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Review Article

The perfect food for perfect health and pleasure?

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Abstract: How perfect a food or meal is depends on hedonic and nutritional factors. The hedonic component is influenced by all of our 5 senses. In addition, social, environmental, and cognitive/experiential factors may have an effect on our attitude towards a food. On the other hand, nutrient composition and content, as well as bioavailability, determine how nutritionally perfect a food is. So, does the perfect food exist? What makes a food or a meal perfect? This paper will try to answer these questions by briefly discussing the most important variables.

Key words: Perfect food, health, food pleasure, nutrition, hedonic

Mükemmel sağlık ve gıda zevki için mükemmel besin nasıl olmalıdır?

Özet: Mükemmel bir besin veya yemeğin kusursuzluğu zevk ve gıda ile ilgili faktörlere bağlıdır. Zevke bağlı faktörler bizim beş duyumuzun tamamı tarafından etkilenir. Ayrıca, sosyal, çevresel, kavrama ve tecrübeyle ilgili etkenler de bizim besinlere doğru davranışımıza bir etkisi olabilir. Diğer taraftan, gıdanın kompozisyonu ve yararlanabilirliği yemeğin ne kadar besin değeri açısından kusursuz olduğunu tayin eder. Bütün bunlara göre, kusursuz besin var mıdır? Bir besin veya yemeği mükemmel yapan unsurlar nelerdir? Bu makalede önemli değişken faktörlerin ışığı altında bu soruları cevaplamaya çalışacağız.

Anahtar sözcükler: Mükemmel besin, sağlık, besin memnuniyeti, beslenme, besin zevki

Introduction

Perfection is broadly understood as a state of completeness and flawlessness. Whether something is considered perfect depends on subjective and objective factors, but also on factors that can or cannot be modified. For example, many things in nature are or must be perfect from the philosophical point of view, because they have evolved over millions of years and are simply there. On the other hand, things that are created and can be modified and optimized by man will never be perfect, because there is and always will be something better or different. However, in spite of this, the term “perfect” is used for many things created by man. Examples for perfection can be found in all areas of life and can be quantified by more or less objective criteria. From perfect numbers to perfect art and literature to perfect machines, the latter is probably one of the best objectifiable examples of perfection. A machine is perfect when it has maximal efficiency in the presence of low wear and energy expenditure. Turning to food, most of the foods that simply exist and cannot be modified must be perfect. Therefore, any further discussion concerning “the perfect food” seems to be unnecessary. However, things change with time. In ancient times, man ate food

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to survive: eating to live, as Socrates said. Nowadays, however, many people in developed countries are living to eat instead. The hedonic factor has become more important and, with this, the palatability of food is categorized as "tasteless," "okay," "good," or "perfect." The perfection of a food, however, is not only dependent on hedonic but also on nutritional factors. Nutritional science has made enormous developments in the last decades and it is now widely accepted that there are nutritionally highly valuable and less valuable foods. Foods of higher value, such as, for example, vegetables and fruits, contain a considerable amount of essential nutrients and/or fiber and antioxidative ingredients that are important for "perfect health." On the other hand, for example, snacks and sweets are less valuable and are considered as foods providing "empty calories."

The purpose of this paper is to discuss factors that can make a meal perfect by composing it with perfect food. The reader should be aware that I am not supplying a formula for the calculation of "the perfect factor." This would be highly unserious and heretical. However, some considerations based on scientific knowledge are provided, which may help the reader to create a highly valuable meal that can be considered as more or less perfect.

What makes a perfect meal? As mentioned already, the perfection of a meal or food depends on both hedonic and nutritional factors (Figure). In the following sections, I will focus on these 2 variables.

