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ABSTRACT

While over the last century food systems have become more controlled, standardized and globalized, the plants and animals that form the basis of our food production still show seasonal fluctuation. The growth and reproductive cycles of these organisms follow seasonal weather patterns, including changes in rainfall, light exposure and temperature. Food designers should consider such aspects of seasonality, as they affect the availability and quality of the ingredients that they work with. Moreover, seasonality brings unique possibilities and challenges that can inspire new and interesting solutions for culinary applications, food propositions and social events. In addition, seasonality can be a goal to aspire to, because it can provide benefits in the domains of sustainability, health and well-being. For these reasons, we propose that, instead of following the current trend of deseasonalization, food designers can contribute to reconcile our food systems with the seasons. This will provide an excellent opportunity for enabling more sustainable, meaningful and healthy rhythms of growing, processing, preparing and consuming food.

KEYWORDS

seasonal fluctuation
food availability
food quality
well-being
health
sustainability

INTRODUCTION

Walk into any grocery store at any time of the year and there is a wide variety of food items available to choose from. Whether shopping in summer or winter, many of the foods that were originally seasonal are now available year-round. This constant abundance is well captured in the notion of 'Permanent Global Summer Time', which geographer Susanne Freidberg defines as 'the worldwide system of standardized production, high-speed transport, and climate-controlled storage that has largely destroyed the seasonality of fresh produce and with it, many would argue, its taste' (2009: 155). Where once food products and eating traditions were intertwined with the seasons, the current trend in food is marked by eating whatever we want, whenever we want. As a result, many people have little awareness of what is currently in season, and why this is even relevant to consider.

Despite this trend, some qualities of seasonality remain part of contemporary food culture. In the Netherlands, for example, spring is still marked by the asparagus season, summer is a typical barbeque season, autumn brings stews with red cabbage and mashed potatoes and winter remains a typical period in which traditional pea soup (*erwtensoep*) and hotchpotch (*hutspot* and *boerenkool*) are prepared (van Mil 2004). Similarly, there are various festivities that have been around for decades or centuries, which are typically associated with certain kinds of food, such as a bread with almond paste (*paasstol*) during Easter, and a type of fried dumpling called *oliebollen*, which are highly popular around New Year's Eve.

In addition to such traditional elements of food culture, there also seems to be a renewed interest in using seasonal products. Popular media, governmental organizations, as well as citizen initiatives, promote seasonal diets for reasons of food quality, low costs, health and sustainability benefits. Such an interest in seasonality is often part of wider ethical considerations of food, as reflected in calls for 'food localism', 'slow food' and 'food citizenship' (DuPuis and Goodman 2005; Petrini 2003; Wilkins 2005).

In the culinary arts, seasonality is also given a central role. In a study by Ottenbacher and Harrington (2007), all interviewed Michelin star chefs indicated that they first ask themselves what products are in season when creating their menu. From their point of view, seasonality stands for quality. Apart from quality, the seasons can also inspire new or altered dishes by constantly supplying chefs with a shifting set of available ingredients that offer unique tastes, textures and colours. Such seasonal knowledge and inspiration are increasingly finding their way to consumers. For example, celebrity chefs use television media to educate and inspire people through cooking shows, often highlighting seasonality along with its ethical, enjoyable and sensory dimensions (Cardwell 2017).

In this article, we focus on seasonality in the context of food design. Similar to Zampollo (2016), we see food design as a branch of design research and practice that addresses food-related topics and which can take various forms. This includes the design of foods, packaging and food experiences, as well as the attempt to change food habits, practices and systems through design interventions. Food design also includes critical and speculative approaches that question or critique food practices and systems, or that visualize possible food futures. Earlier work in food design suggests that seasonality presents unique possibilities and challenges for food designers and that it aligns with relevant themes such as sustainability and local food cultures (Bordewijk and Schifferstein 2019; Schifferstein 2016). Here, we dive deeper into the topic of

seasonality, focusing on the general roles that this phenomenon can play in food design.

In what follows, we first introduce the concept of seasonality by placing it in a historical trajectory, which is mainly characterized by deseasonalization. We then turn to the core content of this article, showing how seasonality can serve as a *consideration*, an *inspiration* and an *aspiration* in food design. We argue that, despite deseasonalization, food designers will still benefit from considering seasonality in their work, as food availability and quality fluctuate throughout the year for many products. To illustrate our point, we describe fluctuations in detail for three food items. We then highlight the various ways in which seasonality can serve as a source of inspiration in food design, which we illustrate with examples from food design and culinary practice. We then describe seasonal food and eating as an aspiration to pursue, as they can be an important part of a sustainable and healthy diet, and can potentially contribute to people's well-being.

