>
<td>AFSSA 2008</td>
</tr>
<tr>
<td>NR6</td>
<td>Protein, fiber</td>
<td>Vit A, C</td>
<td>Ca, Fe</td>
<td>Drewnowski et al 2008</td>
</tr>
<tr>
<td>NR9</td>
<td>Protein, fiber</td>
<td>Vit A, C, E</td>
<td>Ca, Fe, Mg, K</td>
<td>Drewnowski et al 2008</td>
</tr>
<tr>
<td>NR9z</td>
<td>Protein, fiber</td>
<td>Vit A, C, E</td>
<td>Ca, Fe, Zn, K</td>
<td>Drewnowski et al 2008</td>
</tr>
<tr>
<td>NR11</td>
<td>Protein, fiber</td>
<td>Vit A, C, E, B₁₂</td>
<td>Ca, Fe, Zn, Mg, K</td>
<td>Drewnowski et al 2008</td>
</tr>
<tr>
<td>NR12</td>
<td>Protein, fiber</td>
<td>Vit A, C, E, thiamin, riboflavin, B₁₂</td>
<td>Ca, Fe, Zn, K</td>
<td>Drewnowski et al 2008</td>
</tr>
<tr>
<td>NR14</td>
<td>Protein, fiber</td>
<td>Vit C, D, E, thiamin, riboflavin, B₁₂, folate</td>
<td>Ca, Fe, Zn, K</td>
<td>Drewnowski et al 2008</td>
</tr>
<tr>
<td>NNR15</td>
<td>Protein, fiber, MUFA</td>
<td>Vit C, D, E, thiamin, riboflavin, B₁₂, folate</td>
<td>Ca, Fe, Zn, K</td>
<td>Drewnowski 2005</td>
</tr>
<tr>
<td>NDS16 afssa</td>
<td>Protein, fiber, linolenic, DHA</td>
<td>Vit C, D, E, thiamin, riboflavin, B₁₂, folate</td>
<td>Ca, Fe, Zn, Mg, K</td>
<td>Darmon et al 2006</td>
</tr>
<tr>
<td>NDS23</td>
<td>Protein, fiber, linoleic, linolenic, DHA</td>
<td>Vit A, C, D, E, thiamin, riboflavin, B₁₂, niacin, folate</td>
<td>Ca, Fe, Zn, Mg, Cu, Se, K, I, (Ph)</td>
<td>Mailot et al 2007</td>
</tr>
</tbody>
</table>

# Select nutrients to limit

*Use simple and objective criteria*

- **The 2005 Dietary Guidelines six**
  - Total fat, saturated fat, trans-fat, cholesterol, added sugar, sodium
- **The Food and Drug Administration four**
  - Foods are disqualified from health claims if they contain too much fat, saturated fat, cholesterol, or sodium
- **The European Union four**
  - EC lists total fat, saturated fat, trans fat, sugar and sodium
- **The AFSSA three**
  - Saturated fat, added sugar, sodium
Select reference daily values

Use published reference amounts

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Reference DV</th>
<th>Nutrient</th>
<th>Maximum RV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>50 g</td>
<td>Total fat</td>
<td>65 g</td>
</tr>
<tr>
<td>Fiber</td>
<td>25 g</td>
<td>Saturated fat</td>
<td>20 g</td>
</tr>
<tr>
<td>Vit A</td>
<td>5000 IU</td>
<td>Total sugars</td>
<td>125 g</td>
</tr>
<tr>
<td>Vit C</td>
<td>60 mg</td>
<td>Added sugars</td>
<td>50 g</td>
</tr>
<tr>
<td>Vit E</td>
<td>30 IU</td>
<td>Sodium</td>
<td>2,400</td>
</tr>
<tr>
<td>Calcium</td>
<td>1,000 mg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron</td>
<td>18 mg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potassium</td>
<td>3,500 mg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnesium</td>
<td>400 mg</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Select the basis for calculation

Use science to decide among potential options

• **100 grams**
  – Food labels in the EU are based on 100g amounts – so are some EU-based nutrient profiles (e.g. UK FSA)

• **100 kcal**
  – Better reflects the nutrient-to-calorie ratio – but will consumers relate?

