The issue of ‘Ultra-Processed Foods’ and public health

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Some questions to take home from this introductory class

• Should we food engineers, technologists and scientists really be concerned about food processing being condemned for having gone too far?
• Are over-processed foods the source of such chronic non-communicable diseases as obesity and diabetes?
• Should we perhaps update the concept of food safety?
• Are food additives and ingredients to be banned in order to improve public health worldwide?
• Could we view processed foods as one more environmental pressure that the human species will overcome with time?
• How much is there that we can do to help solve the problem?
Overweightness & Obesity

• Started to increase in affluent nations following World War II.
• One generation later, the issue became a public health concern in the US.
• Spread to virtually all countries before the 20th Century was over.
• Obesity affects 1 billion persons today, and it includes young children.
• About 2.8 million people die each year as a consequence of being obese or overweight.

According to the US (NHANES, 2013-2014):
• More than 2 in 3 adults were considered to be overweight or obese.
• More than 1 in 3 adults were considered to be obese.
• About 1 in 13 adults were considered to have extreme obesity.
• About 1 in 6 children and adolescents ages 2 to 19 were considered to have obesity.

NOTES: Obesity is defined as body mass index (BMI) greater than or equal to the 95th percentile from the sex-specific BMI-for-age 2000 CDC Growth Charts.

Obesity is central to a variety of chronic, non-communicable diseases.

- High BP
- High TAGs
- Obesity
- PCOS
- Hepatic steatosis
- Type 2 diabetes
- CVDs
- Breast cancer
- Alzheimer T3 Diabetes
Diabetes

US NIH NIDDK, 2017:
An estimated total of 30.3 million people have diabetes (9.4 percent of the U.S. population)
Diagnosed: An estimated 23.1 million people have been diagnosed with diabetes (7.2 percent of the U.S. population)
Undiagnosed: An estimated 7.2 million adults, ages 18 years or older are undiagnosed (23.8 percent of people with diabetes)

• In the US, 23.1 million adults (48.3 %) ages 65 or older have prediabetes.
• An estimated 84.1 million adults ages 18 years or older have prediabetes.
• More men (36.6 %) than women (29.3 %) have prediabetes.
Both diabetes and prediabetes result in a vast number of chronic, non-communicable diseases.
Is the public uproar that processed foods are responsible for the global epidemic of chronic diseases scientifically sound?

A sample of three papers may help us to draw an opinion.
“Ultra-processed products are becoming dominant in the global food system”

Monteiro et al., 2013

“Ultra-processed foods and the nutritional dietary profile in Brazil”

Louzada et al., 2015

“Ultra-processed foods and added sugars in the US diet: evidence from a nationally representative cross-sectional study”

Steele et al., 2016
What do we understand by “Processed Foods”?  

**Food**: is any material, whether liquid, paste or solid, that is meant to be ingested as nourishment.

**Food (Codex Alimentarius)**: “Food means any substance, whether processed, semi-processed or raw, which is intended for human consumption, and includes drink, chewing gum and any substance which has been used in the manufacture, preparation or treatment of “food” but does not include cosmetics or tobacco or substances used only as drugs.”

**Processing**: any transformation produced by cleaning, fractionating, salting, fermenting, heating, etc. is a process introduced for the purpose of preserving freshness or nutritional properties, avoiding deterioration, and expanding the options of utilization, or improving palatability.
So, what should we understand by “Ultra-Processing of Foods”? 

It is easy to draw a line between unprocessed and processed foods, but not between Processed and Ultra-processed foods.

Therefore, the term “Ultra-processed Foods” is a rather subjective concept and it dodges a clear definition.
Ultra-processed products are becoming dominant in the global food system

Monteiro et al., 2013

‘This paper examines trends in the purchase and sales of a specific type of processed food product in high- and middle-income countries, with special attention to Canada and Brazil. The determinants of these trends and their impact on the quality of diets and on health are discussed, along with policy implications’. 
Ultra-processed products are becoming dominant in the global food system

Were defined by the authors as:

“Ultra-processed products are made from processed substances extracted or refined from whole foods – e.g. oils, hydrogenated oils and fats, flours and starches, variants of sugar, and cheap parts or remnants of animal foods – with little or no whole foods. Products include burgers, frozen pasta, pizza and pasta dishes, nuggets and sticks, crisps, biscuits, confectionery, cereal bars, carbonated and other sugared drinks, and various snack products. Most are made, advertised, and sold by large or transnational corporations and are very durable, palatable, and ready to consume, which is an enormous commercial advantage over fresh and perishable whole or minimally processed foods . . . [They] are typically energy dense; have a high glycaemic load; are low in dietary fibre, micronutrients, and phytochemicals; and are high in unhealthy types of dietary fat, free sugars, and sodium.”
Ultra-processed products are becoming dominant in the global food system

Note that according to the above definition we should also include the following:

- Animal fat
- Virgin olive, Palm and other natural vegetable oils
- Egg whites, Egg yolks
- Coconut water
- Teas and coffee
- Wines
- Roasted pig skin
- Fresh or naturally fermented cheeses
- Cheeses, Ricotta cheese
- Butter
- Whole milk whey
...and many others.

