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International Journal of Gastronomy and Food Science 22 (2020) 100273

Contents lists available at ScienceDirect

International Journal of Gastronomy and Food Science

journal homepage: www.elsevier.com/locate/ijgfs

Review Article

Perspectives on the trends, challenges and benefits of green, smart and organic (GSO) foods

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ARTICLE INFO

Keywords:
Green food
Smart food
Organic food
Sustainability
Health

ABSTRACT

Rapid rate of industrialization has turned our planet around in favor of fast foods, food fraud, food terrorism, food waste, food adulteration, food poisoning, food contamination and food injustice, paving the path for green, smart and organic products. Green foods are grown and harvested in the absence of any form of environmental pollution or harmful conditions. Smart foods are termed to be good for the consumers, farmers and the planet. Organic foods are regarded as "credence goods" because some of the attributes that consumers may consider are neither obvious nor easily verified. Therefore, these three terms are interconnected as they forge a substantive common denominator - healthfulness. The concepts of green, smart and organic (GSO) foods are herein recounted together with their interdependence and relationship to health and sustainability. The processes, policies and global trends of GSO foods were discussed, whilst not undermining the benefits and challenges associated with them.

Introduction

The thought of health foods by many consumers can not be disparaged in this age. Both for health and sustainable impacts, green, smart and organic (GSO) foods keep ringing bells in the ears. They can also be regarded as functional foods, which provide advanced technological properties and health claims, and may also be derived from the recycling of food wastes (Galanakis, 2012, 2013, 2015; Ashaolu, 2020). Rapid rate of urbanization and industrialization has turned our planet lopsided in favor of fast foods, food fraud, food terrorism, food waste, food adulteration, food poisoning, food contamination and food injustice (Sadiku et al., 2019a-d; 2020a), leading to the introduction of GSO products, also regarded as environment-friendly products. Green foods are those produced under the principle of sustainable development, fine quality, nutrition, health and safety (Khan et al., 2015). Smart foods are foods like blueberries, leafy greens and foods that can be eaten as staples. They are foods termed to be good for the consumers, farmers and the planet (SFEC, 2019). Organic foods are crops that are grown without the use of harmful pesticides, irradiation, fertilizers, and other synthetic materials. They may include cereals, animal products, fruits and vegetables (Boye and Arcand, 2013).

Bekele et al. (2017) set out to define foods based on environmental friendliness to be normal, green, and organic. Normal foods are limited in terms of nutritional status, quality or cleanliness. Green foods are described to be green because they are grown and harvested in the absence of any form of environmental pollution or harmful conditions. Organic foods are regarded as "credence goods" because some of the attributes that consumers may consider are neither obvious nor easily verified (Bekele et al., 2017). Smart foods concept was better portrayed by Sadiku et al. (2020b), as eating smart. The expensiveness of organic foods as compared with normal foods makes them affordable only to the wealthy or environment-conscious people. However, the purpose of organic food campaigns will be that of sustainable agricultural development promotion. The terms "green food" and "organic food" have been used interchangeably even though they are not the same. Green food is somewhat between chemical and organic farming, and it consists of two types: green foods that permit the use of chemicals, and those that are purely organic. Therefore, all green foods are not organic foods, while smart foods are based on the concept of eating smart.

Based on the current state of coronavirus disease (COVID-19) pandemic, global food security is threatened, irrespective of the healthfulness of GSO. To avoid massive food shortages, it is of the highest importance that countries should keep the food supply chains going, just as the United Nations Food and Agriculture Organization

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https://doi.org/10.1016/j.ijgfs.2020.100273
Received 7 September 2020; Received in revised form 15 October 2020; Accepted 15 October 2020
Available online 20 October 2020
1878-450X/

(FAO) has suggested specific strategies, including the expansion of emergency food assistance programs, and providing immediate assistance to the agricultural production of smallholders by boosting e-commerce (Galanakis, 2020). Also, appropriate measures are to be taken against key logistics bottlenecks such as hampered food transportation across provinces and GSO perishable foods like fishery, vegetables, and fruits (Galanakis, 2020).

