Food processing

Summary factsheet

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Nutrition Center

Food processing, such as fermentation and boiling, is useful and often necessary to increase edibility, digestibility, perishability, microbiological and other safety characteristics, composition (nutritional value), palatability, sustainability and convenience[1]. In recent years, the extensive processing of food has been subject to criticism and the concept of ultra-processed foods (UPF) has been introduced. Some consider UPF to be not nutritious due to a low level of fresh ingredients, dietary fibre, and micronutrients, and supposedly harmful ingredients such as additives. There is ongoing debate among nutrition experts regarding the classification of foods based on their degree of processing and the implications of UPFs for public health[2-5].

Definition

There are several different definitions (and therefore classifications) of UPF. NOVA is the most commonly used classification system with four categories of foods: group 1 includes unprocessed or minimally processed products, group 2 culinary ingredients, group 3 processed foods, and group 4 ultra-processed foods. Examples of UPF are crisps, meat substitutes and (diet) soft drinks.

The creator of the NOVA classification system, the Brazilian Carlos Monteiro, uses the following definition of ultra-processed foods: "Industrial formulations made mostly or entirely with substances extracted from foods, often chemically modified, and from additives, with little if any whole food added. Sequences of processes are and must be used to obtain, alter, and combine the ingredients and to formulate the final products (hence 'ultra- processed')."[2] Gibney et al.[6] believe that this definition makes several interpretations possible and according to Gibney[7] and Forde[8], each classification is subjective to some degree.

Health effects

UPF allegedly has negative effects on public health, especially the development of obesity and chronic diseases[11, 12]. Observational (epidemiological) research shows a link between the consumption of UPF and an increased risk of chronic lifestyle diseases, including cardiovascular diseases, type 2 diabetes and cancer[13]. In one experimental

International debate and recent developments

Globally, there is division among nutrition scientists regarding the NOVA classification and the use of terms such as 'ultra-processed foods', as illustrated by two open letters that followed immediately after the launch of the UPDATE project[4, 5, 9]. This project, led by Prof. Bügel and funded by the Novo Nordisk Foundation, focuses on evaluating the relationship between food processing, nutritional quality, and health, and has sparked differing reactions from both the original NOVA developers and other scientists concerning the use and scientific basis of these terms.

In addition, a recent series in The Lancet highlighted that UPFs have become dominant in diets worldwide and are associated with an increase in obesity and chronic diseases[10].

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study, weight gain and a higher energy intake were observed with a higher consumption of UPF[14].

The extent to which the aforementioned relationships can be attributed entirely to food processing or may be caused by the underlying suboptimal nutrient composition and high energy density of many UPF is not yet fully clear. The indications of associations are based on epidemiological (cohort) research and have the inherent disadvantage that they do not provide sound evidence of cause and effect. For example, the consumption of UPF is related to numerous other factors, including the existing guidelines for a healthy diet, such as less salt, as well as socioeconomic status.

The cohort study by Mendoza et al. indicates that not all UPFs are harmful. Sugar-sweetened beverages and processed meat were particularly associated with a higher risk of cardiovascular disease, whereas other subgroups such as bread, breakfast cereals, and yogurt showed an inverse association[15]. This suggests that the negative health effects of UPFs are mainly driven by these specific categories. Also the results of the EPIC cohort show that it is unwise to treat UPF as one group, as the effects of different food groups vary[16]. The consumption of plant-based substitutes for meat and dairy, for example, did not demonstrate a significant association with multimorbidity. In addition, results are often not corrected for energy-density of the food product.

A limited number of intervention studies have been conducted. In one of the first studies by the American Kevin Hall weight changes were found to have a strong correlation with energy intake[14]. The energy density of highly processed foods in solid form was nearly twice as high compared to unprocessed foods. The energy intake rate of UPF was around 50% higher. This suggests that the increase in energy intake is associated with the softer texture/ faster eating rate and higher energy density of UPF. Eating rate and energy density have long been known as very important causes of obesity and associated diseases. In another randomized crossover study within the Restructure project, researchers from Wageningen University examined the effect of food texture on energy intake within a UPF-based diet[17]. In this crossover study, participants consumed two diets providing more than 90% of energy from UPFs, differing only in texture (soft vs hard). Participants were allowed to eat as much as they wanted. The meals were comparable in taste, portion size, total energy content, energy density (excluding drinks), and variety. On average, participants consumed 369 kcal less per day on the diet with harder textures, without any difference

in satiety or satisfaction. The results support the hypothesis that eating speed, influenced by texture, is an important mechanism behind overconsumption of UPFs and demonstrate that even within UPFs, variation in texture plays a substantial role.