SEASONALITY IN THE CONTEXT OF FOOD AND EATING

Seasonality refers to the fact that something changes during the year and that these changes repeat on an annual basis. Many phenomena are seasonal, ranging from weather conditions and bird migration to tourism and mental illnesses. A 'season', in this regard, refers to a particular period of the year that is characterized by particular conditions or features, often linked to a geographical area (e.g. the 'breeding season' of birds, the 'rainy season' or the 'baseball season'). Such temporary circumstances often structure the way people organize their lives – they offer a degree of predictability about what happens throughout the year, and people can anticipate and act on them (e.g. bird watching, bringing an umbrella or watching baseball every Sunday).

In the context of food, seasonality is perhaps most commonly spoken of in terms of 'seasonal food' – i.e. food that is produced and consumed within its natural growing season. A more nuanced distinction can be made between local and global seasonality, if we also include where the food is consumed. Food is locally seasonal when produced in its natural growing season and consumed within the same climatic zone, while it is globally seasonal when produced in the natural growing season but transported over long distances and consumed outside the climatic zone (Macdiarmid 2014). Both definitions relate to the natural growing season and as such are related to 'natural seasonality'; this, in turn, can be distinguished from 'cultural seasonality', which refers to 'the marking of changing seasons via customs, rituals and traditions particular to a culture or community' (Cardwell 2017: 14). As we will see in the subsection below, cultural seasonality has followed the rhythm of natural seasonality throughout most of human history. Only over the last century have the two been out of step due to industrialization and globalization.

A short history of seasonality in food and eating

Food and eating are subject to seasonal influences, and this has been the case throughout human history. As hunter-gatherers, humans often lived at the mercy of the seasons, which determined the presence of plants and animals, and thus what potential food sources were available. This fluctuation in food availability led to various forms of adaptation, including behavioural and biological strategies. Behavioural strategies were, for example, to move from one habitat to another on a seasonal basis (Lieberman 1993) and to use

storage techniques when food was abundantly available in order to preserve it for periods of scarcity (Testart 1982). An example of a biological adaptation is how the gut microbiome changes according to the seasons as the diet changes according to food availability – this phenomenon was discovered relatively recently in a hunter-gatherer society that still exists today (Smits et al. 2017). Seasonal changes in the microbiome are likely to create ideal digestive conditions to efficiently utilize particular nutrients from the foods that are available in particular periods of the year (Koliada et al. 2020).

During the Neolithic Revolution, when the majority of hunter-gatherer societies transitioned to agrarian societies, seasonality brought about new food-related challenges. People came to rely on domesticated plants and animals, which, despite hundreds of years of selection, depended on the natural cycles of their natural ancestors (Chemineau et al. 2007). As a result, many early farmers had to balance periods of abundance (e.g. during warm or wet seasons) with periods of scarcity (e.g. during cold or dry seasons). The intensity of fluctuations in weather conditions varied per climatic region, which is why some societies were more challenged than others (Bellwood 2005). By bringing periods of food scarcity, seasonality challenged food security, and it continues to do so in various rural communities today (e.g. see Hirvonen et al. 2016; Sibhatu and Qaim 2017).

As some agricultural societies progressed, various strategies emerged to counter or cope with seasonality. By safeguarding themselves against periods of scarcity, people were able to maintain a more balanced diet throughout the year. McMahon (1985, 1989) refers to this process as ‘deseasonalization’. In her work on the dietary history of rural New England, McMahon suggests that deseasonalization started as early as the mid-eighteenth century, through techniques such as preserving fruits in sugar, salting and barrelling meat, and storing grains in meal bags. By the mid-1800s, scarcity was no longer an issue in New England families, although production was still seasonal and peasant life followed traditions according to the seasons (McMahon 1989). Thanksgiving, for example, was a harvest festival in the fall; it was ‘a celebration of the annual task of “putting up” stores for the long winter and an occasion to consume the last of the fresh foods before those went bad’ (McMahon 1989: 141).

The process of deseasonalization has continued during the twentieth century and continues to this day. Improvements in food stability, storage and transportation have resulted in what is now a globalized food system (Wilkins et al. 2002). The food system became industrialized, increasing the production and availability of processed foods. In the context of animal-based products, Chemineau et al. (2007) describe how this shift from fresh towards processed foods has resulted in a demand for constant supply, not only in terms of quantity but also in terms of quality. In today’s industrial food production, this constancy in supply still poses a challenge, for instance in the dairy industry (e.g. Sodini and Tong 2006), the meat industry (e.g. Chemineau et al. 2007) and in the fruit and vegetable processing industry (e.g. Jayaraman and das Gupta 1995).

