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Citizen Science and the Food System—A Focus Group Pilot Study

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Abstract

New and old scientific methodologies are constantly emerging. Citizen science (CS) is a research methodology that enables the involvement of citizens in scientific research, fostering new knowledge while empowering society. This pilot study explored university students' perceptions regarding citizen science and the food system through a focus group. None of the participants had prior experience with CS, and most had never heard of it; nevertheless, they identified knowledge acquisition and societal change as the main motivators for participation. Concerning the food system, participants expressed concerns about unhealthy and unbalanced diets, lack of food and health literacy, and limited access to healthy options. Proposed solutions included transparent labeling, support and access to local food production, intersectoral awareness campaigns, and reinforcement of the relevance of citizen-led approaches to solving complex food-related issues. These findings highlight the potential of CS as a powerful approach to engage citizens in scientific research and, consequently, contribute to actionable solutions that address the complex challenges of the food system.

Keywords: citizen science; food system; focus group; food challenges; food system opportunities

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1. Introduction

Food production meets a basic human need; however, recent times have highlighted the unsustainability of the current global food system. To overcome the challenges of the present food supply chain, it is necessary to transform the food system into a more sustainable one, guaranteeing safe and nourishing food for the present and future generations without compromising economic, social, and environmental sustainability [1–6].

To attain a more sustainable food system, some scientific targets have been set, specifically, decarbonization of the food production chain by 2050, reduction in the environmental footprint, reforestation, ecological and biodiversity preservation and restoration, adoption of sustainable agricultural practices, conscious utilization of natural resources, reduction in pesticides, antibiotics and fertilizers, conservation of seeds diversity, shorter supply chains, provision of food for humans without utilizing more than the existing agricultural land, promotion of healthy and nutritious diets, reduction in food waste, improvement of food accessibility and stimulation of economic circularity [2,3,5,7,8].

Dietary choices are influenced by both individual and environmental factors. These factors can be classified into three classes: food-related characteristics, for example, food

organoleptic characteristics or packaging, individual preferences, such as physical needs, biological, psychological, social, and cognitive drivers, and society-related attributes, for instance, culture, income, and governmental policies [2,6]. The food environment can be defined as the physical, economic, political, social, and cultural surroundings where people engage with the global food system, influencing their food choices. The food environment can occur at an individual level, such as in the workplace or at home, and at a societal level, impacted by government policies, cultural beliefs, and societal frameworks [9,10].

Citizen science (CS) is a concept that describes a scientific methodology that engages scientists and volunteer citizens in scientific research, with the main objective of generating new knowledge and creating societally significant research, to base decision-making on. This methodology translates a connection between science and society, urging for a more democratized science and the active participation and involvement of the public [9,11–14]. Citizens are encouraged to participate in various activities of the scientific process, from formulation of research questions to problem definition, data collection and analysis, and results dissemination [9,13,14]. CS projects have increased in recent years, mainly because of the need to collect large amounts of data with limited human and economic resources [9,11].

Compared to more traditional research methods, CS has a lower financial burden and higher information quantity. This methodology also entails other advantages for both scientists and citizens. On the one hand, it promotes the public consciousness, education, empowerment, and awareness of diverse scientific topics. On the other hand, it generates new knowledge and creates a sense of community [9,13].

Lotfian et al. [13] highlight important factors that may motivate volunteer citizens to participate in CS projects, such as the acquisition of new skills and knowledge, personal development, self-enjoyment, humanitarianism, community, reinforcement of social relations, and career, among others.

Notwithstanding the numerous benefits, CS also presents challenges related to project duration, data reliability, operational processes, and ethical concerns [9]. Regarding project duration, Lee et al. [9] mention that short project lifespans do not allow for a real impact on society. With reference to data reliability, this may be compromised by problems related to the lack of citizens' training and the continued motivation of participants in the project. However, some measures can be taken to increase data quality, for example, creating simpler and more objective tasks, and ensuring the validation of the data collected by an expert or through citizens' training. On the subject of operational processes, most issues arise from difficulties in the recruitment, retention, and communication procedures of citizen scientists. Apart from these challenges, some ethical questions are also being raised, mainly regarding labor exploitation, data proprietorship, and conflicts of interest [9].

Despite the various challenges presented, this type of research brings several benefits and outcomes, such as societies' increased interest and trust in the scientific work, a deeper understanding of innumerable scientific subjects, larger databases, public education, and encouraged community engagement [12].

The agri-food system faces many challenges that can be addressed by CS projects, as described by Ryan et al., with, for example, the monitoring of harmful microorganisms, conservation of Earth's ecosystems, promotion of food security, and strengthening societies' education [7].

Collaborative and citizen-driven methodologies, such as CS, have been shown to have the potential to, at a local and international level, contribute to generating knowledge regarding the current sustainable challenges, co-create solutions for these, and tackle the Sustainable Development Goals proposed by the United Nations. The scientific literature indicates that not only can CS contribute to the world's sustainability, but it can also enhance critical thinking and educational and scientific outcomes [10,12,15].