Mechanisms

Although direct evidence for a causal link between the consumption of UPF and weight gain is limited, several plausible mechanisms have been proposed to explain the observed associations. Studies suggest that the high energy density and rapid energy intake of UPFs play a central role[18]. Foods with high energy density lead to an unnoticed increase in calorie intake, while the soft or liquid texture of many UPFs results in faster eating. This means people eat more quickly and have less time to experience satiety, which increases total energy intake. Research on the influence of food texture shows that hard products, such as a whole apple, lead to lower energy intake and greater satiety compared to softer alternatives like apple sauce or apple juice[19]. Less chewing and faster consumption of soft or liquid foods reduce the satiety effect, which can contribute to overeating and weight gain. Eating speed and energy density of UPFs therefore appear to be key factors in the mechanism underlying the relationship between UPF consumption and the risk of overweight.

Consumption of ultra-processed foods

The consumption of UPF increases with a rise in prosperity. In Europe, an average of approximately 27% of total daily energy intake comes from UPF, with significant differences between the different countries. The lowest intake has been calculated for Italy (approx. 13 en%), while the highest calculated consumption is in Sweden (approx. 43 en%). From 2012-2016, Dutch adults derived around 37% of their daily energy intake from UPF[20]. Vellinga et al. estimate that the percentage for the Dutch population is 61% among 1- to 79-year-olds[21]. Children (aged 1 to 18) even derive 75% of their energy from the consumption of UPF and the difference in age composition is an important explanation for the higher estimate by Vellinga et al.[21] compared to Mertens et al.[20].

Dietary recommendations

Due to an increase in overweight and obesity, the Brazilian government has recommended avoiding the consumption of UPF since 2014. Their example was followed by other South American countries (Uruguay, Peru and Ecuador) a few years later. In Belgium, Israel, Malaysia and Canada, the population is also advised to limit the consumption of UPF. The Dutch dietary guidelines 2015 established by the Health Council of the Netherlands do not contain any recommendations related to UPF, although a number of specific guidelines point in a comparable direction: replace refined grain products with whole grain products, limit the consumption of processed meat and drink as few sugar-sweetened beverages as possible. In addition, in the 2026 Work programme of the Health Council of the Netherlands is stated that an exploration will take place into structural changes in the food supply, such as reducing highly (industrially) processed products[22].

The Scientific Advisory Committee on Nutrition (SACN; United Kingdom)[1], Agency for Food, Environmental and Occupational Health & Safety (ANSES; France)[23] and the Nordic Recommendation Committee[24] state that differentiating UPF does not have any added value to the existing food classifications and recommendations. It is unclear to what extent food processing, independent of food composition, is related to diseases. Various experts indicate that the focus should continue to be on products for which it has been proven that their consumption among an important percentage of the population has a negative effect on public health, and there is indeed some overlap with UPF. On the other hand, reformulated foods with an improved composition may be labelled as UPF, which could prevent consumers from recognizing the intended effect of better nutrition.

Consumer behaviour

Consumers must understand dietary advice in such a way that they can put it into practice[25].

Various studies have raised questions about the NOVA classification, as it uses complex, inconsistent, and broad or ambiguous definitions[26]. Knowledge, perceptions, and behavioural intentions regarding UPF vary among different consumer groups[27].

Conclusions

UPF is a broad and heterogeneous group of foods, making it difficult to formulate a uniform definition. The evaluation of UPF differs across various consumer groups. In spite of this, various cohort studies show a consistent relationship between the consumption of UPF and development of chronic diseases. However, these studies cannot establish a causal relationship. Since there is little to no direct evidence of a causal link between the consumption of UPF and chronic diseases, it is also unclear which mechanism would be underlying this. However, research does show that eating rate, which is influenced by food texture, and energy density are important factors in weight gain.

The specific added value of UPF to the (existing) dietary guidelines based on existing scientific research has not yet been demonstrated. There is increasing evidence that known nutritional risk factors (refined grains, sugary drinks, and processed meat) are responsible for the health effects of UPF consumption. There is no consensus among nutrition experts on the value of classifying foods based on the degree of processing, nor on the recommendation to limit UPF consumption. This is partly because food processing can also have positive effects from a nutritional perspective, such as reducing food waste and promoting the sustainability of food chains.

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