In addition to the industry as a driving force behind deseasonalization, consumer demand also plays a role. Where in the past what people ate depended on what was produced locally, now consumer demand partly determines what the food industry produces. For instance, consumers demand constancy, because they are now accustomed to the many products that are available all year-round. This demand can reinforce further deseasonalization,

industrialization and upscaling. The consequences of these developments are detrimental in various ways. According to ecologist Rob Dunn (2017), people's current desire for food that is 'never out of season' creates a fragile agricultural system; it fosters monocultures that threaten biodiversity in food resources, which in turn harms global food security and takes away the rich abundance of flavours, textures and ways of living that used to accompany the wide variety of local foods. In addition, the demand for constancy also requires energy-intensive forms of production, storage and transport.

What stands out in the above historical narrative is that natural and cultural seasonality in modern food systems are no longer in sync. This does not mean that seasonality does not affect the current availability and quality of food; it remains an important consideration for food designers, as the next section will illustrate.

SEASONALITY AS A CONSIDERATION FOR FOOD DESIGNERS

As a food designer, it is useful to be sensitive to seasonal fluctuations in food production, as these affect the availability, quality and price of food items and ingredients. Some food designers may have to deal with more than just seasonal fluctuations in availability and quality, for example when they are more directly involved in food production, distribution and sales. Think of urban farming initiatives such as community gardens, local food forests or rooftop farms. When food designers initiate or participate in such initiatives, they can also expect seasonal fluctuation in the amount and type of maintenance required and the level of community engagement (Morckel 2015). This means designers must shift their focus throughout the year and be creative in dealing with peaks and troughs in production and community activity.

Consumer demand also fluctuates seasonally. We discussed above how people have come to expect constancy in what food is available to them, but traditions and changing weather conditions cause demand to also fluctuate. Consider how certain food items and ingredients become more or less popular due to traditional festivities (e.g. turkey for Thanksgiving) or climatic conditions (e.g. increased beer consumption in the summer). This leads to variations in demand, to which food companies adapt their production and branding. Food trucks are a contemporary example, where seasonality of demand is a challenge, not only in terms of changing food preferences but also in terms of attracting customers during seasons when people spend less time outdoors (Weber 2012).

Seasonal consumption patterns have also been reported in relation to dietary patterns, such as higher total food intake in winter than in summer (Capita and Alonso-Calleja 2005), lower fat consumption in the summer months (van Staveren et al. 1986) and a peak in unhealthy food spending on sugar-sweetened beverages, ice cream and candy in December, with a sharp reversal and increased sales of fruit, vegetables and whole grains in January (Sturm et al. 2016). People with seasonal affective disorder – also called winter depression – may show seasonal fluctuations in food intake and consume more carbohydrate-rich foods during the colder months (Spence 2021). Similar patterns have been found in people with bulimia nervosa, where binge eating is more severe during the autumn and winter months (Gruber and Dilsaver 1996; Lam et al. 1996). Some people consciously follow the seasons; for example, members of food cooperatives appear to have a preference for local and seasonal food (Wilkins 1996). These general and more specific patterns of

seasonal fluctuation in demand highlight particular challenges and opportunities worth considering and addressing by food designers.

Another aspect to consider with regard to seasonality is that seasonal fluctuations are not always predictable. For example, barley harvests in Germany and France were low in 2016 and provided insufficient supplies for Dutch breweries. The main reason for the low harvests was a wet early season. This led brewers such as Gulpener to buy barley from external suppliers outside Europe. While production continued, Gulpener had to make do with grains that did not meet the sustainability standards guaranteed by their internal suppliers (Gulpener n.d.). Such bad seasons are rare, but climate change will make more extreme weather events such as drought and heavy rainfall more common, making seasonal harvests increasingly unpredictable (Rosenzweig et al. 2001). Furthermore, seasons are predicted to change in length, with summers becoming longer and winters shorter in the northern hemisphere midlatitudes, which will likely affect agricultural production (Wang et al. 2021).

Below we describe seasonality in three distinct food items, with particular emphasis on shifts in availability and quality. The food items have been deliberately chosen with the aim of representing a varied range of food items. By including a vegetable, a meat product and a processed milk product, we show how seasonality can affect quality and availability in a variety of ways. Furthermore, the examples show how seasonality can be related to a variety of phenomena, such as perennial growth cycles of plants and animal reproductive cycles, and particular conditions of moisture, light exposure and temperature. Each of these phenomena is artificially manipulated in modern food production. Although food availability may become more constant through these efforts, various food properties will still fluctuate seasonally.

Seasonality in asparagus

The asparagus that can be found in the supermarket are the young shoots, or 'spears', of the perennial *Asparagus officinalis*. Asparagus comes in white and green, depending on whether the spears have been exposed to sunlight during their growth. Asparagus is primarily eaten as a vegetable. It requires heating and is prepared in various ways around the world.