Hedonic factors

The hedonic component includes primarily the 3 senses of seeing, smelling, and, most importantly, tasting. Furthermore, the temperature, texture, and the sound of the meal during chewing have an effect on palatability (1). A German proverb states that "Das Auge isst mit", or that when you are eating, the eye eats with you. A beautifully decorated table with an aesthetically pleasing meal by candle light obviously has a greater hedonic value than a low-budget menu that is thrown carelessly on a plate in a large, sterile cafeteria for hundreds of employees. In addition to how meals are arranged and served, the food color might also affect man's perception. For example, orange juice was rated as sweeter when it had a bright yellow-orange color compared to one that was pale yellow (2). Furthermore, the food's temperature might affect food preference, with food served at familiar temperatures being perceived as the most pleasant (2,3). The texture of food, which is closely related to the visual appearance, might also influence the acceptance and liking of a food (4). One example could be a chocolate bar with optimal dimensions and ideal mechanical properties such as hardness and viscosity. Not only the texture but also the sound of the chocolate bar after the first bite might influence palatability. Extreme examples are crispy chocolates that enjoyably "crack" during chewing. In addition to this "intrinsic music," background music might also influence food consumption, as ambient music generally increases food intake. Loud and fast music increases food intake through possibly stress-mediated mechanisms (5) and

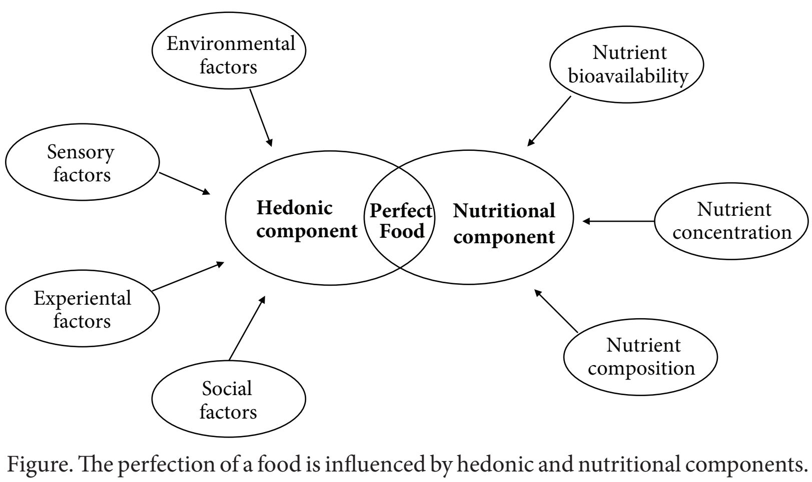

Figure. The perfection of a food is influenced by hedonic and nutritional components.

by influencing diners to adapt their chewing frequency to the music's speed (2). On the other hand, slower and softer music leads to a longer stay in a restaurant, which also results in higher food intake (2).

Taste is the key variable for the selection of foods (6). Taste determines palatability, which in turn has various definitions, such as an individual's response to a given food under standardized conditions, an invariant property of a food, or the immediate effect of a particular food on ingestion (7,8). Palatability is measured using questionnaires including questions like how pleasant the food was found to be, or how palatable. The notions of the palatability and pleasantness of the taste of the eaten food are often mixed together, but there are differences between these 2 definitions. Whereas, for example, the rate of pleasantness declines between the start and the end of an eaten meal, changes in palatability are more flexible (7). The decline of perceived pleasantness for a specific eaten food compared to another unconsumed food is referred to as sensory-specific satiety (9). Sensory-specific satiety is an important mechanism that promotes the consumption of meals with greater nutritional variety (10).

Fat is one of the main factors promoting palatability (11). However, food rich in fat may be hedonically perfect but generally imperfect from the nutritional point of view. Sweetness is another main factor for palatability, although individual genetically determined differences in the most palatable sweetness levels exist (12,13). Palatability is also increased by the addition of spices or mustard, as many studies have shown (12). In addition, monosodium glutamate has been used to increase palatability. The mechanisms causing differences in palatability between foods are not fully understood. Based on several studies, endogenous opioids seem to be involved in inducing palatability (12). In human studies, for example, it was shown that an opioid antagonism reduced the rate of the pleasantness of food and sucrose/fat mixtures; such studies were reviewed by Gosnell and Levine (14).