The GSO foods

Green food

The term "green" is beyond a color parameter, figuratively denoting pollution-free, health and safety properties. Green foods are environment-friendly and safe for human consumption. They are healthy and are of high quality because they are packed with nutrients and have low-calorie density. Green food civilization is in its early stage as it is being sought after as an alternative to conventional or "normal" foods often produced with fertilizers and other forms of chemicals. However, Green food production may involve the use of manure (Boye and Arcand, 2013). Examples of green foods include green beans, which have a number of health benefits when eaten raw or cooked; spinach, which is a healthy versatile food; avocado, which is loaded with healthy fat that helps lower bad cholesterol (low density lipoprotein); and green pepper, a very low-calorie food known for its ability to promote digestive health (Sadiku, 2020). See Fig. 1.

Green food first came into the limelight 70 decades ago by the International Organization of Consumer Unions (IOCU), as a response to certain humanitarian and climatic issues, including the Green Revolution, environmental pollution, pesticide contaminations, food insecurity, climate change, biodiversity, and water availability (Leggett, 2017). As the days go by, it is expected that the acceptability, affordability and accessibility of green foods will increase. Wild food plants and wild mushrooms are not only green, they are also organic and smart based on their beneficial effects upon consumption. They can be certified and commercialised as organic products under European Council Regulations No. 834/2007 and No. 889/2008 on organic farming if the wild plants were gathered from areas that for three consecutive years have not been treated with products forbidden in organic farming, if wild plant gathering does not impair the stability of the habitat and maintenance of the species in the gathering area, and if a series of control arrangements for organic production were met (European Union, 2007, 2008; Schunko and Vogl, 2020). In their study, Schunko and Vogl (2020) showed that organic consumers know and gather wild plants, value the good quality and responsible gathering of wild plant foods, but still report to neither purchase them much nor bother to differentiate between wild plant foods with or without organic certification, indicating a lack of consumer information (Schunko and Vogl, 2020).

Fig. 1. The GSO foods.

Smart food

Smart food was introduced in order to provide limit to the daily hazardous impact of regular farming on the environment and climate. It affords a personalized, mobile, on-site counseling service for consumers with food allergies. Therefore, smart food utilizes technologies and policies for inclusive development, presenting a high range of nutritional and health benefits. It is good for the planet, the consumer, the farmer and is environmentally sustainable. Smart foods include blueberries and leafy greens as well as all foods that can be eaten as staples (Fig. 1). Diversifying these staples can lead to a drastic reduction in malnutrition and maximization of overall benefits (Anitha et al., 2020).

There is a climate smart agriculture concept introduced by Food and Agriculture Organization (FAO) in 2010 with the objectives of: sustainable increase of agricultural productivity, climate change adaptation and the increase of resilience in the agricultural sector, and green house gas emissions reduction that can contribute to the mitigation of climate change effects (Beddington et al., 2012; FAO, 2017). Localization of these objectives will aid in realizing their full potentials, while delivering smart foods to the end users. At the same time, however, national and international plans will be necessary as the value chain from the field to the consumer are considered (Agrimonti et al., 2020).

Organic food

The term "organic" as a food production system increasingly gained popularity towards the end of twentieth century as governments and economists adopted it in par with consumer awareness, preference and activism. It has eventually become majorly recognized by researchers in the food industry (Rana and Paul, 2020). Organic foods are products grown naturally, produced with the standard methods of organic farming. It involves the production of food crops devoid of synthetic pesticides or chemical fertilizers. These foods are healthy and environment friendly as they contain lower levels of toxic metals and contaminants than regular foods. These organics include organic oil, organic milk, organic chicken, organic dairies, organic tomatoes, organic spinach, organic snacks, and organic apples (Fig. 1).

There is a general notion among the populace that organic foods are healthier than regular or conventional foods due to the belief that organics have health benefits, are pesticide-free and are nutritionally superior. Compared to conventional or normal foods, organic foods are often regarded as healthier in the public eye. Fig. 2 illustrates this point using an apple as an example. Besides, in their choice of food, some consumers consider health considerations, ethical considerations (animal welfare), and political considerations (environmentalism) as well as "private good" attributes such as freshness, taste, and quality (Sadiku, 2020).

