

THE NOVA SYSTEM AND ULTRA-PROCESSED FOODS IN RELATION TO CONSUMER DECISION-MAKING IN FOODS CHOICE

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ABSTRACT

The purpose of the study was to investigate strawberry yogurt according to the NOVA food classification system. The object of research were strawberry yogurts from 6 different manufacturers, which are commonly available to food consumers, were randomly selected to investigate food samples under the NOVA food classification system. Based on this food, we present a methodology for assessing food safety with the application of the procedure. At the same time, we justify the classified food to Group 4, i.e. one of the 4 groups according to the NOVA system of food classification on a scientific basis, knowledge from the scientific literature. The evaluated results of the labeling of strawberry yogurt from various producers indicate that they are all classified as ultra-processed foods. Their characteristic feature is that they are industrial products with five or more, and usually many, items. Strawberry yogurt samples from various manufacturers evaluated contained 7 to 12 specific items that are not basic raw material, i.e. unprocessed or minimally processed food of Group 1.

Keywords: NOVA food classification system; strawberry yogurt; specific item; methodology; ultra-processed food

INTRODUCTION

The term ultra-processed foods come from the NOVA classification scheme, which divides foods into four groups:

Group 1: *unprocessed or „minimally processed“ foods*, including fruit, vegetables, and meat. Foods in this group may be processed in a manner that does not add other ingredients. They may be cooked, ground, dried, or frozen.

Group 2: *processed culinary additives*; they are substances obtained directly from foods of group 1 or nature by processes such as pressing, refining, grinding, milling, and spray-drying; they are processed food items, including sugar, salt, and oils, when the items of this group are combined, for example by the production of salty butter, this product remains in this group.

Group 3: *processed foods*, represents the combination of unprocessed or minimally processed foods with processed culinary additives; i.e. Group 1 and Group 2. These are bread, wine, and canned vegetables. Additives are allowed provided they preserve the original characteristics of the food, such as ascorbic acid added to preserved fruit to prevent browning.

Group 4: *ultra-processed foods* do not have a strict definition, but the NOVA system points to some characteristics. They usually have five or more additives. They can be aggressively sold and highly profitable. The risk of ultra-processed foods of Group 4 is from „substances which are not normally used in culinary

preparations and additives intended to imitation the sensory properties of Group 1 foodstuffs or culinary preparations thereof or to mask (conceal) undesirable sensory properties of the finished product" (Monteiro et al., 2016).

The risk of ultra-processed food of group 4 is from "substances not normally used in culinary preparations and additives intended to imitate the sensory properties of Group 1 foodstuffs or culinary preparations from these foods or mask (conceal) undesirable sensory properties of the final product" (Monteiro et al., 2018).

Hall et al. (2019) followed hospitalized adult patients who received ultra-processed and unprocessed food every day for 14 days. The diet was compared for energy intake, sugar, fat, fiber, and macroscopic minerals. Ad libitum intake was 2,093.4 kJ.day⁻¹ (500 kcal) more for ultra-processed foods compared to unprocessed food. The body weight changes of these respondents were highly correlated with dietary differences in energy intake (see Figure 1).

The ultra-processed products listed in the second row are not variants of the food and meal mentioned above. They are composed of industrial food substances but contain little or no unprocessed food. They are unhealthy for their character and should be grouped. We should avoid these foods (Monteiro et al., 2016).

The definition of ultra-processed foods has been gradually developed and improved over the years 2009 to

2017 (Monteiro, 2009; Juul et al., 2018; Monteiro et al., 2010; Moubarac et al., 2014; Monteiro et al., 2010; Monteiro et al., 2016; Costa Louzada et al., 2015; Martínez Steele et al., 2016).

In the publication of the team of Monteiro et al. (2016) the food groups 1, 2, 3, and 4 of the NOVA system are characterized in detail.

We focused on Group 4 foods, i.e. ultra-processed foods and drinks in our article.