The relevance of these citizen-led projects has been recognized by the European Commission and incorporated in the 2020 Strategy. This recognition has been translated into the implementation of several CS projects in more than 100 European cities. In Portugal, citizen-led research is still scarce, since the communities, both scientists and citizens, are still beginning to engage with the concept of CS and the creation of projects [10,11].

To the authors' knowledge, only one article [16] has been published regarding the use of a qualitative research design to diagnose the Donostia-San Sebastián food system and identify potential solutions, in a CS approach to create a greener city. The current research provides new knowledge by assessing citizens' perceptions of the food system as a whole and not just in a specific city, as well as by focusing on the solutions, not only from a sustainable perspective but also to promote healthier and balanced food systems.

Therefore, this work aimed to explore citizens' perceptions regarding CS and the food system through a qualitative research methodology. This work is a first step in the development of a CS tool aimed at promoting the active participation of citizens in the preparation of a CS initiative that allows for a broader and longitudinal observation of the Portuguese food system. As a pivotal phase of the CS process, this study seeks to engage with citizens in order to gather their contributions and insights regarding the food system to guide the development and co-creation of a CS project.

This research aims to collect information on citizens' perceptions and involvement in participatory methodologies, to identify challenges in the food system, and solutions that may exist to overcome them. Furthermore, the authors propose to evaluate some research hypotheses, namely, (1) In general, citizens are not familiar with the concept of CS and have low experience with projects of this nature; (2) Challenges related to the current food system are perceived by citizens; (3) Citizens are able to propose solutions to the previously presented challenges.

2. Materials and Methods

For this research, a qualitative research methodology was conducted, specifically focus groups. Focus groups are a methodology based on group interviews and communication between participants to retrieve people's attitudes, views, knowledge, experiences, and thoughts to generate new scientific data [17–19]. In these focus groups, people are encouraged to talk with each other to help elucidate and explore different points of view regarding a specific research question [17–19]. This methodology has some disadvantages, such as limited consistency, restricted generalization, and participant bias, but also presents some advantages, specifically, encouraging reluctant people to engage, empowering participants through their contribution to new knowledge, and being more inclusive, allowing illiterate people to participate [17–19]. It is recommended that groups are homogeneous, with six to twelve people, and conducted in a relaxed and comfortable environment with food and refreshments available, lasting between one to two hours [17,19]. The semi-structured interview is conducted by a moderator who explains the aim of the focus group, encourages and facilitates participants' intervention, and summarizes the main conclusion, as well as at least one observer who notes verbal and non-verbal interactions between the participants, without actively participating in the discussion. The focus group should also be recorded, transcribed, and coded for subsequent analysis [17,18].

2.1. Participant Recruitment

The participants consisted of a sample of university students from the Polytechnic University of Viseu in Portugal, over 18 years of age, who were voluntarily willing to participate in the research. Students from other higher education institutions could not participate in the study. Participants were recruited through an invitation on the Moodle

platform version 5.1 (Moodle, Perth, Australia), a learning and course management software. In total, six students took part in the focus group from three different areas of study: nursing, agriculture, and social education.

2.2. Study Design

The study consisted of a semi-structured interview that was conducted in the form of focus groups. This research was approved by the Ethical Commission of the Polytechnic Institute of Viseu with the reference N.º 31/SUB/2024.

For this research, a guiding script was created with questions and the main outcomes that should be achieved during the session. The guide consisted of four parts: (1) presentation, (2) research aims and procedures to be adopted, (3) exploration of the themes, and (4) closing of the session, which was followed by the moderator during the focus group. Additionally, a questionnaire was created to collect sociodemographic characteristics of the participants, namely, age, gender, level of education, place of residence, characterization of the living environment as rural, urban, or suburban, area of study, number of people in the household, type of diet, and participation in CS projects, with open and multiple-choice questions.

2.3. Data Collection

The focus group was conducted in December 2024 in a relaxed environment, where refreshments and food were available to all participants during the session, and lasted one hour. Before the start of the session, all participants were asked to answer the sociodemographic questionnaire and sign the informed consent, safeguarding anonymity, ensuring the confidentiality of the collected data, and authorizing the recording of the session. After obtaining consent from all participants, the session began, and the recording started.

In the first part of the session, the research team, including the moderator and two observers, was introduced, and each participant presented themselves. In the second part, the moderator exhibited a PowerPoint presentation that contained an explanation of the research project, the aims of the focus group, the rules and procedures to be adopted during the session, and a brief description of the CS and food system concepts. The third part consisted of the debate of the proposed themes, with some pre-conceived questions from the guiding script and some additional ones that were a result of the discussion created. Regarding CS, three questions were asked of the participants, whereas for the food system, four questions were explored (Table 1).

Table 1. Questions asked of the participants about citizen science and the food system.