It is also clear that the perfection of a food is dependent on the degree of hunger. For a person who is extremely hungry, any food or meal will have its attractiveness and perfection, whereas even excellent caviar offered to someone who is totally full would possibly not induce a feeling of extraordinary pleasure. Cognitive processes, especially the memory, can also affect the liking of a food (15).

When we talk of hedonic factors, it is important to discriminate between "wanting" and "liking" (16). "Wanting" refers to hunger or, in the extreme case, craving, or the motivation to obtain food as soon as possible (17). "Liking," on the other hand, is the hedonic component and refers to the pleasure induced by the neurosensory stimulation of food in the mouth cavity. Liking also includes the individual's experience with this food. Liking and wanting are often dependent on each other: we want what we like and like what we want (18).

It is known that chronobiological aspects, like time of day of food intake and meal frequency, might affect energy balance and weight regulation (19). Therefore, it may be possible that the circadian variation of sensory variables also affects the "perfection" of a meal. In nonobese individuals, for example, it was shown that taste recognition exhibits diurnal variations, with significant increases at 2200 compared to 0800 (20). An earlier study of recognition thresholds for the taste of salt also showed circadian variations in 6 healthy young individuals (21).

To summarize, many hedonic factors influence the perfection of a food or meal in generating perfect pleasure. In addition to the 5 senses, social, environmental, and cognitive/experiential factors are also more or less involved in individuals' rating of a specific food (Figure).

Nutritional factors

The perfection of a food is also dependent on the content of essential nutrients and biologically active compounds with health-promoting effects. These can be naturally contained in the food, or nowadays may be added to or enriched in the food. However, not only the amount of nutrients in the food is important, but also their bioavailability. I will briefly summarize these aspects below.

Natural nutrient content of food

The Table provides a few examples of foods with a very high density of some important micronutrients per 100 grams of edible part. As a cut-off value, the recommended dietary allowances from the German, Austrian, and Swiss societies for nutrition were used

Table. Examples of foods with high levels of selected nutrients.*

Nutrient	**Concentration**	**Foods (examples)**
Calcium	More than 1000 mg/100 g	Emmentaler cheese, cinnamon, oregano, dill, poppy seed
Magnesium	More than 350 mg/100 g	Pumpkin seed, cocoa, sunflower seed, sesame
Iron	More than 10 mg/100 g	Thyme, cardamom, cinnamon, sesame, pumpkin seed, soybean
Zinc	More than 10 mg/100 g	Oyster, bitternut, wheat bran, poppy seed
beta-Carotene	More than 1 mg/100 g	Paprika, dill, durian, carrot, dandelion, spinach, parsley
Vitamin A	More than 1 mg retinol equivalent/100 g	Cod liver, foie gras, eel
Vitamin E	More than 15 mg tocopherol equivalent/100 g	Wheat germ oil, sunflower oil, corn oil, almond, hazelnut, dried bean curd (yuba)
Vitamin C	More than 100 mg/100 g	Acerola, rosehip, sea-buckthorn, guava, bell pepper
Vitamin D	More than 5 μg/100 g	Cod liver, herring, trout, anchovy, salmon, sardine

*Data are taken from the BfEL (47).

(22). As can be seen, with the exception of foods carrying vitamins D and A, most of the high-density foods listed are vegetables, and also spices. However, it should be mentioned that values per 100 grams of food can be considerably different from those related to a single serving, which is a more practical approach. This could be especially relevant for spices, but also for other foods served in small amounts.

