


The Food System

Food classification. Public health
***NOVA*. The star shines bright**



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Introduction

NOVA is the food classification that categorises foods according to the extent and purpose of food processing, rather than in terms of nutrients. In recent decades some attention has been paid to the increasing importance of food processing in global food supplies and dietary patterns, and its role in the pandemics of diet-related non-communicable diseases. But the specific types of processing that modify food attributes and risks of disease – either negatively or positively – have not been precisely defined. Food processing has remained a side issue.

Set out here in its adjusted and refined form, *NOVA* (a name, not an acronym) classifies all foods and food products into four clearly distinct and in our view meaningful groups. It specifies which foods belong in which group, and provides precise definitions of the types of processing underlying each group.

NOVA is now recognised as a valid tool for nutrition and public health research, policy and action, in reports from the Food and Agriculture Organization of the United Nations and the Pan American Health Organization. We owe thanks to many colleagues throughout the world for support in the work set out here, for responses to our papers and other publications published since 2009, and for discussions during conferences and other meetings at which *NOVA* and its implications have been presented.

The *NOVA* star is born



Top: fruits; grains and legumes; meat stew with beans and vegetables; water.
Then: fruit flavour popsicles; breakfast 'cereals'; reconstituted meat product; soft drinks.
The ultra-processed products below are not variants of the foods and meal above.
They are formulated from industrial ingredients and contain little or no intact foods.
By their nature they are unhealthy, and should be grouped together, and avoided

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The significance of industrial processing – and in particular methods and ingredients developed or created by modern food science and technology – on the nature of food and on the state of human health, is so far understated. This relative neglect is found in reports and other documents that include dietary recommendations, in epidemiological studies, and in policies and strategies designed to improve population nutrition and health.

Historically this is understandable. When early dietary guidelines were compiled and published in the first half of the last century, most food was combined with culinary ingredients and consumed in the form of dishes and meals, or was eaten as such. But in the second half of the century, packaged, branded, ready to eat, to drink or to heat 'fast' or 'convenient' products became increasingly prominent in the food supplies and dietary patterns of high-income countries.

Since the 1980s a monolithic global industrial food system has emerged. The food supplies of high-income countries with less strong culinary traditions, such as the US, Canada, the UK, and Australia, have become dominated by packaged, ready-to-consume products. In other high-income countries and settings, and in middle- and low-income countries, these products are rapidly displacing traditional dietary patterns based on minimally processed foods and freshly prepared dishes and meals. Rates of obesity and diabetes have correspondingly risen very rapidly.

In 2009, in a commentary signed by one of us (1), we argued that the extent and purpose of food processing had changed globally, and that these changes were driving the emergence of a harmful global food system and the pandemic of obesity and other nutrition-related chronic non-communicable diseases. We also argued that classifying foods into two groups of unprocessed and processed foods is useless,

because most foods as now consumed are processed in some way. We then proposed a new system to classify foods and food products based on the extent and purpose of the industrial processes applied to preserve, extract, modify or create them.

The new classification, detailed in a later paper (2), included one group made up of snacks, drinks, ready meals and many other products created mostly or entirely from substances extracted from foods or derived from food constituents with little if any intact food, which often contain flavours, colours and other additives that imitate or intensify the sensory qualities of foods or culinary preparations made from foods.

The formulation and the ingredients of these products make them highly convenient (ready-to-consume), highly attractive (hyper-palatable), highly profitable (low cost ingredients), and – of great importance – highly competitive with foods that are naturally ready to consume and freshly prepared dishes and meals. As a result of their formulation, products belonging to this food group are intrinsically nutrient-unbalanced and tend to be consumed in great amounts. We termed this group 'ultra-processed food and drink products' (1,2).

This *NOVA* classification has now been applied in several countries. Applications so far include description of changes over time in national dietary shares of ultra-processed products; analyses of the association of this share with the nutrient profile of diets and with health outcomes; development of dietary guidelines; and orientation of nutrient profile systems. Based on these applications and on questions raised by users, groups and criteria specifications with comprehensive lists of examples have been developed in successive updated versions of *NOVA* (3-7). Next, we present the most recent *NOVA* update, and a summary of its uses and findings up to now.