Global green processing, smart policies and organic farming

Green technology implies the use of green chemistry, electronic devices, environmental monitoring and science to control, conserve and make models of natural resources while reducing the menace of human involvement (Boye and Arcand, 2013). This process is used in the production of green food products, and may be utilized in smart and organic foods production. Equally important to the green, smart and organic trio concept is the interwoven recent term known as climate smart agriculture. Apart from rapid response to climatic and environmental changes, climate smart agriculture drives proper management of natural resources and the population, using newer technologies and innovations (Capalbo et al., 2018).

The smart policies are meant to improve agriculture and all of its dimensions, ensure food security and healthy populations. It appears that the current agricultural systems are limited in ensuring these aims. The global population continues to grow steadily at an alarming rate, and we still lack a clear-cut path on sustainability of organic food production, green processing and the smart wherewithal to hamper all vices emanating from the other side of the divide, including environmental pollution and rapidly diminishing natural resources. Braimoh (2013) speculated that there is a linkage between the conventional agriculture and food insecurity, due to the massive pollution/emissions and deforestation that occur from the practice of the current form of conventional food production. In fact, more than 20 percent of global greenhouse gas emissions are the result of unsustainable agriculture (Brohm and Klein, 2020).

Although food producers can label their products as organic only if they are certified by the United States Department of Agriculture (USDA) as having met comprehensive regulatory standards for environmental stewardship, yet the USA Federal Government has not defined the term natural for most food products (Kuchler et al., 2020). Survey and experimental studies suggest that even though consumers are confused by the meanings of natural and USDA Organic on food labels (see Fig. 3), they still view the two claims as related, or even view the two claims as identical (Kuchler et al., 2020).

Global green foods production and their emerging popularity

Green food production is part of the green agriculture, and are

Fig. 2. Normal and organic apples.

Fig. 3. Organic food label samples.

produced using organic methods of agriculture (Adams and Wang, 2009). Limited amounts of pesticides and synthetic fertilizers are allowed for green food production since they are construed as fresh, chemical-free, nutritious, natural, and produced in an environmentally-sustainable manner. A green-growth strategy for the food and agriculture sector encompasses agriculture, fisheries, and food supply chain. Green food processing techniques include preservation, transformation, and extraction (Chemat et al., 2017). Green food has become more popular around the world, and had become the principal demand of people in developed nations. The consumption of green food is growing and has become the international trend (Yan-li, 2007). Green consumption patterns and purchasing behaviors vary from country to country. The green food industry is also developing rapidly in developed nations like USA, UK, Germany, Denmark, Switzerland, and Austria.

Other than the developed economies, green food is also gaining popularity in the developing and less developed countries. For instance, in China, green food consumption and technology are rapidly growing. China has a rich history of diverse sustainable farming practices. The concept "Green Food", is organized and implemented by the Ministry of Agriculture (MOA). Chinese consumers seem to be more attentive to the quality of food and green food originating from organic food abroad. Frequent food incidents and the widespread use of chemicals in Chinese agriculture have led to the expansion of the green food market in China.

Also, the consumption of green food in Malaysia is contributing towards achieving the citizens' clamour for food safety, animal welfare and environmental sustainability. The country is strongly supporting the green technology by adopting food safety and environmental friendliness. This is evidently shown by the Malaysian government in establishing a new ministry known as Ministry of Energy, Green Technology and Water. Apart from focusing on vegetable and fruit production, the Malaysian government is also concerned with the green concept among livestock and fishery producers. There have been many food incidents in Malaysia, which made Singapore stop importation of their vegetables in 1987 due to high dithiocarbamate residue (Rezai et al., 2013; Sulaiman and Janai, 2017).

Finally, in India, the two major scientific revolutions affecting food supply in India are the Green Revolution and the Gene Revolution. The Green Revolution has played a major role in producing green foods for the increasing population. Consumption is often used as a measure of welfare and changes in grain flour consumption may have a corresponding influence on household welfare (Miller-Tait, 2013).