Antioxidative capacity

In addition to the essential micronutrients mentioned, primarily fruits and vegetables but also spices, coffee, tea, wine, and dark chocolate contain health-promoting bioactive substances called polyphenols. By exerting potent antioxidative effects, polyphenols can prevent various diseases, such as cancer and atherosclerosis, where radical-induced damage is involved in the pathogenesis. However, as can be assumed, the antioxidative capacity among the polyphenol-containing foods is not similar. Therefore, when looking at the radical scavenging activity, there are more and less perfect foods. In an extensive study, Ninfali et al. (23) used the oxygen radical absorbance capacity (ORAC) method to scan the antioxidative capacity of various vegetables, herbs, and spices. They found that from the group of examined vegetables, artichoke, garlic, beetroot, radish ('Tondo'), red chicory, and broccoli showed especially relatively high antioxidative capacities, with more than 3000 μmol Trolox equivalents [TE]/100 g. The herbs did considerably better, with garden sage, garden thyme, and marjoram showing 25,000 μmol TE/100 g and oregano, peppermint, and tarragon showing more than 10,000 μmol TE/100 g. Cumin had the highest value, with more than 75,000 μmol TE/100 g. After cooking selected Brassica vegetables in boiling water, almost 80% of their phenolic content was lost, whereas steamed vegetables preserved most of their polyphenols and antioxidant capacity. Wolfe et al. (24) looked at the antioxidative activity of common fruits and found that wild blueberry, cranberry, strawberry, blackberry, cherry, plum, raspberry, blueberry, apple, and pomegranate showed especially high values of TE, exceeding 4000 μmol TE/100 g. Similar to the results of the study by Ninfali et al. (23), it was also shown that ORAC values did significantly correlate with the phenolic content of the food. Fruits and vegetables do not only contain important essential nutrients and polyphenolic compounds but also melatonin, which is known to exert important antioxidant activities (25). In a recent paper by Garrido et al., for example, it was shown that a diet enriched with Jerte Valley cherries, which contain high levels of melatonin and its precursors, tryptophan and serotonin, can have a positive effect on urinary total antioxidant capacity in middle-aged and elderly individuals (26).

Enrichment of nutrients in food: biofortification

Food can be enriched with micronutrients by various methods. The easiest way is simple fortification. This can be done population-wide in order to prevent diseases, such as fortification of table salt with iodine, or to achieve a "functional effect" in so-called functional foods (27) enriched with a multitude of different nutrients, beginning with minerals and vitamins but also including living species, such as in probiotics.

Another method to fortify food is through agronomic strategies, such as the application of fertilizers containing essential minerals. The disadvantage is that this method is not applicable to all minerals and not at all to vitamins, and it is also dependent on several factors like mineral mobility in the plant and accumulation site as well as soil composition (28). Furthermore, the growth of plants and other soil organisms can be harmed by applying large quantities of metals to the soil. Therefore, genetically modified food became common in the last decades and has conquered the world. In a criminal thriller from 2009, The Two Sides of the Galata Bridge, which played in Vienna and İstanbul, a Turkish professor intends to create the perfect food, perfect from the composition of the nutrients (29). He uses a genetic approach for his perfect "creation." This is no longer science fiction. Genetically modified plant foods can already be found in the supermarkets (30). Through genetic engineering or biotechnology, it is possible to incorporate genetic material from any source into various plant species, such as rice, potatoes, or maize. The primary goal of genetic modification of food was to enhance the resistance to diseases, viruses, and herbicides. Afterwards, the second generation of genetically modified plants evolved, showing an improvement in nutritional value such as a modification in fat composition or better flavor characteristics (31). In addition, it is also possible to improve the levels of some micronutrients and phytochemicals in special foods. Genetic engineering can either enhance the synthesis of organic substances, such as vitamins, in the plants or improve mineral content and bioavailability by increasing the efficacy of uptake and distribution of the minerals into the edible parts of the plants. Examples of genetically modified plants are rice with higher beta-carotene or iron levels (32,33), tomatoes with higher levels of polyphenols and folate (34-36), potatoes with enhanced calcium content (37), or, a recent development, white corn with higher levels of beta-carotene, ascorbate, and folate (38).