The *NOVA* classification

The *NOVA* classification outlined below groups foods according to the extent and purpose of the processing they undergo. Food processing as identified by *NOVA* involves physical, biological and chemical processes that occur after foods are separated from nature, and before they are consumed or used in the preparation of dishes and meals. Methods used in the culinary preparation of food in home or restaurant kitchens, including disposal of non-edible parts, fractioning, cooking, seasoning, and mixing various foods, are not taken into account by *NOVA*.

Foods may be consumed by themselves (such as fruits, nuts, milk); or are a main item in a culinary preparation (such as vegetables, grains, flours, meat, eggs); or are accompanying items (such as oil, salt, sugar, herbs, spices); or are food products ready to consume or heat (such as bread, cheese, ham; packaged snacks, soft drinks, pre-prepared frozen dishes). *NOVA* classifies all foods and food products, including the individual items of culinary preparations obtained from recipes, into the following four groups.

Group 1

Unprocessed or minimally processed foods

The first *NOVA* group is of unprocessed or minimally processed foods. Unprocessed (or natural) foods are edible parts of plants (seeds, fruits, leaves, stems, roots) or of animals (muscle, offal, eggs, milk), and also fungi, algae and water, after separation from nature.

Minimally processed foods are natural foods altered by processes such as removal of inedible or unwanted parts, drying, crushing, grinding, fractioning, filtering, roasting, boiling, pasteurisation, refrigeration, freezing, placing in containers, vacuum packaging, or non-alcoholic fermentation. None of these processes adds substances such as salt, sugar, oils or fats to the original food.

The main purpose of the processes used in the production of group 1 foods is to extend the life of unprocessed foods, allowing their storage for longer use, such as chilling, freezing, drying, and pasteurising. Other purposes include facilitating or diversifying food preparation, such as in the removal of inedible parts and fractioning of vegetables, the crushing or grinding of seeds, the roasting of coffee beans or tea leaves, and the fermentation of milk to make yoghurt.

Group 1 foods include fresh, squeezed, chilled, frozen, or dried fruits and leafy and root vegetables; grains such as brown, parboiled or white rice, corn cob or kernel, wheat berry or grain; legumes such as beans of all types, lentils, chickpeas; starchy roots and tubers such as potatoes and cassava, in bulk or packaged; fungi such as fresh or dried mushrooms; meat, poultry, fish and seafood, whole or in the form of steaks, fillets and other cuts, or chilled or frozen; eggs; milk, pasteurised or powdered; fresh or pasteurised fruit or vegetable juices without added sugar, sweeteners or flavours; grits, flakes or flour made from corn, wheat, oats, or cassava; pasta, couscous and polenta made with flours, flakes or grits and water; tree and ground nuts and other oil seeds without added salt or sugar; spices such as pepper, cloves and cinnamon; and herbs such as thyme and mint, fresh or dried; plain yoghurt with no added sugar or artificial sweeteners added; tea, coffee, drinking water.

Group 1 also includes foods made up from two or more items in this group, such as dried mixed fruits, granola made from cereals, nuts and dried fruits with no added sugar, honey or oil; and foods with vitamins and minerals added generally to replace nutrients lost during processing, such as wheat or corn flour fortified with iron or folic acid.

Group 1 items may infrequently contain additives used to preserve the properties of the original food. Examples are vacuum-packed vegetables with added anti-oxidants, and ultra-pasteurised milk with added stabilisers.

Group 2
Processed culinary ingredients

The second *NOVA* group is of processed culinary ingredients. These are substances obtained directly from group 1 foods or from nature by processes such as pressing, refining, grinding, milling, and spray drying.

The purpose of processing here is to make products used in home and restaurant kitchens to prepare, season and cook group 1 foods and to make with them varied and enjoyable hand-made dishes, soups and broths, breads, preserves, salads, drinks, desserts and other culinary preparations.

Group 2 items are rarely consumed in the absence of group 1 foods. Examples are salt mined or from seawater; sugar and molasses obtained from cane or beet; honey extracted from combs and syrup from maple trees; vegetable oils crushed from olives or seeds; butter and lard obtained from milk and pork; and starches extracted from corn and other plants.

Products consisting of two group 2 items, such as salted butter, group 2 items with added vitamins or minerals, such as iodised salt, and vinegar made by acetic fermentation of wine or other alcoholic drinks, remain in this group.