All cultivars of asparagus are derived from the cultivar 'Violet Dutch', which, as the name implies, was originally grown in regions of the Netherlands in a temperate climate. The original asparagus harvest season lasts approximately from mid-April to mid-June. This short season is primarily explained by the fact that *A. officinalis* is a perennial and that the harvest takes place in a particular life stage, namely when the young shoots appear. Over time, the spears tend to get woody and unfit for consumption. Moreover, the grower must be careful not to overharvest and thereby exhaust the plant, in view of future harvests. At some point, the spears have to grow out to collect energy from the sun, which can then be stored in the root system over the winter. The result of this life cycle is a short peak in availability of asparagus in spring.

An important consideration regarding the quality of asparagus is the storage time, which in turn is affected by seasonal influences. A longer storage time has a negative effect on the texture and sugar content, and thus on the eating quality (Anastasiadi et al. 2020). The storage potential, in turn, is affected by the timing of the harvest; late season spears appear to have only half the shelf life of early season ones (Hurst et al. 1993).

In temperate climates, temperature control techniques have advanced the original harvest season from mid-April to early March. Examples of techniques are polytunnels and black polythene foil to cover the soil. White polythene foil is used to delay harvest. Asparagus production now also takes place in different climatic regions and asparagus is exported over long distances via air freight. Peru is currently a leading supplier of asparagus and growers have adapted production to stable and relatively warm temperatures. Instead of winter cold, irrigation techniques are used to induce dormancy in asparagus plants in Peru (Shimizu 2006). This allows for two harvests per year.

Seasonality in lamb

Lamb is the meat of the young of domestic sheep (*Ovis aries*). Lamb is known to be more tender and delicate in its flavour compared to the meat of older sheep. Lamb, like many other meats, comes in various cuts (e.g. rack, shoulder and shank) and can be processed in several ways (e.g. into a sausage or burger). In the United Kingdom, the traditional roast lamb is served with mint sauce, and in Turkey, lamb is marinated and roasted on a skewer, also known as 'shish kebab'.

Lamb production is influenced by the reproductive cycle of sheep, which have a typical breeding season. For example, in Australia sheep fertility increases as daylight decreases, from December 22. The pregnancy rate in January and February can be up to 20 per cent higher compared to in October and November (Curnow 2020). In addition to daylight, the availability of food is important: the energy requirement of a ewe increases significantly during pregnancy and further increases during lactation. The farmer must respond to this by offering sufficient nutrition, which in turn depends on the availability of grassland, which can fluctuate seasonally. These factors contribute to seasonal fluctuations in meat availability and can lead to significant changes in the market price, as reported in France (Chemineau et al. 2007).

The season of slaughter affects the quality of the lamb's carcass and meat. Studies show that lambs slaughtered in spring show better characteristics than when slaughtered in winter or autumn (D'Alessandro et al. 2013; Yalcintan et al. 2017). Characteristics measured in these studies include live weight, percentages of commercial cuts, the amount of fatty tissue in the body and the force required to cut through a piece of meat. Another study reports how the sex of the lambs influences flavour in relation to the seasons and concludes that ram lambs should be slaughtered by September, meaning that consumer demand for fresh lamb in winter, spring and summer is preferably met with ewe lambs (Mushi et al. 2008).

There are various ways to breed sheep in order to extend the production season. First of all, breeds differ in the length of their breeding season. Genetic selection can be used to breed out of season, which is a permanent method, but it is also slow as the traits that are involved have a low heritability (Kennedy 2008); after all, seasonality has not been 'bred out' of modern sheep, despite thousands of generations of sheep. More directly applicable techniques for off-season breeding include altering light conditions, using hormones or stimulating ovulation in ewes through the use of fertile rams or 'teaser rams' (Curnow 2020; Kennedy 2008). Another common way lamb is made available year-round is by freezing meat products immediately after slaughter (Bhatti et al. 2019).

Seasonality in yoghurt

Yoghurt is a fermented milk product. It is most commonly defined by the two bacteria that form the starter of the fermentation process: *Streptococcus thermophilus* and *Lactobacillus delbrueckii*, subspecies *bulgaricus* (Tamime and Robinson 2007). Yoghurt is made from the milk of various mammals, including cows, sheep, goats and camels, and it comes in many varieties. Yoghurt is consumed in various ways in different cultures. It is used as breakfast, appetizer, dinner and dessert and it is a key component of various traditional dishes, such as *tzatziki*, a dip or sauce commonly eaten in Greece and Turkey, and *dovga*, an Azerbaijani yoghurt soup.