Smart food policies

When consumers are asked to eat smart, they are simply advised to eat significant quantities of low-caloric, nutritious and healthful foods. Food choices more often include eating more whole grains (breads, cereals, pasta, etc.), vegetables and fruits (broccoli, spinach, collards, kale, peppers, etc.), and choosing heart-friendly fats that can help lower cholesterol (olive oil, canola oil, soybean oil, safflower oil, etc.). Consumption of junk foods are detrimental to the environment, as foods with saturated fat (ice cream, full-fat cheese, lard, etc.), salts (sodium/sodium chloride), trans fat, and high-cholesterol foods (egg yolks, organ meats, high-fat dairy products etc.) should be minimally consumed. In all, smart consumption implies that consumers should choose climate-friendly foods, buy organic and other sustainable certifications, as well as eat locally.

To address an increasing global health problem of obesity and other diseases requires policies that work. Smart food policies should address interaction between people's food preferences and their environments. In order to improve dietary intake, governmental policy and commercial industry increasingly promote health qualities and nutritional benefits of healthy foods (Turnwald and Crum, 2019). According to Hawkes et al. (2015), the following four mechanisms for food-policy actions could be expected to work: (1) Providing an enabling environment for healthy preference learning. (2) Overcoming barriers to the expression of healthy preferences. (3) Encouraging people to reassess existing unhealthy preferences. (4) Stimulating a positive food-systems response. Following these policies can help the management of diet-related diseases like obesity, diabetes, and cardiovascular diseases.

Smart food policies are been softly enforced by smart food movements across the world. The selected smart foods are millets and sorghum, which used to be traditional staple foods across many countries in Africa, India, China, and other Asian countries. The selected cereals have benefits such low glycaemic index and twice as much protein as milk (Hawkes et al., 2015). There are local food movements around the world, such as Healthy Food Movement in America, the Eat Right Movement in India, Smart Agriculture Movement in Nigeria, and the Sustainable Singapore Movement.

Organic foods going global

Organic farming addresses soil, human, and environmental health.

Organic farm animals are expected to be fed with certified organic food that contains no animal byproducts. The certification is regulated by governments of some countries. Countries such as the United States, the United Kingdom, Canada, Mexico, Japan and the European Union require producers to obtain special certification in order to market foods as organic. Certification is basically aimed at regulating and facilitating the distribution, marketing, and sale of organic products, and protecting consumers.

Organic crops cannot be grown with synthetic fertilizers, synthetic pesticides or sewage sludge. They cannot be genetically engineered or irradiated. Organic animals must eat only organically grown feed and cannot be treated with synthetic hormones or antibiotics.

The increasing awareness of the fitness and health benefits of organic foods are fueling the demand for these products across the world. Most developed countries, including the European Union, United States, Canada, Japan, China, Russia, and Australia, require country of origin labeling in order to market food as organic within their borders. Organic food is the fastest growing sector of the American food industry (Alexander et al., 2015). In 1990, US Congress required the USDA to forbid organic growers from using synthetic materials in production and set national minimum standards for the production, marketing, and labeling of organic foods.

In the European Union (EU), organic farming is currently one of the most dynamic farm sectors. The market for organic foods is developing fast throughout Europe due to consumers' health concerns and demands for safe foods. Since July 2010, all organic foods produced and sold in the EU must be labeled with the mandatory EU logo (Janssen and Hamm, 2012).

The notion of organic agriculture has been developed in the United Kingdom (UK) since the 1930s and certified organic produce has been available since the early 1970s. In the UK, demand for organic food products is estimated to be growing at about 40% per year (Semos, 2003).

Due to its utter size, China already has the fourth largest organic agricultural land area and China is one of the largest producers of organic foods. Although organic foods are a Western invention, they are now available in supermarkets in the East, including East and South-East China metropolises such as Shanghai, Beijing, and Guangzhou (Thøgersen and Zhou, 2012).

Just like China, India is becoming a global producer of organic crops. The government of India is offering strong support and promoting organic farming as it will increase the economic contribution, positive impact on biodiversity, and effective soil management. Organic foods are getting popular in India due to the availability of organic manures in rural areas, the depleted soil and product quality, as well as increased commercialization and competitiveness of the Indian agro-market.