A contradictory or incomplete definition?
### Ultra-processed products are becoming dominant in the global food system

Monteiro et al., 2013

How ultra-processed foods were classified in 2013

<table>
<thead>
<tr>
<th>Frozen goods</th>
<th>Snacks</th>
<th>Beverages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Included: Frozen processed products (Bakery products; potatoes; desserts; meat, poultry, fish, seafood, meat substitutes, red meat, processed poultry, processed fish/sea food, meat substitutes; dishes such as pizza, ready meals, others).</td>
<td>Included: Sweet and savoury snacks (Chips/crisps, corn chips, pretzels, sweet snacks, salted nuts. Confectionery (Chocolates, sweets, gums, pastilles, jellies) Ice creams (Also frozen yoghurt).</td>
<td>Included: Carbonates (Carbonated drinks). Fruit and vegetable juices (Sweetened juices, nectars, fruit drinks, fruit-flavoured drinks). Ready-to-drink tea or coffee. Sports and energy drinks Asian speciality drinks.</td>
</tr>
</tbody>
</table>
How countries were classified. Monteiro et al., 2013

<table>
<thead>
<tr>
<th>Income classes</th>
<th>Annual GNI per head ($US)</th>
<th>Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower-middle</td>
<td>1,036–4,085</td>
<td>Belarus, Bolivia, Bosnia-Herzegovina, Cameroon, China, Egypt, Georgia, Guatemala, India, Indonesia, Morocco, Nigeria, Pakistan, Philippines, Ukraine, Uzbekistan, Vietnam</td>
</tr>
<tr>
<td>Upper-middle</td>
<td>4,086–12,615</td>
<td>Algeria, Argentina, Azerbaijan, Brazil, Bulgaria, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Hungary, Iran, Kazakhstan, Latvia, Lithuania, Macedonia, Malaysia, Mexico, Peru, Poland, Romania, Russia, Serbia, South Africa, Thailand, Tunisia, Turkey, Uruguay, Venezuela.</td>
</tr>
<tr>
<td>High</td>
<td>12,616 or more</td>
<td>Australia, Austria, Belgium, Canada, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Saudi Arabia, Singapore, Slovakia, Slovenia, South Korea, Spain, Sweden, Switzerland, Taiwan, United Arab Emirates, UK, USA</td>
</tr>
</tbody>
</table>
Time evolution of estimated household expenditures or trend of food energy contributed by ultra-processed foods in Canada and Brazil.
Per capita retail sales of selected ultra-processed products in high-income countries (1998–2012).
Monteiro et al., 2013

Per capita retail sales of selected ultra-processed products in lower- and upper-middle-income countries (1998–2012).
Ultra-processed products are becoming dominant in the global food system

Monteiro et al., 2013

Conclusions

“This paper shows that ultra-processed products dominate the food supplies of high-income countries, and that consumption of these products is now rapidly increasing in middle-income countries. The general effect is displacement of dietary patterns based on regular freshly prepared meals, by constant snacking on relatively energy-dense, fatty, sugary or salty ready-to-consume products. The scale and power of the corporations whose profits depend on these products is colossal. Realistic policies and actions to check or reduce their consumption will go beyond education and information programmes and will be centred on fiscal and other statutory measures.”
Ultra-processed products are becoming dominant in the global food system

Monteiro et al., 2013

So, what did the authors really contend in this paper?