Group 4 NOVA food products are food and beverage products that are fully processed. These are industrially manufactured products with five or more, and usually many, items. Additives often include those also used in processed foods such as sugar, oils, fats, salt, antioxidants, stabilizers, and preservatives.

Additives found only in ultra-processed products include

those not commonly used in culinary preparations and additives. The purpose of the additives in ultra-processed foods is to imitate the sensory properties of Group 1 foods or culinary preparations from these foods or to mask the undesirable sensory properties of the final product. Foods in Group 1 are proportional or absent in ultra-processed products.

Substances that are only found in ultra-processed products are some directly extracted from foods such as casein, lactose, whey, and gluten and some derived from further processing of food ingredients such as hydrogenated or interesterified oils (fatty acid exchange in the triacylglycerol structure), hydrolyzed proteins, soy protein isolate, maltodextrin, invert sugar and high fructose corn syrup.

Food additives found in ultra-processed products include

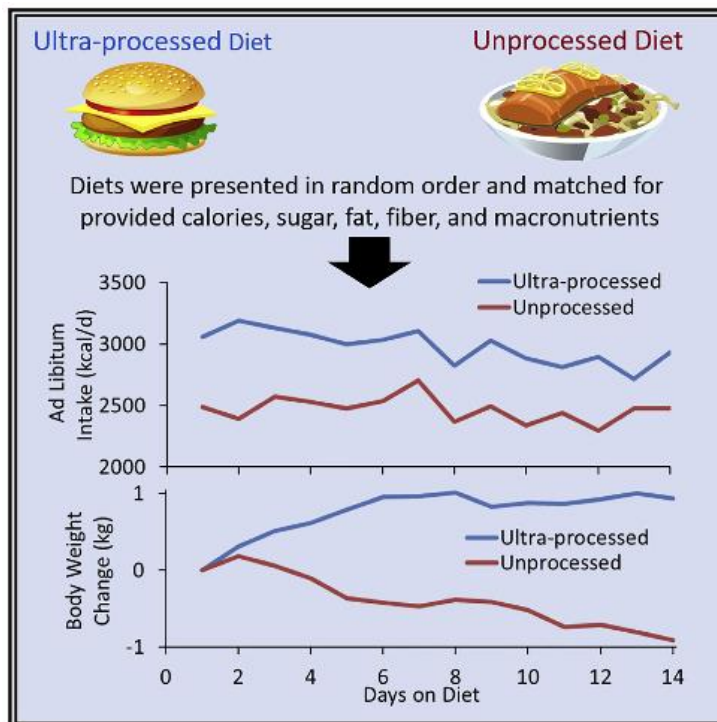


Figure 1 High correlation between intake of different energy content from ultra-processed and unprocessed foods ad libitum and body weight (Hall et al., 2019).



Figure 2 Unprocessed (1st row) and ultra-processed foods (the 2nd row) (Monteiro et al., 2016). Note: The first row: fruit; grains and legumes; stew with beans and vegetables; water. The second row: fruit flavored popsicles; breakfast cereals; reconstituted meat product; non-alcoholic drinks.

coloring, flavor enhancers, sugar-free sweeteners, and processing aids such as carbonation, firming, volume expansion and leveling, antifoams, anti-caking and glazing agents (e.g. palm kernel oil), emulsifiers, sequestrants, and humectants.

Some industrial processes without domestic equivalents are used to produce ultra-processed products such as extrusion and molding and pre-frying.

The main purpose of industrial ultra-processing is to produce products that are ready to be consumed, drunk, or heated and which can replace unprocessed or minimally processed foods that are naturally ready to be eaten, such as fruit and nuts, milk and water, and freshly prepared beverages and meals. Common features of ultra-processed products are excessive tastiness, sophisticated and attractive packaging, multimedia, and other aggressive marketing for children and adolescents, health claims, high profitability, and multinational corporations.