The sales of organic foods is increasing in Canada as well as the amount of land devoted to organic agriculture. The current Canadian National Standard forbids the use of all materials and products from synthetic pesticides in organic production. When eating out of the house, Canadians typically look for healthy choices, locally grown foods, and organically certified foods (Holmes et al., 2018).

In Australia, the organic certification bodies provide guarantees of authenticity through labels that are attached to certified organic products. There are seven certification bodies in Australia with each having its own label. The Organic Federation of Australia is currently liaising with industry to come up with a one-label requirement like the US and EU (Henryks and Pearson, 2010). Sample labeling logos in different countries are represented in Fig. 3.

Since the collapse of the Union of Soviet Socialist Republics (USSR), the markets of the former member countries have gone through major economic changes. Organic food is relatively new on the Russian market. Among the lovers of organic foods, displeasure emerged about the high prices for organic foods in Russia. Price is often the main barrier for the demand of organic food (Bruschi et al., 2015).

Challenges associated with GSO foods

For green foods, the surrounding propagandas seem confusing and misleading to consumers. If the propagandas and other challenges are properly addressed, more consumers may consider green foods. The primary challenge is that food production is inherently dependent on nature. In addition to this, there are challenges associated with carbon footprint for food items. Therefore, green food processing techniques need optimization and standardization. The emission intensity of the production process and the supply chain must be optimized.

Further, culture often dictates to some extent how much a behaviour can change. However, green food consumption needs governmental involvement. For each nation, its government has a key role to play on sustainable food issues by providing leadership and indicating priority areas for action. In fact, the Green Revolution was confined to certain crops (such as rice and wheat) at the expense of others; and the wide variety of foods available to consumers poses a huge challenge for eating less, improving sustainability, and measuring the carbon impact of a meal. Moreover, there are problems with the traditional marketing of green foods, although web marketing has been effective. Then, the high costs of green foods, and the need for more market penetration are constant challenges, just as safety remains a great concern.

For smart foods, it still remains immature, uncertain, and without regulation or standardization. Research and development for both climate- and nutrition-smart agriculture face the challenges of enhancing the food and nutrition security of poor women, men, girls and boys, increasing gender and social equity and decreasing poverty as part of human development and being socio-economically, and environmentally sustainable (Beuchelt and Badstue, 2013).

For the organic foods, many food scientists have actually disagreed that organic foods are really healthier than conventional foods, and a good number of them are highly skeptical. It is cost-ineffective to handle organic foods based on mandatory classification and separation from conventional foods. Organic foods have labor intensive demand and farmers do not use pesticides, chemical fertilizers, or drugs. Thus, organic foods normally cost 20%–100% more than conventional foods. Moreover, after all the rigours involved in obtaining labels for organic foods, there is no means for distinguishing between organic and conventional foods unless they are taken into the lab for testing. Therefore, consumers will not be able to ascertain if the food was produced according to the promised characteristics such as safety and trustworthiness or not. A lot of skepticism are shown by consumers regarding the certification process of organic and non-GMO labels.

Organic foods tend to spoil faster than non-organics because they are produced without artificial preservatives or irradiation. Moreover, products like organic ice-cream, cookies, sodas, and chips have not been proven healthful, even though they are labeled as organic.

A study among 274 Brazilian organic foods consumers, conducted by de Morais Watanabe, Alfinito, Curvelo and Hamza (2020), they indicated that functional and emotional values positively affect consumers' trust and that only emotional value motivates purchase intention. Whereas in another study, which investigates gender-based behavioural pattern of GSO foods, women expressed greater interest in consuming fruits and vegetables mostly compared to men; and while both men and women agree that organic foods are produced in a sustainable manner, their high price, difficult access, irregular supply and availability in few establishments were highlighted as the main limiting factors for not consuming organic foods (Martins et al., 2020). A similar study conducted in Spain and Thailand towards consumers' perception and attitude, as well as retailers' attitude to GSO foods showed similar results, respectively, with cost being a premium factor (Rodríguez-Bermúdez et al., 2020; Kantamaturapoj and Marshall, 2020). These studies showed that emotion, trust, gender differences, cost, access and availability are challenges associated with GSO foods and should be considered to formulate good smart policies.

