Canadian Consumers' Perceptions of Sustainability of Food Innovations

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Educated consumer food choices not only enhance personal health but can also contribute to environmental, economic, and social well-being, as well as food sustainability. Consumers refer mostly to the ecological aspect of food sustainability in their perceptions and food-buying behavior. Web-based information was a widely consulted source of information about food-related sustainability and innovation, although it ranked low among consumers in terms of trust level.

Keywords: consumer behaviour ; dietary identity ; environment ; food price

1. Introduction

The shift towards more sustainable diets and food systems has led to evolving consumption habits, changing food-business practices, and increased academic research. This reform movement is a core policy goal as reflected in both national and global strategies. The Canadian federal government set "Supporting a healthier and more sustainable food system" as the second goal of its Sustainable Development Strategy for 2022–2026 [1]. The United Nations set "Ensuring sustainable consumption and production patterns" as the 12th goal of its 2030 Agenda for Sustainable Development [2]. Consumers have exhibited interest in sustainable agrifood products as reflected by changes in eating patterns, such as integrating plant-based proteins, locally sourced products, organic food, natural food, etc., into their diets. Furthermore, there is a trend to reduce the consumption of red meat and highly processed foods and food waste. Other incentives include reusable bags in grocery stores. Those trends are deeply influenced by the increased awareness of environmental issues [3][4]. Kovacs and Keresztes [5] posit that food-sustainability concerns are increasingly highlighted due to the sustainability goals related to climate change, the effects of which have caused more health and social dilemmas. As such, consumers play a key role in reducing the burden on the environment through their food choices, while enhancing their personal health. Indeed, the consumer's decision-making process is not only about satisfying needs from an economic perspective, but it also involves psychological, sociological/personal-related, and cultural/environmental aspects [6][7].

Sustainability is also a multi-dimensional concept as captured in the Food and Agriculture Organization's definition: "sustainable diets are those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources" ([8], p. 7). As to a sustainable food system, it is defined as "a food system that delivers food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised" ([9], p. 1). Both definitions highlight that the concept of sustainability is complex, as it considers different, yet interdependent, aspects, namely: environmental/ecological, economic/financial, and social/ethical. Sustainable food products contribute—through their attributes and consequences—to these three goals. The economic aspect has to do with a fair price for the agricultural producers and affordable consumer prices. The ecological component refers to sustainability in the strict sense of preserving the environment and sustainable use and management of natural resources—for instance through reductions in pesticide and water usages. The social component concerns an integration of agriculture in the priorities and needs of the citizens and an appreciation and support for the agri-food sector from the society, as well as from the government [10]. While the economic and social aspects are important indicators of sustainability, they are largely ignored compared with the environmental sustainability that has been prioritized in research and practice [11][12].

Sustainability requires major transformations in the modes of innovation. In fact, "the world can only meet its future food needs by harnessing scientific agriculture innovation" ([13], p. 1). Consumers' acceptance of new and emerging food production technologies is tied to their understanding of the costs and benefits of the outcomes. Advances in agrifood

biotechnology not only provide direct benefits to consumers (e.g., nutrition), but also potential environmental benefits. Improved consumer understanding of the benefits of innovative agrifood products can aid in the adoption process. Thanks to brands such as Beyond Meat and Impossible Foods, animal-free burgers are commonplace innovative foods on the market. The popularity of these products is driven by concerns over climate change, global food security, the ethics of farming and health trends. Another example of food innovation is gene-editing technology that has been leading advancements in crops and animal breeding within the last decade owing to its technical simplicity and potential socio-economic and environmental benefits [14][15].

2. Emerging Sustainable Innovations in the Agrifood Sector

Climate change, population growth, the pandemic's outbreak, and ongoing conflicts are shaking the environmental, societal, and economics ecosystems. Those global challenges pose a threat for food security; thus, there is an urgent need for innovative solutions and technologies to render the agrifood system more sustainable and resilient [16]. Two food-related megatrends have emerged in recent years in response to these global dilemmas: the shift in eating habits—with the emergence of vegan, vegetarian, and flexitarian diets, and the digitalization of farming and food transformation (the latter is beyond the scope of this article). Among the food trends that have emerged are novel or different food sources (e.g., plant-based proteins, algae, fungi) and advanced biotechnologies such as gene editing in plant breeding and cell-cultured foods that have been associated with more sustainable food systems and enhanced nutritional qualities, including safety [16].