Yoghurt production is dependent on the availability of milk, which in turn is dependent on the reproductive and lactation cycles of dairy cattle. Reproductive cycles are interconnected with factors such as heat load, light exposure, water and food availability. As a result, milk production can be significantly higher in wet versus dry seasons (Baars 2000) and in summer versus winter seasons (Tamime and Robinson 2007). This has led to shortages in the past, with yoghurt producers unable to meet consumer demand and deciding to add milk powder to their product (Stoilova 2014, Chapter 6). The fermentation process to turn milk into yoghurt was originally also seasonal, which had to do with temperature: below 10°C, fermentation stops as the growth of *S. thermophilus* ceases (Robinson 2002).

The composition and qualities of milk fluctuate throughout the seasons. Sodini and Tong (2006) describe some of these fluctuations based on various sources. A variation of about 10 per cent has been observed in fat and protein levels, which affects the consistency and quality of manufactured dairy products (Sodini and Tong 2006). Also viscosity, serum separation and acidity in yoghurt have been reported to change seasonally (Sodini and Tong 2006). Processes of standardization have largely reduced these fluctuations.

Milk production has been deseasonalized in several ways. Many efforts have been made to manipulate the reproductive and lactation cycles of dairy animals (see Chemineau et al. 2007 for an overview). An example is photo-periodic treatment, which subjects farm animals to artificial light regimes to influence semen production in males or to advance the breeding season in females. These treatments are sometimes combined with hormonal treatments, including melatonin implants. These implants are commonly used for off-season farrowing and can increase fertility and productivity. The above techniques are some of the ways in which milk is constantly made available for yoghurt production. Standardization has reduced the seasonal effects of milk composition on yoghurt quality; in particular, the protein content has been standardized by adding milk proteins in various forms (Sodini and Tong 2006).

Just like asparagus, lamb and yoghurt, the production of many other foods is linked with the seasons. Taking these fluctuations into account is important to optimize quality and maintain the food supply.

SEASONALITY AS AN INSPIRATION FOR FOOD DESIGNERS

Besides the fact that it makes sense for designers to take seasonal influences into account in their work, seasonality can also be a source of inspiration. Below, we outline seven ways in which seasonality can inspire design, using examples from food design and the culinary arts to illustrate.

Using seasonally abundant foods as a positive constraint

Throughout the year, the ingredients available to a designer change, and particular foods can become abundant at specific times of the year. Vegetable gardeners often find themselves in this situation, requiring them to use the same ingredient in their meals for several consecutive days or even weeks. Rather than leading to monotony, a single vegetable or fruit can challenge a food designer to prepare it in many different ways, resulting in diverse food products and experiences. Illustrative is how celebrity chef Jeremy Fox decided to organize an event with other chefs and create an entire tasting menu using carrots as the main ingredient (Phaidon 2019). Dishes included carrot carpaccio, pickled carrot, carrot mustard, steamed carrots, carrot top flatbread and carrots braised in their own juice. Similarly, food designers can challenge themselves by focusing on a single abundantly available food item and thoroughly exploring its various qualities and possible applications.

Keeping track of what is seasonally available

By keeping a close eye on seasonal fluctuations, food designers have access to a constantly changing palette of ingredients to use in their design work. Seasonal influences challenge food designers to continuously try new things for the food products and experiences they design. As mentioned earlier, Michelin-starred chefs create their new dishes by first looking at what is in season (Ottenbacher and Harrington 2007). For example, they may be sensitive to when the asparagus season is running and include it in their menu for that period of time. Some chefs go one step further. They do this by partnering with local farmers, searching for edible wild plants through foraging activities, or connecting to local 'food forests' (i.e. ecosystems with edible plants that mimic the functioning of natural forests). For example, Dutch chef Emile van der Staak actively harvests from a partnering food forest and considers his work a form of 'botanical gastronomy' (Figure 1). With this comes a refined seasonal awareness, as described on his restaurant's website: 'We follow the seasons. From day to day. From week to week. With micro seasons that sometimes last only a few days: flowers, young shoots and soft leaves. [...] Dishes that move along with nature' (de Nieuwe Winkel n.d.: n.pag.).



Figure 1: Harvesting from his food forest (left, centre), Chef Emile van der Staak creates unique dishes that mark very specific periods of the year, such as using particular wild flowers that only bloom for a few consecutive days. Photographs at the courtesy of Emile van der Staak.



Figure 2: Studio Inés Lauber organized a spontaneous dinner event in response to a hot summer period using seasonal ingredients and decoration. Photographs at the courtesy of Cem Guenes.

Attending to seasonal appetites

Changing weather conditions can trigger certain cravings in people, and holidays and special events also come with particular food preferences. Food designers can anticipate and react to these seasonal changes; they can respond to a heat wave in the middle of summer, a rainy week in autumn or a long and cold winter. Some food producers and restaurants are well aware of this and are continuously adapting their assortment accordingly. For example, many Dutch brewers offer ‘fresh’ or ‘lemony’ flavours in the summer, while they provide ‘rich’ or ‘caramel’ flavours in the winter. On a different scale, Studio Inés Lauber shows how a hot summer can be an ideal opportunity to host a dinner event, celebrating the ‘fresh, juicy and sweet taste of summer’ (Figure 2).