Willingness to pay for organic food is often driven by environmental

concern, health awareness, quality, and locality (Katt and Meixner, 2020). Therefore, retailers and producers of GSO foods would have to critically consider this challenge. Moreover, Danner & Menapace (2020) suggested that online comments can serve as an alternative data source for exploratory consumer research because knowing consumers' beliefs can help policy-makers and certification bodies improve communication about organic and other sustainability standards, thereby creating realistic consumer expectations and enhancing the comparability of standards across retail outlets and countries of origin (Danner and Menapace, 2020).

Benefits and future prospects

The basic objectives of green foods development include food quality enhancement, consumers' health promotion, and ecological environments protection for sustainable development (Lin et al., 2010). Green foods are safe, nutritive, pollution-free and of high quality. They are healthy to consume, with the use of less chemicals, and contain higher vitamin and mineral contents than conventional foods. Thus, consumption of green foods can guarantee the life quality of consumers. Due to the absence of chemicals and genetically modified ingredients in green foods, hostile environmental impacts are reduced. The green food certification process is simple, accurate, and efficient, avoiding wastes due to the complicated and repetitive process of the traditional method. McCarthy (2015) listed safety, freshness, seasoned sourcing, reputable production lines, competitive pricing, usage of humanely treated livestock, good tastes, self, and family future health as benefits associated with green foods.

For smart foods, consumers ought to be smart with what they eat as it is often said that we are what we eat. The low glycemic indices of smart foods help manage blood sugar level and prevent diabetes. Smart foods are also good for our planet and thus are environmentally sustainable. They have been a versatile tool for the adaptation and mitigation of climate change. Smart foods are good for the farmer as they are viable and climate smart, thereby increasing yield for a global market growth.

Thanks to smart foods, a globalized diet now exists, and the trend in developing countries is that more nutritious foods like millets are now preferred. Millets lower heart disease and cancer risks, and are recommended for pregnant women. Moreover, smart foods help to fight poverty and food insecurity.

Organic foods have their own benefits too. They are low-calorie foods and thus, healthy. The procedures for organic farming avoid the use of pesticides. Organic foods contain higher levels of antioxidants and less harmful chemicals. Therefore, they are often fresher due to lack of preservatives. Environment-wise, organic farming is a much better option than other forms of farming because it reduces pollution, conserves water, reduces soil erosion, increases soil fertility, and uses less energy. As a fact, organically raised animals are not given antibiotics, growth hormones, or fed animal byproducts. Therefore, their meat and milk are richer in certain nutrients. No use of genetically modified organisms or ingredients are permitted in organic foods too. Lastly, organic foods consumption may reduce overweight, obesity, and the risk of allergic disease (Essoussi and Zahaf, 2008). In the same study by Martins et al. (2020), an increased consumers' motivation of organic foods consumption was related to the awareness that organic foods are healthier and can improve quality of life.

Conclusions

As the public shifts toward a greener planet, the food industry should implement green policies. The uprising of the green movement is inevitable due to food contamination that is happening around the world. With a growing improvement in people's awareness, green food will be the mainstream and will improve the future health of human populations. Cities around the world are also engaging in food and agriculture practice. It is not too late for smart food choices and policies to be made by the cities' authorities and urban movements to curb chronic diseases. Also, organic food advocates claim that it is better for the environment than the conventionally foods, but there is no clear evidence or justification for this claim. Yet, the organic food market has experienced unprecedented growth over recent years. The reasons consumers submit for choosing organics include healthfulness, taste, environment-friendliness, safety, and local agriculture support.

Funding

No external funding received.

Ethical guidelines

Ethics approval was not required for this research.

Consent to participate

Not applicable.

Availability of data and material

Available upon request.

Authors' contributions

The authors equally contributed to the manuscript.

Declaration of competing interest

The authors confirm that they have no conflicts of interest with respect to the work described in this paper.

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