• **Government-mandated serving size**
  – Food labels in the US are based on Reference Amounts Customarily Consumed (RACC)
Because the Nutrient Rich Food Index is calculated per RACC it is:

- Consistent with US labeling schemes
- Consistent with portion sizes normally consumed
- Consistent with the nutrient density approach (nutrients/100 kcal)

- RACC-based scores resemble 100 kcal-based ones
- By contrast, 100 g and 100 kcal are very different
Capture the total nutrient package

**Balance nutrients to encourage and nutrients to limit**

<table>
<thead>
<tr>
<th>Nutrient profile model</th>
<th>Nutrients/Foods to encourage</th>
<th>Nutrients to limit</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIM</td>
<td>Sat fat, added sugar, Na</td>
<td>Maillot 2007</td>
<td></td>
</tr>
<tr>
<td>LIM tot</td>
<td>Total fat, total sugar, Na</td>
<td>Drewnowski 2008</td>
<td></td>
</tr>
<tr>
<td>Unilever</td>
<td>Sat fat, trans fat, sugar (total + added), Na</td>
<td>Drewnowski 2008</td>
<td></td>
</tr>
<tr>
<td>Kellogg</td>
<td>Energy, sat fat, trans fat, total sugar, Na (cholesterol)</td>
<td>Drewnowski 2008</td>
<td></td>
</tr>
<tr>
<td>AFSSA</td>
<td>Protein, fiber, Vit C</td>
<td>Sat fat, added sugar, Na</td>
<td>AFSSA 2008</td>
</tr>
<tr>
<td>FSA WXYfm</td>
<td>Protein, fiber, Fruit, Vegetable, Nut</td>
<td>Energy, sat fat, total sugar, Na</td>
<td>Rayner 2007</td>
</tr>
<tr>
<td>Nutrient Rich Foods 9.3</td>
<td>Protein, fiber, Vit A, C, E, Ca, Fe, Mg, K</td>
<td>Sat fat, added sugar, Na</td>
<td>Drewnowski 2008</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Basis</th>
<th>Algorithm</th>
</tr>
</thead>
<tbody>
<tr>
<td>NR9_100 g</td>
<td>$\sum_{1}^{n} ((\text{nutrient}_i / \text{DV}_i)/n) \times 100$</td>
</tr>
<tr>
<td>NR9_100 kcal</td>
<td>$(\text{NR}_{100g} / \text{ED}) \times 100$</td>
</tr>
<tr>
<td>NR9_RACC</td>
<td>$(\text{NR}_{100g} / 100) \times \text{RACC}$</td>
</tr>
<tr>
<td>LIM_100g</td>
<td>$\sum_{1}^{n} ((\text{nutrient}_i / \text{MRV}_i)/3 \times 100)) \times 100$</td>
</tr>
<tr>
<td>LIM_100 kcal</td>
<td>$(\text{LIM}_{100g} / \text{ED}) \times 100$</td>
</tr>
<tr>
<td>LIM_RACC</td>
<td>$(\text{LIM}_{100g} / 100) \times \text{RACC}$</td>
</tr>
<tr>
<td>Nutrient Rich Food 9.3</td>
<td>Sums</td>
</tr>
<tr>
<td>Nutrient Rich Food 9.3</td>
<td>Means</td>
</tr>
<tr>
<td>Nutrient Rich Food 9.3</td>
<td>Ratios</td>
</tr>
</tbody>
</table>