Designing seasonal rituals or customs

Food and eating in human cultures have always been imbued with seasonal traditions, customs and rituals. Above, we already mentioned the harvest festival that came to be known as Thanksgiving. Another example is the practice called *hanami* in Japan: every year, when the cherry trees blossom in a period of approximately one week, people gather in groups under the trees for a picnic during which they consume significant amounts of alcohol (Lindström 2007). Such seasonal rituals or traditions can serve as an inspirational starting point for food design. New rituals can be designed or existing ones can be renewed or reinvigorated. Co-designing new seasonal rituals has been suggested to connect people not only with the natural seasons but also with family, friends and the larger (food) systems of which they are part (Venkataramani and Menter 2020). Illustrative in this regard, is the work of Tess van den Berg, who designed ‘Gaia’, a box with instructions, information and inspiration to prepare a Midsummer celebration with friends or family (Figure 3).

Using seasonality as a business strategy

Seasonality can also be seen as a strategic opportunity. A clear example is the increasingly popular subscription boxes for fresh meals. In the Netherlands, many of these boxes contain mainly seasonal vegetables from local farmers. Furthermore, these boxes are often accompanied by recipes that help consumers prepare seasonal dishes. Another way seasonality can be at the



Figure 3: With a first prototype of 'Gaia' (left), design student Tess van den Berg set out with a group of friends to organize a Midsummer dinner with seasonal ingredients and decoration. Photographs at the courtesy of Tess van den Berg.

heart of a business strategy is to rotate a select number of product variations throughout the year. An example is the Dogfish Head Craft brewery, which rotates seasonally between different types of beer, creating a sense of scarcity and a constant novelty in what is available to their customers (Pitta and Scherr 2009).

Exploring and revealing seasonal differences in flavour and texture

Not only the availability of food items changes through the seasons, but also the qualities of these products. Fluctuation in particular qualities of food items can be used deliberately, for example by accentuating them in a dish. They can also be seen as an interesting experience in themselves, as in the work of Sietske Klooster. In her 'Melksalon' (Figure 4), she investigates the various qualities of milk and how they change per season. She does this while engaging with consumers and various stakeholders in the supply chain, creating awareness about the role of different seasons and regions in determining the milk's flavour.

Reinvigorating and experimenting with preservation techniques

Many of the culinary skills and techniques that are known today were developed in response to seasonality. In particular, productive seasons resulted in excess food that required preservation to provide nourishment for the lean seasons. From this perspective, the seasons not only bring fresh produce, but they also led to a variety of preservation techniques and skills such as smoking, salting, pickling and bottling, which are used today for making many of people's favourite foods (Waddington 2004). Accordingly, peak seasons can be seen as an incentive for food designers to use and reinvigorate certain preservation techniques, and to experiment with new combinations of ingredients and techniques. An example of such experimentation is the Fermentation GutHub project, which takes hacker and makerspaces as a model and aims to create a platform for DIY food fermentation to support local sustainability (Figure 5; Dolejšová and Kera 2016).



Figure 4: Sietske Klooster's 'Melksalon' (in English 'Milk salon') explores the various qualities of milk that modern industry tends to hide through standardization and industrial processes. One such quality is how milk tends to taste different per season, depending on the source of nutrition and the timing of calving. Photograph at the courtesy of Sietske Klooster. Credit to Nichon Glerum.



Figure 5: In the Fermentation GutHub project, a community of food makers experimented with fermentation to support local sustainability. Photographs at the courtesy of Markéta Dolejšová. Credit to Fermentation Guthub.

The above design directions show how seasonal influences can serve as a source of inspiration in food design. Note that the directions should not be considered mutually exclusive and that they are related in several ways. For example, *keeping track of what is seasonally available* can be seen as a prerequisite for most other directions. Or consider *using seasonality as a business strategy*, which may be done by *attending to seasonal appetites* or *designing seasonal rituals or customs*. Similarly, *reinvigorating and experimenting with preservation techniques* could be the focus when *designing seasonal rituals or customs*. While these design directions are interrelated, each emphasizes a different aspect of seasonality, which can inspire food design in a distinct way.

SEASONALITY AS AN ASPIRATION

Besides the possible role of seasonality as a consideration or inspiration in food design, it can also be considered an aspiration that is worth pursuing. Below we discuss how seasonal influences can contribute to sustainability, health and well-being.