- **Sales (consumption)** of processed foods have steadily increased in middle and upper-middle income countries since 1998.
- The authors propose to accept processing only for the purpose of making the food material chewable, deglutible, digestible and trouble-free from the digestibility standpoint.
- They raise an objection to the use of all ingredients and/or additives.
- Also, by their definitions, we would have to forego even the use of virgin olive oil and vinegar to season a salad dish.
Ultra-processed products are becoming dominant in the global food system

Main observations drawn from Monteiro et al. (2013)

• This paper shows that consumption or sales of the ultra-processed products may dominate the food market in high-income countries, and that middle-income countries are rapidly following this trend.
• They raise the alert that drastically modified diets can harmfully impact public health, but... the blame is put only on the industry and policy makers.
• The authors ignore the inevitable role of man’s natural drives for: sugar, salt and fat, as they neglect brain metabolism, choosing instead to blame the food industry for immoral practices.
• Lastly, the enormous contribution of food processing, additives and ingredients to present day societies goes mostly unrecognized, while no plausible solutions to the problem are offered.
Ultra-processed foods and the nutritional dietary profile in Brazil.

Louzada et al., 2015

**OBJECTIVE:** To assess the impact of consuming ultra-processed foods on the nutritional dietary profile in Brazil.

**METHODS:** Cross-sectional study conducted with data from the module on individual food consumption from the 2008-2009 Pesquisa de Orçamentos Familiares (POF – Brazilian Family Budgets Survey).

The sample: 32,898 individuals (10 years or older); Food purchased declared in two 24-hour food records.

Food items were classified into: **natural** or minimally processed; **processed**; and **ultra-processed**.
Ultra-processed foods and the nutritional dietary profile in Brazil. Louzada et al., 2015

“Definitions”

Natural foods are obtained directly from plants or animals (such as leaves and fruit or eggs and milk) and are purchased in a state ready for consumption without having undergone any alteration after leaving the natural source. Minimally processed foods are natural foods that, prior to their acquisition, underwent minor changes that do not involve adding substances to the food. Cleaning, removal of non-edible parts, fractioning, drying, packaging, fermentation, pasteurization, refrigeration, freezing, milling and refinement are examples of the processes that natural foods go through...
Ultra-processed foods are ready-to-consume products that are made up entirely or mostly from substances extracted from food (oils, fats, sugar, proteins), derived from food constituents (hydrogenated fats, modified starches), or synthesized, based on organic materials (dyes, flavorings, flavor enhancers and other additives used to alter the food’s sensory properties).

Refs.11,12,15,16,18” [all self references or own quotations]

What about olive oil, molasses, coconut water, palm oil, butter? How much is meant by “entirely or mostly”? Why is gelatin still given to convalescing patients in hospitals?
RESULTS: The average daily energy *per capita* (1,866 kcal) intake was 69.5% from natural or minimally processed foods, 9.0% from processed and 21.5% by ultraprocessed food.

The ultraprocessed foods showed to contain higher energy density, higher fat contents, higher saturated and trans fats, higher levels of free sugar and less fiber, protein, sodium and potassium, than natural or minimally processed foods.

The greater the consumption of ultra-processed foods, the farther the population was from meeting the WHO recommendations of healthy nutrition.

The stratum of the population that consumed less ultra-processed foods (except for sodium) was closer to meet the international recommendations for a healthy diet.
Ultra-processed foods and the nutritional dietary profile in Brazil.

Energy from natural or minimally processed foods

<table>
<thead>
<tr>
<th>Food Group or item</th>
<th>kcal/day</th>
<th>% cal/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural or Minimally Processed</td>
<td>1275</td>
<td>69.5</td>
</tr>
<tr>
<td>Rice</td>
<td>226</td>
<td>12.6</td>
</tr>
<tr>
<td>Beans</td>
<td>190</td>
<td>10.3</td>
</tr>
<tr>
<td>Pork or Beef meats</td>
<td>189</td>
<td>10.0</td>
</tr>
<tr>
<td>Fruits</td>
<td>133</td>
<td>7.0</td>
</tr>
<tr>
<td>Other Cereals</td>
<td>111</td>
<td>6.0</td>
</tr>
<tr>
<td>Milk</td>
<td>96</td>
<td>5.4</td>
</tr>
<tr>
<td>Poultry</td>
<td>88</td>
<td>4.9</td>
</tr>
<tr>
<td>Roots &amp; Tubers</td>
<td>77</td>
<td>3.9</td>
</tr>
<tr>
<td>Fish</td>
<td>33</td>
<td>1.7</td>
</tr>
<tr>
<td>Vegetables</td>
<td>22</td>
<td>1.4</td>
</tr>
<tr>
<td>Eggs</td>
<td>24</td>
<td>1.4</td>
</tr>
</tbody>
</table>
Ultra-processed foods and the nutritional dietary profile in Brazil.