Make it transparent

**Algorithms for subscores will be published**

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<th>Algorithm</th>
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<td>$\sum_{1}^{n} ((\text{nutrient}_i / \text{DV}_i)/n) \times 100$</td>
</tr>
<tr>
<td>NR9_100 kcal</td>
<td>100 kcal</td>
<td>$(\text{NR}_{100g} / \text{ED}) \times 100$</td>
</tr>
<tr>
<td>NR9_RACC</td>
<td>RACC</td>
<td>$(\text{NR}_{100g} / 100) \times \text{RACC}$</td>
</tr>
<tr>
<td>LIM_100g</td>
<td>100 g</td>
<td>$\sum_{1}^{n} ((\text{nutrient}_i / \text{MRV}_i)/3 \times 100)) \times 100$</td>
</tr>
<tr>
<td>LIM_100 kcal</td>
<td>100 kcal</td>
<td>$(\text{LIM}_{100g} / \text{ED}) \times 100$</td>
</tr>
<tr>
<td>LIM_RACC</td>
<td>RACC</td>
<td>$(\text{LIM}_{100g} / 100) \times \text{RACC}$</td>
</tr>
<tr>
<td>Nutrient Rich Food 9.3</td>
<td>Sums</td>
<td>$9 \times \text{NR9} – 3 \times \text{LIM}$</td>
</tr>
<tr>
<td>Nutrient Rich Food 9.3</td>
<td>Means</td>
<td>$\text{NR9} – \text{LIM}$</td>
</tr>
<tr>
<td>Nutrient Rich Food 9.3</td>
<td>Ratios</td>
<td>$\text{NR9}/\text{LIM}$</td>
</tr>
</tbody>
</table>

Maillot, Darmon, Drewnowski, submitted
## Testing and validation

**The NRF index was validated against healthful diets**

<table>
<thead>
<tr>
<th>Type of test or validation</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does a list of foods look “right”?</td>
<td>Drewnowski 2005; Braesco 2007, Rayner 2007</td>
</tr>
<tr>
<td>Are scores correlated with consumer attitudes?</td>
<td>Drewnowski (in preparation)</td>
</tr>
<tr>
<td>A scores linked to other food components, energy density, and cost?</td>
<td>Drewnowski, Maillot, Darmon (EJCN 2008)</td>
</tr>
<tr>
<td>Are index foods linked to diet quality (DQI) measures?</td>
<td>Rayner 2007; Volatier 2007, Fulgoni and Drewnowski (in preparation)</td>
</tr>
<tr>
<td>Are index foods linked to the 2005 HEI?</td>
<td></td>
</tr>
</tbody>
</table>


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## The validation process

- Used NHANES 1999-2002 data for analyses
  - For each subject each food reported was scored via one of LIM, NRF$_n$, or NRF$_n$.3 algorithms
  - An overall “average” score was determined based on either 100 kcal or RACC
    - For per 100 kcal bases, total diet score was divided by the number of calories consumed/100
    - For per RACC bases, total diet score was divided by the number of RACCs consumed
  - 2005 Healthy Eating Index scores were calculated
  - Regression analyses were conducted adjusting for gender, race/ethnicity and age (R-square for these three variables was 6.78%)
### Healthy Eating Index - 2005

<table>
<thead>
<tr>
<th>Component</th>
<th>Points</th>
<th>Std. for max. score</th>
<th>Std. for min. score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Fruit (includes 100% juice)</td>
<td>5</td>
<td>≥0.8 cup equiv. per 1,000 kcal</td>
<td>No Fruit</td>
</tr>
<tr>
<td>Whole Fruit (not juice)</td>
<td>5</td>
<td>≥0.4 cup equiv. per 1,000 kcal</td>
<td>No Whole Fruit</td>
</tr>
<tr>
<td>Total Vegetables</td>
<td>5</td>
<td>≥1.1 cup equiv. per 1,000 kcal</td>
<td>No vegetables</td>
</tr>
<tr>
<td>Dark Green and Orange Vegetables and Legumes</td>
<td>5</td>
<td>≥0.4 cup equiv. per 1,000 kcal</td>
<td>No Dark Green or Orange Vegetables and Legumes</td>
</tr>
<tr>
<td>Total Grains</td>
<td>5</td>
<td>≥3.0 oz equiv. per 1,000 kcal</td>
<td>No Grains</td>
</tr>
<tr>
<td>Whole Grains</td>
<td>5</td>
<td>≥1.5 oz equiv. per 1,000 kcal</td>
<td>No Whole Grains</td>
</tr>
<tr>
<td>Milk</td>
<td>10</td>
<td>≥1.3 cup equiv. per 1,000 kcal</td>
<td>No Milk</td>
</tr>
<tr>
<td>Meat and Beans</td>
<td>10</td>
<td>≥2.5 oz equiv. per 1,000 kcal</td>
<td>No Meat or Beans</td>
</tr>
<tr>
<td>Oils</td>
<td>10</td>
<td>≥12 grams per 1,000 kcal</td>
<td>No Oil</td>
</tr>
<tr>
<td>Saturated Fat</td>
<td>10</td>
<td>≤7% of energy</td>
<td>≥15% of energy</td>
</tr>
<tr>
<td>Sodium</td>
<td>10</td>
<td>≤0.7 gram per 1,000 kcal</td>
<td>≥2.0 g per 1,000 kcal</td>
</tr>
<tr>
<td>Calories from Solid Fat, Alcohol, and Added Sugar (SoFAAS)</td>
<td>20</td>
<td>≤20% of energy</td>
<td>≥50% of energy</td>
</tr>
</tbody>
</table>