Undoubtedly, genetically modified food is an important strategy to combat hunger in a world in which the population is growing rapidly with a simultaneous decline in soil area. Therefore, in addition to being somehow perfect, genetically modified food is probably essential in the long term, saving many lives. However, one topic that is discussed intensively and emotionally among scientists and ecologists is the safety of genetically modified plants for the environment, as well as for humans. This is not the topic of this paper and can be read in detail in other reviews (30,39).

Bioavailability

Not only is the amount of nutrients in the food important, but their bioavailability is also critical. Bioavailability can be defined as the proportion of the total element in a food, meal, or diet that is utilized for normal, physiological body functions. The main determinant of bioavailability is the absorption rate in the intestine, since it can be assumed that a micronutrient that is absorbed will be used in the short term or long term by the body. The bioavailability of nutrients in the gut is dependent on host-related gastrointestinal and dietary factors (40). The host-related factors are particularly the nutritional status and the individual's requirements. Maximal absorption of a micronutrient will therefore occur when the body's stores are depleted and the requirements are high, such as in pregnancy. On the other hand, overloads of an element will downregulate the transport in the gut. There are a multitude of gastrointestinal factors affecting bioavailability. Primarily, a proper functioning of the exocrine pancreas and sufficient secretion of bile salts is important for digestion of macronutrients and absorption of fat and fat-soluble vitamins. Sufficient mucosal area (lowered, for example, in celiac disease), low pH levels in the gastric juice, and adequate transit time are also essential factors influencing the digestion and absorption of many micronutrients.

The dietary factors influencing bioavailability are the amount of the nutrient in the food, chemical properties such as valency and composition, the presence of the nutrient in solid or liquid food, and, especially, the ratio of enhancers to inhibitors in the meal. The intestinal bioavailability of micronutrients can vary hugely between the elements. Regarding minerals, for example, some chromium compounds show a very low bioavailability of less than 3%, whereas organic selenium compounds can have more than 90% (41). The bioavailability of vitamins varies in general between 20% and 90% (42). The most frequently studied and clinically relevant example for bioavailability is iron. The bioavailability of iron from plant sources (so-called nonheme iron) is significantly lower (in the range of 1%-15%) than that of animal-based heme iron, which has a bioavailability of up to 40% (43). The absorption rate of heme iron is high because it is absorbed intact (44). In contrast, nonheme iron enters an exchangeable pool, with the absorption being influenced by many factors present in the meal, especially affecting the solubility/complexation of nonheme iron. Nonheme iron and zinc absorption are both inhibited by phytic acid (6-phosphoinositol), which is especially frequent in whole grains, legumes, and lentils; by polyphenols such as tannic and chlorogenic acids, from tea and coffee, for example; and by soy protein and oxalic acid, which is especially frequent in spinach and beetroot grains (45). The most potent enhancer of nonheme iron is ascorbic acid. It reduces $Fe3+$ to the more soluble $Fe2+$, which is the form required for transport into mucosal cells. Vitamin C also binds nonheme iron, thus preventing it from forming an insoluble complex with phytic acid or polyphenols that makes the iron unavailable for transport (46).

To summarize, although many foods have a considerable amount of iron and other micronutrients, the bioavailability determines what can really be used by the body.

Conclusion

Does the perfect food or perfect meal exist? The answer is yes. However, it is “yes” for hedonic or some nutritional values, but not for both them. Everyone has favorite highly palatable foods and meals that induce pleasure and satisfaction. However, these foods and meals are seldom perfect from the nutritional point of view. Since knowledge of the nutritional composition of foods is available for nearly everyone nowadays, it is possible to create a perfect meal in regard to its nutritional value. However, it remains open to debate as to whether this meal is also perfect for all of our senses. Some hedonic factors, such as serving, ambience, and visual appearance, can be influenced. However, our taste and smell cannot be fully cheated. It is very difficult to combine both arms of perfection in a single food or meal. One should also consider that the ultimate, superlative perfect meal becomes boring when eaten too regularly. Variety is certainly one of the most important components for our perfect health and pleasure.

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