Energy from processed foods

<table>
<thead>
<tr>
<th>Food Group or item</th>
<th>kcal/day</th>
<th>% cal/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normally Processed</td>
<td>167</td>
<td>9.0</td>
</tr>
<tr>
<td><strong>French Bread</strong></td>
<td>126</td>
<td>6.9</td>
</tr>
<tr>
<td>Cheeses</td>
<td>21</td>
<td>1.1</td>
</tr>
<tr>
<td><strong>Processed Meat</strong></td>
<td>18</td>
<td>0.9</td>
</tr>
<tr>
<td>Canned Fruits and Vegetables</td>
<td>1.8</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Ultra-Processed</strong></td>
<td>423</td>
<td>21.5</td>
</tr>
<tr>
<td>Cakes, Pyes &amp; Cookies</td>
<td>62</td>
<td>3.0</td>
</tr>
<tr>
<td>Fast Food Preparations</td>
<td>56</td>
<td>2.9</td>
</tr>
<tr>
<td>Sugar Sweetened Beverages</td>
<td>52</td>
<td>2.6</td>
</tr>
<tr>
<td>Confectionary</td>
<td>47</td>
<td>2.2</td>
</tr>
<tr>
<td><strong>Sliced Bread, Hamburgers, etc.</strong></td>
<td>42</td>
<td>2.4</td>
</tr>
</tbody>
</table>

What is the difference between French bread, sliced bread and hamburger bread?
Energy from more Ultra-processed foods

<table>
<thead>
<tr>
<th>Food Group or item</th>
<th>kcal/day</th>
<th>% cal/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultra-Processed Food</td>
<td>167</td>
<td>9.0</td>
</tr>
<tr>
<td>Crackers &amp; Chips</td>
<td>40</td>
<td>2.0</td>
</tr>
<tr>
<td>Ready or Semi-Ready Meals: pizzas, frozen pastas, instant noodles, powder soups...</td>
<td>60</td>
<td>1.7</td>
</tr>
<tr>
<td>Sweetened Dairy Drinks</td>
<td>32</td>
<td>1.6</td>
</tr>
<tr>
<td>Sausages</td>
<td>28</td>
<td>1.5</td>
</tr>
</tbody>
</table>
CONCLUSIONS: The observed trend in Brazil shows that replacing the traditional diet, composed mostly of natural or minimally processed foods, for ultra-processed foods, can cause damages to public health.

“These results also support the recommendation that consumption of [ultra-processed] foods should be avoided.”
Ultra-processed foods and added sugars in the US diet: evidence from a nationally representative cross-sectional study

Objective: To investigate the contribution of ultra-processed foods to the intake of added sugars in the USA. Ultra-processed foods were defined as industrial formulations which, besides salt, sugar, oils and fats, include substances not used in culinary preparations, in particular additives used to imitate sensorial qualities of minimally processed foods and their culinary preparations.
Results: Ultra-processed foods contribute with 57.9% of energy intake in the US, and 89.7% of the energy in products with added sugar. Ultra-processed foods (21.1% of calories) contain 8X more sugar than normal processed foods. Ultra-processed foods contain 5X more sugar than unprocessed or minimally processed foods and processed culinary ingredients. Each increase of 5% of energy intake from ultra-processed foods increased the energy intake from added sugars by 1%. A total of 82.1% of Americans in the highest quintile exceeded the recommended limit of 10% energy from added sugars, compared with 26.4% in the lowest. Conclusions: Decreasing the consumption of ultra-processed foods could be an effective way of reducing the excessive intake of added sugars in the USA.
Ultra-processed products are becoming dominant in the global food system

Steele et al., 2013

Comments to this and related papers

• To reduce consumption would mean to reduce addition.
• Prohibition of current formulations by law will have foreseeable self-defeating effects.
• Lowering the sugar content of processed foods, or prohibiting the addition, is just one of the targets of the proponents.
• The purpose of this series of papers is apparently to use the main author’s leverage with WHO to condemn processed foods as we know them and make a world-wide motion in favor of minimally processed foods.

By classifying all ingredients and additives in the same category, the authors jeopardize any scientifically sound technical contentions.
At present, innovative technologies are becoming available for the improvement of food quality in an integrated form.

The time may have come to start a truly integrated reevaluation of food ingredients and food processing to make foods more wholesome in the long run.
The consumer’s perception of food in the 21st Century

Mounting responsibilities during the last 70 years

Mounting responsibilities during the last 70 years

Amaya-Farfan, 2010
“The Story of Food”
Ira Garard, an AVI Book, 1974

How the biological need of humans for glucose in the diet made the sweetness of a grassy plant become sugar.
Rapadura (solid molasses)
Ground molasses (Açúcar mascavo)
Demerara sugar
Crystal sugar
Refined sugar (~99.5% sucrose)

Man has modified his foods from the beginning of times to make them more palatable, nutritious, durable and safe.
Do we eat what we like,  
Or do we like what we (have to) eat? 