Eating for sustainability

Governments and popular media often promote seasonal foods as an integral part of a sustainable diet for various reasons. For example, growing products out of their natural growing season often makes use of energy-intensive techniques for heating, especially in colder climates (Mariani et al. 2016). Furthermore, particularly in the case of local seasonality, the transport distance between farmer and consumer – i.e. ‘food miles’ – is kept to a minimum. Additionally, vegetables produced in their natural season tend to have a longer shelf life, which is likely to lead to lower amounts of food waste. Eating seasonally can also be seen as part of a more generic argument that, in order to live within their ecological means, people need to become more attuned to the processes and rhythms of the ecosystems they are part of (Princen 2010).

Whether seasonal food contributes to a more sustainable diet can also be questioned. A first concern is that the meaning of ‘seasonal’ is often unclear (Macdiarmid 2014). For example, do we consider food grown in an unheated polytunnel to be seasonal? Do particular forms of storage imply that fresh produce is no longer seasonal? The term ‘seasonal food’ does not directly clarify such matters and requires further specification in terms of the modes of production, transportation and storage used (e.g. see Sumberg and Sharp 2009). A second concern is that the environmental benefits of consuming more seasonal foods are relatively small when compared to, for example, shifting diets from meat-based to plant-based (Vargas et al. 2021, referring to various authors). Finally, looking at sustainability beyond the environmental dimension creates a more nuanced picture of the role of seasonality. For example, the seasonality of asparagus production also comes with unfavourable social impact, such as low job security due to temporary employment (Schwarz et al. 2016).

From the above, we can conclude that seasonal foods can contribute to a more sustainable diet in several ways, but that seasonality does not inherently imply improved sustainability. Seasonality should be considered as part of a wider range of sustainability indicators, including indicators beyond the environmental dimension. This ties in with what was briefly mentioned in the Introduction, namely that seasonality is often advocated as an integral part of more holistic perspectives on food ethics, such as ‘food localism’, ‘slow food’ and ‘food citizenship’ (DuPuis and Goodman 2005; Petrini 2003; Wilkins 2005). While remaining aware of a wider range of considerations, the seasons can serve as a rough, but helpful, guide for individuals as well as larger communities and societies to follow diets and create food systems that are attuned to the processes and rhythms of the natural ecosystems that human beings depend on (Princen 2010; van Tongeren 2003).

Eating for health

Another reason why seasonal foods are often promoted is because of their potentially positive impact on health. In general, eating seasonal products

means eating a varied diet throughout the year. Such variety is important for a balanced diet because each food item contains different beneficial nutrients, such as vitamins and minerals. Another advantage of a seasonal diet is that seasonally harvested produce tends to contain higher amounts of beneficial nutrients. For example, broccoli tends to have twice as much vitamin C content when harvested in autumn than in spring (Wunderlich et al. 2008). Storing food for off-season consumption can lead to loss of bioavailable nutrients, the extent of which depends on the type of storage (e.g. Cermak et al. 2009). Finally, in the case of local seasonality, vegetables will travel shorter and require less processing, thus better preserving their nutritional value.

These health benefits of seasonal food, however, are not straightforward. For example, some products improve in terms of bioavailable nutrients when they are processed. Tomatoes are a clear example, as they contain higher levels of lycopene when processed into tomato paste (Hwang et al. 2012), with lycopene possessing anticancer, antioxidant, anti-inflammatory and antidiabetic potential (Imran et al. 2020). A seasonal diet can also be considered undesirable from a health point of view in some cases. As mentioned above, seasonality still poses a nutritional challenge in certain countries due to limited supplies. In many countries, the winter season has no fruit and only a limited amount of vegetables to offer. While a fully seasonal diet could theoretically meet nutritional needs in a country like the United Kingdom, it would probably be unacceptable for most people, Macdiarmid (2014) suggests. In this case, consuming a seasonal diet could further reduce fruit and vegetable intake, which is already quite low.

Introducing seasonality into people's diets can have health benefits, but as with sustainability, this is not necessarily the case. We propose that in countries where adequate food choices are available year-round, seasonality is likely to bring greater variety in people's diets. In Europe, for example, people of low socio-economic status tend to eat more monotonously, with negative consequences for micronutrient intake (Dowler 2001). Seasonal foods can bring more variety to people's diets, in particular when added to the more commonly available foods that are already being consumed. Seasonal fruits and vegetables also tend to be more affordable compared to those produced out of season. This forms the basis for an interesting design challenge: how to support people in including these sometimes unfamiliar products in their diets? In countries where seasonality still brings periods of scarcity, however, there is still a need to find appropriate forms of deseasonalization, creating food systems that make people less susceptible to malnutrition. How to achieve such deseasonalization without causing negative environmental effects?

Eating for well-being

In addition to the role of seasonal food for health and sustainability, it can also play a role in people's well-being. Cardwell articulates persuasively how it can do so:

[S]easonal food offers up a fascinating and varied set of pleasures: not only the satisfaction of eating food at its freshest, cheapest and tastiest; not only the assurance that we are supporting sustainable, ethical, environmentally friendly practices; but also subtler, enduring pleasures, such as balancing abstention with indulgence as a route to greater

appreciation, and embracing our connection to the natural world and its seasons via the food we prepare and eat.

