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The more foods are ultra-processed, the less satiating and hypoglycemic they tend to be The big issue is food structure

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Abstract Scientific literature shows that food structure is a key parameter of food health potential. Ultra-processing destroys food structure through refining and fractionation, leading to hyperglycaemic and poorly satiating foods.

One can be surprised that food structure has not been really taken into consideration in defining food health potential (1). Indeed food health potential is traditionally defined through food nutrient composition as exemplified by nutritional indices and the color labeling proposed in some countries to help people choosing healthy foods. As well analyzed by Scrinis, this led agro-food industry to market reformulated foods and to convince us that they are healthier, but always on an ultra-processed basis (2). This reductionist vision of the health potential of foods does not really allow deeply reconsidering processing and its tough impact on food structure, this latter participating in a more holistic picture of food health potential (1).

Food structure is essential because it defines nutrient bioavailability, transit time but also a less studied parameter - satiety (3). Indeed, some studies clearly showed that the more food is fractionated and unstructured, the less satiating it is and the bigger its glycaemic impact, as shown for example, with raw and processed (cooked, blended or refined) apples and carrots (4-6). The same is true for cereal-based foods. For example, breads with denser structure (bread volume) or containing more intact grains are more satiating and less hyperglycaemic than breads with more porous structure due to different conditions of processing (7, 8). Concerning the glycaemic response, a look at Foster-Powell et al. glycaemic index database tends to confirm that less processed starchy foods are less hyperglycaemic (9).

Drastic processing generally involves fractionation, refining, and/or extrusion-cooking at very high temperature and pressure and in the presence of water, favoring high starch gelatinization. That ultra-processed foods are less satiating and more hyperglycaemic suggests that nutrient interaction following ingredient recombination or refining are less 'strong' and favor enzyme accessibility, increasing nutrient

bioavailability. It is not surprising that cooked intact legume seeds are very satiating and exhibit a very low glycaemic index, generally under 40 (10). The presence of an intact fiber network surrounding partially gelatinized starch within cells limits enzyme accessibility leading to the slow release of hydrolysis products within the digestive tract. The same is true for pasta in which starch is embedded in a structured protein network limiting starch gelatinization and starch hydrolysis by α -amylase (11). Interestingly, both cooked legume seeds and pasta are minimally-processed foods, as defined by the NOVA food classification system (12, 13).

Beyond the nutritional composition, the physical and structural characteristics of the food matrix are therefore key players in the health food potential (11). In other words, for the same nutritional composition but different processing, two different foods may give very different glycaemic and satiety responses, which suggests that we should encourage complex natural and minimally processed foods over highly unstructured foods. Satiety potential should be therefore a key feature of a healthy diet sought by technologists. For this, food structure characteristics associated with satiety needs to be more investigated. Indeed, we know little about this key issue apart that complex natural food matrix seems to be more satiating than refined one (3). This will imply building a database about physical characteristics of foods. In fact, some scientific networks are beginning to collect such data.

Finally, a shift toward a new holistic paradigm will help to preserve and better process food products for improving their health effects (10). A more holistic picture of foods is synonymous of a more 'respectful' way of processing them. My purpose is not to say that ultra-processed foods should be completely suppressed from our diet, but rather, that they should take their right place within food supply, more as niche products. Notably, fractionated/recombined foods could find

a relevant place as for pastry and candies (addressing human needs for endless creativity), fast foods when time is counted, medical nutrition, military food rations and foods for astronauts, among others.

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