Food preferences are set at an early age

The Six Basic Tastes and Flavors:
1. Sweet (Doce),
2. Salt (Salgado,)
3. Acid (Ácido, sour),
4. Bitter (Amargo),
5. Umami (MSG),
6. Oleogustus [recently recognized]

There exists a biological and evolutionary explanation for each one of them, except for Umami:
Why do we like sweet foods?

Sugar: early primates discovered and craved for sweet foods (mostly fruits) because their brains depended from glucose for survival and development (expansion).

The reward was a greater brain capacity, and this craving remains with us till today. Humans developed an extra capacity to select potential sources of glucose by acquiring salivary amylases.
Sodium and saltiness

Throughout man’s history, another sensory appeal that was essential to perform physical work and be able to migrate away from the sea was the perception of saltiness.

Almost all minerals are essential nutrients for man, but no other is so rewarding with an intense flavor as sodium. This was another opportunity for man to establish his "genetic-sensory kit" of survival.

The reward: a feeling of strength and well-being.

The biological explanation: the Na+ / K+ pump must produce ATP to perform work, enhance glucose absorption and even enhance flavor perception.
Can we (or anybody) prohibit the consumption of sugar by law?

Food formulations can be regulated by law, but not the desire of the population to consume them.

If the consumption of a processed food or ingredient were to become habit-forming, the next step will be to make it illegal to produce and commercialize processed foods.
And just what can we do about the problem?

Is criticizing enough?
Dietary composition has an immediate impact of the gut microbiota, and the microbiota, long-term effects on the host

(P.J. Turnbaugh et al. Sci Transl Med, 2009)

Diet changes the gut microbes, and the microbes change our body

A Western diet makes normal mice become obese in a few days. The first impact of the diet was to alter the gut microbiota. It was the altered microbiota that directly induced obesity, not the diet. Implanting the altered microbiota of obese persons into normal mice induced the metabolic changes in the rodents that made them accumulate body fat.

This characteristic was inherited by the offspring.
Obesity is central to chronic, non-communicable diseases

- High BP
- High TAGs
- Obesity
- PCOS
- Hepatic steatosis
- Type 2 diabetes
- CVDs
- Breast cancer
- Alzheimer T3 Diabetes
The intestinal microbiome profile was affected by phenotype, genotype, immune function and DIET of the host.

The effect of the DIET was shown for 2 genotypes (in the presence and absence of obesity) indicating that it was the high-fat diet, and not the obese state, that changed the microbiota.

The high-fat diet decreased the Phylum Bacteroidetes and increased Firmicutes and Proteobacteria.”
The microbiota in the obese is altered and this characteristic is both transferable and inheritable (implications in child obesity?).

[The three mice on top had their microbiota wiped out with antibiotics]

It is the microbiota that determines the phenotype
If dietary fats have an impact on the normal gut microbiota, would dietary proteins also have an impact?

For instance

Work we have done suggests that proteins could have both positive and negative impacts.
The milk whey proteins resist the microbiotal disarray caused by a diet rich in fat. 

Monteiro et al., 2016
And how do our microbes protect us?

Why the gut microbiota? Because these microorganisms are the first to receive the impact of harmful dietary changes; they die by the billions because of their small genome, the surviving individuals adapt, but we survive.
Microorganisms possess tiny genomes and we, humans, a huge genome.
FEA is proposing a course to study possible solutions

ESPCA. Reverse Engineering of Processed Foods. A FAPESP-sponsored 10-day course, 2017
Faculdade de Engenharia de Alimentos - UNICAMP

São Paulo School of Advanced Sciences on the Reverse Engineering of Processed Foods

What is expected from the course? The organizers of this course expect to selected and start training about 120 of both Brazilian and foreign graduate students, post-docs and young teachers from the food science, technology and engineering to consider this multidisciplinary field as potentially ready to utilize new techniques for the improvement of nutrient/nutraceutical bioavailability, in addition to making future foods safer from the standpoint of chronic non-communicable diseases by the application of novel biomolecular techniques as a criterion of long-term food safety. This course should give students the fundamentals to understand and design future foods from a new angle, whose foremost function is to be health-promoting in the long term.