(2017: 15)

Other positive experiences are conceivable, such as anticipating particular food products, a sense of gratitude for the abundant variety that the seasons bring, the feeling of being challenged by unfamiliar seasonal recipes, the nostalgic experience of preparing traditional seasonal dishes or the joy of a seasonal celebration. In addition to such positive experiences, seasonal food and eating can also bring a certain rhythm to people's lives, by offering structure and predictability (Brinkgreve 2012). From a virtue ethical perspective, seasonal eating can be an expression of temperance, as an inner measure that enables people to live happier and more successful lives (van Tongeren 2003: 127). Research in phenology and chronobiology suggests that human beings are principally 'seasonal animals' and that having a closer look at seasonal patterns can contribute to human health and well-being (Helm et al. 2013). To support our suggestions, we look forward to more studies in the fields of chronobiology, phenology and chrononutrition on seasonal food and eating and its relationship to well-being.

Whether seasonal food and eating can contribute to well-being is a matter of context and individual circumstances. Some people may not appreciate the new tastes that seasonal products bring to the table, or they may find the planning and preparation too demanding. However, we suggest that, in general, the positive experiences that seasonal food and eating can bring are worth pursuing – even more so in light of the potential sustainability and health benefits of seasonal eating, as described above. What are the possible positive experiences that a seasonal diet can bring, and how can these experiences be used to promote more sustainable and healthier diets? How can people experience a seasonal diet as a rhythm that is helpful or meaningful to them, or as an expression of their virtuosity? While these questions are largely unanswered and, at this point, offer little guidance to food designers, they do open up new territories to explore.

DISCUSSION

In this article, we dived deep into the topic of seasonality, focusing on its relationship with food and eating and the potential roles it can play in food design. It thereby builds on previous work, which succinctly describes seasonality as one of the many opportunities and challenges in food design (Bordewijk and Schifferstein 2019; Schifferstein 2016). We propose that the three roles described in this article – seasonality as a *consideration*, *inspiration* and *aspiration* – can be valuable to food designers. The three roles point to various aspects of seasonality that can inform and inspire design goals and decisions, as well as novel ideas and concepts. On a more general level, we hope to have established a foundation for food designers to develop a *seasonal sensitivity* in their work. Such a sensitivity can be important in various design disciplines, but particularly in food design because of its close connection to the natural world. Seasonality is concerned with the temporal dynamics that are inherent in the plants and animals that people cultivate, process and consume, so it is important to give it an appropriate place in the food design process.

We anticipate that food designers can be seasonally sensitive to varying degrees and in different ways, based on which seasonal fluctuations in

food and eating are considered relevant in their practice. In future research, we are interested in further articulating what these differences are and how they inform current food design practice. In line with the differences that we already highlighted with the different food examples, we expect different foods and food industries to have their particular seasonal fluctuations, in terms of both production and consumption. How are food designers and professionals in adjacent disciplines, such as the culinary arts, responding to these different kinds of seasonal fluctuations, and what common principles or best practices can we derive from them? Addressing these questions will provide a more nuanced and topical picture of seasonality as a consideration.

We have shown that a seasonal diet or food system can be a goal worthy to aspire to in many situations, although perhaps not in all circumstances. While efforts in environmental sciences (e.g. life cycle assessments), chronobiology and chrononutrition may build a better understanding in this regard, we propose that food design, in both academia and practice, can make its own contributions. It can help envision, construct and explore possible futures that emphasize seasonal food and eating and evaluate the ways in which they are desirable from the perspectives of relevant stakeholders. In this light, we are interested in initiating our own designerly inquiries, in which we are curious about how a sensitivity to seasonality can lead to novel ideas and solutions to some of the health and sustainability challenges that society currently faces. Ultimately, we aim to generate findings that are relevant and actionable for food designers and the various stakeholders they collaborate with. To do this effectively, we intend to generate and disseminate intermediate-level knowledge on multiple levels of abstraction, integrating a general conceptualization of seasonality with actionable design strategies and concrete design examples (see Boon et al. 2021; Höök and Löwgren 2012).

To conclude, we consider seasonality to be a relevant area of interest in food design research and practice, as it invites food designers and other professionals to deviate from the 'Permanent Global Summertime' that marks today's food systems. This path can lead to novel ways of reconciling food systems with the seasonal rhythms by which natural ecosystems function. We propose that the potential of such a reconciliation is multifaceted, including not only more environmentally sustainable food systems and practices but also inspiration for food designers, as well as healthy and meaningful rhythms and food experiences in people's daily lives.

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