Group 2 items may contain additives used to preserve the product's original properties. Examples are vegetable oils with added anti-oxidants, cooking salt with added anti-humectants, and vinegar with added preservatives that prevent microorganism proliferation.

Group 3
Processed foods

The third *NOVA* group is of processed foods. These are relatively simple products made by adding sugar, oil, salt or other group 2 substances to group 1 foods. Most processed foods have two or three ingredients. Processes include various preservation or cooking methods, and, in the case of breads and cheese, non-alcoholic fermentation.

The main purpose of the manufacture of processed foods is to increase the durability of group 1 foods, or to modify or enhance their sensory qualities.

Typical examples of processed foods are canned or bottled vegetables, fruits and legumes; salted or sugared nuts and seeds; salted, cured, or smoked meats; canned fish; fruits in syrup; cheeses and unpackaged freshly made breads

Processed foods may contain additives used to preserve their original properties or to resist microbial contamination. Examples are fruits in syrup with added anti-oxidants, and dried salted meats with added preservatives.

When alcoholic drinks are identified as foods, those produced by fermentation of group 1 foods such as beer, cider and wine, are classified here in Group 3.

Group 4

Ultra-processed food and drink products

The fourth *NOVA* group is of ultra-processed food and drink products. These are industrial formulations typically with five or more and usually many ingredients. Such ingredients often include those also used in processed foods, such as sugar, oils, fats, salt, anti-oxidants, stabilisers, and preservatives. Ingredients only found in ultra-processed products include substances not commonly used in culinary preparations, and additives whose purpose is to imitate sensory qualities of group 1 foods or of culinary preparations of these foods, or to disguise undesirable sensory qualities of the final product. Group 1 foods are a small proportion of or are even absent from ultra-processed products.

Substances only found in ultra-processed products include some directly extracted from foods, such as casein, lactose, whey, and gluten, and some derived from further processing of food constituents, such as hydrogenated or interesterified oils, hydrolysed proteins, soy protein isolate, maltodextrin, invert sugar and high fructose corn syrup. Classes of additive only found in ultra-processed products include dyes and other colours, colour stabilisers, flavours, flavour enhancers, non-sugar sweeteners, and processing aids such as carbonating, firming, bulking and anti-bulking, de-foaming, anti-caking and glazing agents, emulsifiers, sequestrants and humectants.

Several industrial processes with no domestic equivalents are used in the manufacture of ultra-processed products, such as extrusion and moulding, and pre-processing for frying.

The main purpose of industrial ultra-processing is to create products that are ready to eat, to drink or to heat, liable to replace both unprocessed or minimally processed foods that are naturally ready to consume, such as fruits and nuts, milk and water, and freshly prepared drinks, dishes, desserts and meals. Common attributes of ultra-processed products are hyper-palatability, sophisticated and attractive packaging, multi-media and other aggressive marketing to children and adolescents, health claims, high profitability, and branding and ownership by transnational corporations.

Examples of typical ultra-processed products are: carbonated drinks; sweet or savoury packaged snacks; ice-cream, chocolate, candies (confectionery); mass-produced packaged breads and buns; margarines and spreads; cookies (biscuits), pastries, cakes, and cake mixes; breakfast 'cereals', 'cereal' and 'energy' bars; 'energy' drinks; milk drinks, 'fruit' yoghurts and 'fruit' drinks; cocoa drinks; meat and chicken extracts and 'instant' sauces; infant formulas, follow-on milks, other baby products; 'health' and 'slimming' products such as powdered or 'fortified' meal and dish substitutes; and many ready to heat products including pre-prepared pies and pasta and pizza dishes; poultry and fish 'nuggets' and 'sticks', sausages, burgers, hot dogs, and other reconstituted meat products, and powdered and packaged 'instant' soups, noodles and desserts.

When products made solely of group 1 or group 3 foods also contain cosmetic or sensory intensifying additives, such as plain yoghurt with added artificial sweeteners, and breads with added emulsifiers, they are classified here in group 4. When alcoholic drinks are identified as foods, those produced by fermentation of group 1 foods followed by distillation of the resulting alcohol, such as whisky, gin, rum, vodka, are classified in group 4.