Examples of typical ultra-processed products are carbonated beverages; sweet or savory snacks; ice cream, chocolate, confectionery; meat packaged pastries; margarine and spreads; biscuits, pastries, cakes, and cake mixes; breakfast cereals, energy drinks; dairy drinks, „fruit' yogurts” and „fruit drinks”; cocoa drinks; meat extracts, including chicken and „instant” sauce; infant formulas, milk after milking, other products for infants; powdered or „enriched” meal substitutes; many ready-to-cook products, including pre-made cakes and pasta and pizza; poultry and fish „nuggets” and „sticks”, sausages, hamburgers, hot dogs and other reconstituted meat products and powdered and packaged „instant” soups, noodles and desserts.

Where products produced exclusively from foodstuffs of Group 1 or 3 also contains so-called „food” cosmetic or sensory enhancing additives, such as plain yogurt with added fruit containing artificial sweeteners and breads with added emulsifiers, are classified here in Group 4. Where alcoholic beverages are identified as foods, these produced by fermentation of the foods of Group 1, followed by distillation of the resulting alcohol, such as whiskey, gin, rum, vodka, are classified in Group 4.

Advice based on NOVA knowledge on ultra-processed foods in the area of nutrition in relation to good human health, and the accumulated evidence of their effects in national dietary habits and welfare, it is relatively simple but significant to avoid consuming them. This issue of ultra-processed foods is elaborated e.g. in the official dietary recommendations for Brazilian citizens, where the issue is addressed not only in research but also in politics (**Brazilian Ministry of Health, 2014**).

The importance of industrial processing in terms of methods and uses of food additives or produced by modern food science and technology in terms of food properties and the state of food in relation to human health, it is still undervalued. This state of so-called relative neglect is contained in reports and other documents that include recommendations on diet, epidemiological studies, and in policies and strategies aimed at improving nutrition and health of the population. In the first half of the last century, the guidelines on eating, they contained most of the meals that were a combination of foods with culinary additives and consumed as meals as such. But the second half of the last century is characterized by food packaging, labeling,

and instructions for preparing for eating or heating. These „fast” or „profitable” foods became more and more preferred, they have become more important in the dietary models of high-income countries (**Monteiro et al., 2018**).

Monteiro (2009) published an opinion claiming that the scope and purpose of food processing had changed worldwide. These changes are leading to a harmful global food system and a pandemic of obesity and other nutritional causes of chronic non-communicable diseases.

The NOVA system classification scheme according to **Monteiro et al. (2016)**, which contains four groups of foods, according to the extent and purpose of the processing to which they are subject, includes physical, biological, and chemical processes. These processes occur after the separation of natural foods and before their consumption or use in the preparation of meals. The methods used in the culinary preparation of foods in household kitchens, restaurants, public catering in general, including the disposal of wastes from cooking meals, spices, and blending various foods, the NOVA classification scheme is not taken into account.

The purpose of the study was to investigate strawberry yogurt according to the NOVA food classification system.

Scientific hypothesis

Scientific hypothesis: Based on the evaluation of strawberry yogurt samples from different manufacturers, that these industrial products will contain items, which will be a characteristic attribute and count for inclusion in ultra-processed foods.

MATERIAL AND METHODOLOGY

Object of study

Strawberry yogurts, which are commonly available to food consumers, were randomly selected to investigate food samples under the NOVA food classification system. Based on this food, we present a methodology for assessing food safety with the application of the procedure. At the same time, we justify the classified food to Group 4, i.e. one of the 4 groups according to the NOVA system of food classification on a scientific basis, knowledge from the scientific literature.

Characterization of strawberry yogurt samples

Strawberry yogurt samples from 6 different manufacturers were investigated based on the NOVA food classification system according to **Monteiro et al. (2016)**. These authors have included fruit yogurts among the Group 4 foods, which are ultra-processed.

Method

Strawberry yogurt samples were assessment based on composition, i.e. labeling on the packaging. Each food ingredient that is characterized by Group 4 foods has been identified by a number in the order in which the strawberry yogurt items were listed. For assessment of strawberry yogurt, 6 pcs samples, were available. Each sample originated from a different manufacturer. Initially, the composition items for each strawberry yogurt sample indicated on the packaging were identified by the order

number. The final number of the sample composition item characterized the sum of strawberry yogurt items.