Evidence shows that the environmental impacts of animal products exceed those of vegetable substitutes. To illustrate, meat, aquaculture, eggs, and dairy use about 83% of the world's farmland and contribute 56 to 58% of food's different emissions (greenhouse gas—GHG, acidifying, and eutrophying emissions), despite providing only 37% of our proteins and 18% of our calories [17]. On the other hand, a diet that excludes animal products and includes new vegetable proteins has the potential to "reduce food's land use by 3.1 billion ha (a 76% reduction), food's GHG emissions by 6.6 billion metric tons of carbon dioxide equivalents (a 49% reduction); acidification by 50%; eutrophication by 49%; and scarcity-weighted freshwater withdrawals by 19% for a 2010 reference year" ([17], p1). That is why plant-based burgers are considered better for the environment than meat burgers, as livestock production is a heavy emitter of GHG, and thus a large contributor to climate change [18][19]. In addition to reducing ecological degradation, cutting meat consumption and integrating more plant-based proteins is promoted as a healthy diet that can reduce several diseases, including cancer, obesity, and cardiovascular illnesses [20][21]. However, an assessment of plant-based meats in the United Kingdom found them to have significantly higher levels of sodium, which contributes to higher levels of high blood pressure, strokes, and heart disease, as well as having lower levels of minerals and vitamins than meat from livestock [22]. In addition, plant-based food still faces several challenges, notably consumer acceptance of the sensory properties (e.g., flavor, texture, color) of ingredients. In Canada, dietary guidance and the Food Guide encourages the increased consumption of plant-based foods as a source of dietary protein.

Allowing for targeted improvement in an organism's genetic material, gene editing has revolutionized plant breeding, aquaculture, and livestock. Clustered Regularly Interspaced Short Palindromic Repeats, or CRISPR, dominates the field of gene editing, as it is considered the most efficient, targeted, and affordable tool [13][23][24]. Gene editing in plant breeding has the potential to achieve sustainability by reducing inputs such as fertilizers and pesticides, controlling diseases, increasing yields, improving nutrition, and developing climate-resilient crops [13][14][15]. Similarly, CRISPR applications in livestock can improve production traits, enhance animal welfare through adaptation and resilience, confer resistance to infectious and transmissible diseases, and control pests and invasive species that threaten animals [14][25]. Unlike plant-based products, most gene-editing-based solutions for crops and animals are still proof-of-concept, with hopes of release in the near future.

3. Canadian Consumers' Perceptions of Sustainable Food

In addition to the innovation trends previously highlighted, and parallel to the role of producers as a vital part of the solution, consumers—through their diet—also have a responsibility in contributing to the environmental, economic, and social goals of sustainability. As advanced in the introduction, research studying sustainability as a tripartite concept is lacking in the Canadian context, thus this section briefly reviews Canadian consumers' perceptions of certain aspects (i.e., organic, local, packaging) of food-related sustainability.

Several studies have investigated attributes related to production methods and related quality claims. Using a discrete choice survey instrument, Uzea et al. [26] found a significant diversity of consumer attitudes for animal welfare attributes and the source of verification. While a group of consumers were strongly motivated to purchase meat coming from

welfare-enhanced production systems, others were indifferent between these products and conventional versions. Innes and Hobbs [27] found that one-third of Canadian participants valued bread containing grains produced using environmentally sustainable and/or pesticide-free methods. The authors also observed that those consumers placed similar amounts of trust in the government, third parties, and farmers to provide accurate information about farming methods, while food processors and supermarkets were less trusted. When examining consumer perceptions of ecolabels, Guntzburger et al. [28] found that participants lack knowledge about the difference between organic, local, and genetically modified organisms (GMO)-free claims. The importance of these claims was found to be influenced by health risk perceptions and motivations and vary in different socio-demographic segments. Similarly, Campbell et al. [29] asserted that consumers, in general, know the key concepts of local and organic production; however, many are confused about less-advertised practices, and perceptions are heterogeneous with respect to some demographics. Hamzaoui Essoussi and Zahaf [30] identified health, the environment, and support of local farmers as being the principal values explaining organic food consumption among participants based on Ottawa. In their Canada-wide study on sustainable food-packaging alternatives, Walker et al. [31] observed that most participants (94%) were motivated to reduce their consumption of single-use plastic food packaging, but were less willing to pay for sustainable alternatives. This motivation was also shown to vary across regions and income groups. In their meta-analysis of consumers' willingness to pay (WTP) for sustainable food products, Li and Kallas [32] highlighted that gender, region, sustainable attributes, and food categories influence the WTP estimate, and that there are significant differences between global regions. They found that consumer WTP is lower in North America compared with Asia and Europe.

Based on these insights, consumers' heterogeneity in their perceptions of sustainability and related food choices is expected, along with differences in trust levels toward various sources for accurate information about sustainability and innovation in the agriculture and food sectors. Canadian consumers' perceptions of sustainability and trust in information sources are proposed to vary in different socio-demographic segments.

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