NOVA in use

Studies using *NOVA* have been published regularly. In Brazil, it has been used to assess the socioeconomic and demographic distribution of dietary patterns (4,8); time changes in dietary patterns (9,10); the impact of dietary share of ultra-processed products on the dietary content of macro- and micronutrients (9,11-13); and the association between consumption of ultra-processed products with obesity (14,15), metabolic syndrome (16), and dyslipidemias (17). It has also been used in Brazil to study the relationship between household food purchase patterns and relative prices of ultra-processed and all other food items (18); influence of the food environment (19-21) and of food advertising (22) on the consumption of ultra-processed products; and to evaluate the impact of a nutrition education intervention (23).

In the US, *NOVA* has been used to assess the impact of ultra-processed products on consumption of added sugar (24) In Canada, it has been used to assess secular trends in national dietary patterns (25), and the impact of ultra-processed products on indicators of nutrient profile of diets (26). In the UK, it has been used to study the relationship between household food purchase patterns and relative prices of ultra-processed and all other food items (18), and to estimate the potential for reduction of cardiovascular disease by reducing consumption of ultra-processed products (27). In Chile, it has been used to assess the impact of the consumption of ultra-processed products on the nutritional quality of diets (28). It has been used in New Zealand to describe the nutrient profile of supermarket foods (29), and in Sweden to correlate time trends in consumption of ultra-processed products and of adult obesity (30).

Internationally, *NOVA* has been used to study time trends in sales of ultra-processed products in 79 low-middle, upper-middle, and high-income countries (31), and also in 14 Asian countries (32). A policy paper has used *NOVA* to compare strategies used by the manufacturers of tobacco, alcohol and ultra-processed products, with implications for prevention and control of non-communicable diseases (33). An ecologic study has used *NOVA* to analyse the association between changes in sales of ultra-processed products and changes in population body mass in 15 Latin American countries (34).

Altogether, these studies document exponential growth in production and consumption of ultra-processed products; confirm that they displace unprocessed or minimally processed foods and freshly prepared dishes and meals made from these foods; document their aggressive marketing; and show their huge negative impact on the quality of diets and on obesity, metabolic syndrome and blood lipid profiles.

The proportion of dietary energy in ultra-processed products has been recommended as an indicator of the quality of diets by the INFORMAS initiative (35). The utility of *NOVA* has been recognised in reports from the Pan American Health Organization (34) and the UN Food and Agriculture Organization (36). Also (see below), the *NOVA* four food groups are the basis for the main recommendations of the current official Brazilian national food and nutrition guide (37,38).

The Brazilian food and nutrition guide

Brazilian dietary guidelines

Four recommendations and one golden rule*

NOVA group 1

Make unprocessed or minimally processed foods the basis of your diet

Unprocessed or minimally processed foods, in great variety, mainly of plant origin, preferably produced by agro-ecological methods, are the basis for diets that are nutritious, delicious, appropriate, and supportive of socially and environmentally sustainable food systems.

NOVA group 2

Use processed culinary ingredients in small amounts for seasoning and cooking foods and to create culinary preparations

As long as they are used in moderation in culinary preparations based on natural or minimally processed foods, oils, fats, salt, and sugar contribute towards diverse and delicious diets without making them nutritionally unbalanced.

NOVA group 3

Limit the use of processed foods, consuming them in small amounts as components of culinary preparations or as part of meals based on natural or minimally processed foods

The ingredients and techniques used in the manufacture of processed foods—such as vegetables in brine, fruits in syrup, cheeses and breads – unfavourably alter the nutritional composition of the foods from which they are derived.

NOVA group 4

Avoid ultra-processed products

Because of their ingredients, ultra-processed products – such as packaged snacks, soft drinks, and instant noodles – are nutritionally unbalanced. As a result of their formulation and presentation, they tend to be consumed in excess, and displace natural or minimally processed foods. Their means of production, distribution, marketing, and consumption damage culture, social life, and the environment.

The golden rule

Always prefer natural or minimally processed foods and freshly made dishes and meals to ultra-processed products

Opt for water, milk, and fruits instead of soft drinks, dairy drinks, and biscuits. Do not replace freshly prepared dishes (broths, soups, salads, sauces, rice and beans, pasta, steamed vegetables, pies) with products that do not require culinary preparation (packaged snacks and soups, instant noodles, pre-prepared frozen dishes, sandwiches, cold cuts and sausages, industrialised sauces, ready-mixes for cakes). Choose homemade desserts and avoid industrialised formulations.

*Adapted from (37)

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