The NOVA food classification system according to **Monteiro et al. (2016)** contains fruit yogurts in Group 4 foods, i.e. in ultra-processed foods characterized by 5 or more specific items in the composition.

RESULTS AND DISCUSSION

The evaluated results of strawberry yogurt are given in Table 1.

The table shows the composition of strawberry yogurt from 6 different manufacturers. Given the risks associated with their consumption, which follow from the literature review, our effort was to propose a methodology for their identification, i.e. a simple way that would be understandable for food consumers. The food consumer selects the food itself when buying the food. He decides which food to choose from.

Several factors influence his choice, but one of the most important is a health-related choice. We aimed to assess risks from processed foods, including ultra-processed foods and facilitating decisions in choosing foods for consumers.

This is the initial work, which is closely linked to the tracing of food labels by food consumers, which is already a common part of food purchases.

The present study presents a broader link between consumer decisions in food choice and public health. Even now, in many cases, the food consumer is already deciding on the choice of food based on its composition. The scientific basis for this decision is based on the Nova system, which is presented in this article.

The evaluated results of the labeling of strawberry yogurt from various producers indicate that they are all classified as ultra-processed foods. Their characteristic feature is that they are industrial products with five or more, and usually many, items. Additives are used in them as in processed foods (sugar, stabilizers, and preservatives). Other items have been found in them, which are typical only for ultra-processed products and which are not commonly used in culinary preparations and culinary additives (such as aromas, coloring, acidity regulators, etc.).

Research from recent years confirms data that medicines are being processed, which are now the main shaping force, which has become a global food system and is a key determinant of eating methods and possible health and well-being (**Monteiro, 2009; Ludwig, 2011; Stuckler et al., 2012; Moodie et al., 2013**).

Analysis of survey data confirmed findings from the consumption of ultra-processed foods (**Costa Louzada et al., 2015a, Costa Louzada et al., 2015b; Steele et al., 2015; Cespedes and Hu, 2015**).

Food classification according to the NOVA system it is clear, useful, understandable, and easy to use (**Monteiro et al., 2016**).

According to **Rico-Campà et al. (2019)** the methodology of the NOVA system classification of foodstuffs was criticized, but according to these authors, there is no better alternative. It is also easy to use for reporting and reproducible and therefore beneficial to public health. Also, it is the best known and most commonly used classification of ultra-processed foods in epidemiological studies.

Therefore, these authors used the classification a NOVA system for identifying four different food groups by stage of processing. Their interest was in the fourth group under the NOVA system, which included ultra-processed food and beverages that tend to be nutritionally unbalanced due to several industrial process operations.

These foods are economically advantageous because the shelf life and hence the sale of these foods increases, but the quality of the nutritional value decreases. Ultra-processed foods are characterized by high energy, low fiber, and microscopic minerals and high added or free sugars, sodium, saturated fats, and chemical food additives (**Moubarac et al., 2013**).

Intake of ready-to-eat, ready-to-drinks, ready-to-eat products has increased significantly in all countries, irrespective of economic level over the last two decades. This trend may have contributed to a worldwide increase in total cancer (**Fiolet et al., 2018**), dyslipidemia (**Rauber et al., 2015**), obesity (**Rauber et al., 2016**), and hypertension (**Mendonça et al., 2017**).

Srouf et al. (2019) report in their publication results from the prospective cohort study NutriNet-Santé, during 5.2-year research and conclude that the results could explain some of the scientific hypotheses established in the research of ultra-processed foods in relation to cardiovascular diseases.

The first interpretation: Ultra-processed foods generally have worse nutritional quality than unprocessed or minimally processed foods because they tend to be richer in sodium, energy, fat, and sugar, and poorer in fiber (**Luiten et al., 2016; Moubarac et al., 2017; Cediél et al., 2018**); they are also associated with a higher glycemic reaction (**Costa Louzada et al., 2015a**).