### The optimum NRF9.3 index

The optimum NRF9.3 index is 11.3

The graph shows the percentage of the Healthy Eating Index - 2005 for different NRF values, with NRF9.3 highlighted.
To our knowledge, the NRF Index is the only tool that has been \textit{validated} against a recognized, objective measures of a healthy diet.

### How does the Nutrient Rich Foods Index rank foods?

- \textbf{Grains}
- \textbf{Protein}
- \textbf{Fruits}
- \textbf{Milk}
- \textbf{Meat & Beans}
NRF9.3 scores by food group

Energy per 100g

NRF9.3 racc sum

- Grains
- Fruits
- Vegetables

Choc chip cookies
Cheerios
White bread
Cereal 40% bran
Total

NRF9.3 scores by food group

Energy per 100g

NRF9.3 racc sum

- Grains
- Fruits
- Vegetables

Choc chip cookies
Cheerios
White bread
Cereal 40% bran
Total
NRF9.3 scores by food group

- Dairy foods:
  - Ice cream bar
  - Dry cheeses
  - Milk, 1% fat
  - Milk, skim
  - Yogurt, plain, low fat
  - Yogurt, plain, non fat

- Meat products:
  - Bacon
  - Clams, fried
  - Sausage
  - Hot dog
  - Beef steak, lean
  - Beef chile
  - Beef stew
  - Liver
The Nutrient Rich Foods Index is the only one to meet all 6 criteria:

- **Objective** - based on Dietary Guidelines, MyPyramid and recommendations by expert panels
- **Balanced** – based on nutrients to encourage and nutrients to limit
- **Simple** – based on percent Daily Values and reference amounts (RACC) published by the FDA
- **Validated** – against the Healthy Eating Index (HEI)
- **Transparent** – algorithms published in peer-review journals; based on open-source USDA databases
- **Consumer-driven** – research on how NRF will help consumers to build healthier diets is in progress


What if balance is not achieved?

What if the score is based only on saturated fat, added sugar, and sodium?

And calculated per 100g? (much like the British FSA score)
LIM_{100g} only reflects energy density

Drewnowski & Fulgoni 2008
The case for nutrient profiling

- Nutrient profiling – if done right – can improve the nutrient content of the American diet
- The Nutrient Rich Foods Index is science-based and consumer-driven
- The Nutrient Rich Foods Index uses simple and objective methods to capture the total nutrient package
- All algorithms are being published
- The process is transparent - open to public scrutiny and comment
The Nutrient Rich Foods Index

Nutrients to encourage:
Protein, fiber, vitamins A, C, E, calcium, iron, potassium, magnesium

Nutrients to limit:
saturated fat, added (or total) sugar, sodium

The NutriScore algorithm

\[
NRF\ 9.3 = \sum_{i=9}^{\text{%DV/RACC}} - \sum_{i=3}^{\text{%DV/RACC}}
\]

Expressed as sum percent DV per reference amount of food


Food guidance, not food rating

Consumers will decide what format they like best

The Nutrient Rich Foods Index:
• Stresses the “whole food” or total nutrient package – not just nutrients to avoid
• Will be transformed into a useful consumer tool – to build healthier diets
• Can address issues of food habits, taste, and cost
Thank you!