Sugar sweeteners can delay the initiation of the inner satiety signal, which can lead to excessive energy intake (**DiMeglio and Mattes, 2000**).

In a prospective NutriNet-Santé cohort study, participants included in the high consumption group of ultra-processed foods had lower fruit and vegetable intake. It is well known that a high intake of fruit and vegetables (food Group 1) together with respect for a healthy diet is beneficial for the prevention of cardiovascular diseases (high level of evidence) (**Mozaffarian, 2016**).

The second interpretation: Refers to a wide range of additives in ultra-processed foods. Although the highest permitted levels protect consumers from the adverse effects of individual substances in certain foods (**World Health Organization, 2018**), the effect of the cumulative effect of intake of all foods used and the potential or interaction effect remains largely unknown, unexplained (**Srouf et al., 2019**).

For some, from approximately 350 different permitted food additives in Europe, several adverse effects on cardiovascular disease have been identified in animal experiments or cell model studies.

Also, emulsifiers often found in ultra-processed foods, particularly carboxymethylcellulose and polysorbate (**Santé Publique France DREES, 2018**), demonstrated potential effects of low degree in inducing inflammation and obesity or metabolic syndrome in mice (**Chassaing et al., 2015**).

Table 1 Strawberry yoghurt samples from various manufacturers.

Sample	Basic raw material	Flavoring ingredient	Yoghurt culture
No. 1	cream	1 sugar 2 strawberry thickening: 3 maize starch, 4 strawberry concentrate 5 black carrot concentrate 6 aroma 1 sugar 2 strawberries 3 glucose-fructose syrup 4 modified corn starch 5 water 6 aromas	7 yes
No. 2	cream	thickening: 7 pectins coloring: 8 carmines, 9 acidity regulators 10 citric acid 11 sodium citrates 1 sugar 2 glucose-fructose syrup 3 strawberry puree 4 strawberry juice stabilizer: 5 modified starch 6 aromas	12 yes
No. 3	milk	coloring: 7 carmine 8 concentrate juice from beetroot acidity regulators: 9 citric acid 10 milk proteins 1 sugar 2 strawberries 3 water	
No. 4	milk, cream	thickening: 4 modified corn starch 5 strawberry aroma identical to natural 6 natural coloring carmine acidity regulators: 7 sodium citrate 1 strawberries 2 sugar	8 yes and 9 probiotic culture
No. 5	milk	stabilizer: 3 pectin 4 lemon juice 5 milk protein 1 pieces of strawberries 2 water 3 sugar	6 yes and 7 Bifidobacterium, 8 <i>Lactobacillus acidophilus</i>
No. 6	milk	coloring concentrates: 4 of black carrot 5 of carrot 6 natural aroma 7 concentrated skimmed milk 8 sugar 9 milk proteins	10 yes and 11 „Bifidus“

Note: – the strawberry yoghurts are commonly available for food consumers and they are from different manufacturers; – the composition of the individual strawberry yogurt samples is used from their labelling on the package; – the number for the strawberry yogurt ingredient in the table indicates the order of the ingredients of the composition with the final number of ingredients.

Ultra-processed foods may be contaminated with contact materials (suspected of migrating from the packaging), including bisphenol A in some plastic packaging, which the European Chemicals Agency considers as „Substance of Very High Concern” (European Chemical Agency, 2016). This substance is associated with an increased risk of cardiometabolic sequelae (especially hypertension and coronary artery disease) in a recent meta-analysis (Rancière et al., 2015).

CONCLUSION

The NOVA food classification system is a simple and effective way of assessing food based on its division into 4 groups. Food group characterization is important. This way of assessment foods and dividing them into any of the 4 groups is important for the consumer to make their choices. Based on the assessment of strawberry yogurts that have been the subject of our research, it follows that, according to the characterization of the NOVA food classification system, they are included in Group 4, among ultra-processed foods. Strawberry yogurt samples from various manufacturers evaluated contained 7 to 12 specific items that are not basic raw material, i.e. unprocessed or minimally processed food of Group 1.

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