Topic of the Question	Question
Citizen science	(1) Have you ever participated in any CS projects?
	(2) What do you know about these types of projects?
	(3) What do you think would be the main motivators for citizens to participate in these projects?
Food system	(4) After reading the concept we shared and thinking about the reality of your territory, what worries you most when you think about your diet and food system?
	(5) Which sectors and entities do you think are relevant to make this change and to support the adaptation to healthier habits?
	(6) What could we ask society, in general, if we only had one question, to ensure that the food system guarantees a healthy and sustainable diet?
	(7) How do you think we could investigate and monitor the mentioned situations?

After some solutions were presented, during the focus group discussion for questions six and seven, these solutions were put to the vote, and each participant was able to vote on the two most relevant ones. In the fourth and final part, the moderator gave a brief summary of the main conclusions reached during the focus group, invited the participants to continue to take part in the project's various activities, and thanked everyone present for their collaboration.

2.4. Data Analysis

The responses from the sociodemographic questionnaire were anonymized, and some basic statistical analysis was conducted using Excel version 365 (Microsoft, Redmond, WA, USA). Furthermore, the digital record of the focus group was transcribed and examined by the authors to ensure anonymity. The resulting information was broken down into meaning units and subsequently condensed and coded into categories to facilitate interpretation. A thematic and content analysis was conducted in order to identify common themes, discover patterns, and analyze the frequency of specific ideas [20,21]. The transcription analysis and subsequent coding were performed in parallel by two of the authors, and any conflicts were reviewed and a consensus reached. Throughout the article, some answers were selected to appear in their entirety with the intention of expressing the whole meaning of the reaction.

3. Results

3.1. Sociodemographic Characterization

The focus group was formed by six participants aged between 19 and 34 years of age, with an average age of 23.83 ± 5.46 years (Table 2).

Table 2. Participants age.

	Min	Mean	Max
Age (years)	19	23.83 ± 5.46	34

Regarding sociodemographic characteristics, the majority of the participants were women (83.33%), with a secondary educational level (66.67%), living with family (83.33%), and eating a non-specific diet (83.33%). With respect to the living environment, 50% of the participants lived in rural neighborhoods and 50% in urban areas. The people participating in the session were university students from three different areas of study, namely, social education (33.3(3)%), nursing (33.3(3)%), and agriculture (33.3(3)%) (Table 3).

Table 3. Sociodemographic characteristics.

Variable		N	%
Gender	Men	1	16.67
	Women	5	83.33
Level of education	Secondary	4	66.67
	University (Bachelor's degree)	2	33.33
Living environment	Rural	3	50.00
	Urban	3	50.00
Living situation	Living with family	5	83.33
	Living without family	1	16.67
Area of study	Social education	2	33.3(3)
	Nursing	2	33.3(3)
	Agriculture	2	33.3(3)
Type of diet	Non-specific diet	5	83.33
	Mediterranean diet	1	16.67
Total		6	100

The participants were from five different towns in Portugal: Mangualde (n = 1), Resende (n = 1), Viseu (n = 2), and Nelas (n = 1), from the Viseu district, and Trancoso (n = 1) from the Guarda district.

3.2. Citizen Science Projects

Apart from sociodemographic characteristics, the participants were asked if they had ever participated in a CS project, to which 66.67% answered no, and 33.33% answered that they had never heard of CS (Figure 1).

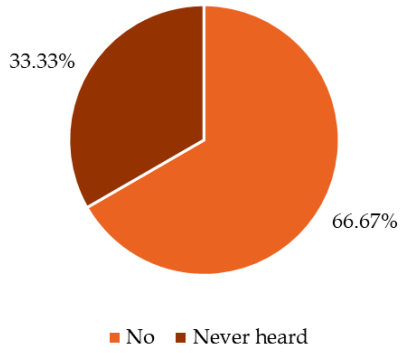

Figure 1. Participation in citizen science projects.

At the beginning of the session, when faced with the fact that none of the participants had partaken in CS projects, the conversation revolved around their perceived knowledge of these projects. CS projects were described as scientific projects and studies of and involving people. The term citizen was also used as a synonym for people in the context of CS projects. When asked about the main reasons that people could have to participate in these types of projects, the participants identified knowledge and change as the two main motivators.

3.3. Food System

This study not only focused on CS but also aimed to identify the main challenges of current food systems and possible solutions to address them.

The participants raised numerous concerns related with the food system, namely, unhealthy and unbalanced diets, inadequate, unhealthy and non-nutritious provision of food to school-aged children, insufficient knowledge and literacy regarding healthy food, unhealthy environments and limited healthy food choices, over-processing of food products, no prioritization of food and health literacy throughout all ages, too much theoretical education and no adaptation of food education to different life stages and available time.

"Maybe, not having a very balanced diet (. . .)"

"One case would be providing age-appropriate food to children."

"(. . .) knowledge, I think, it is very important (. . .)"

"And even at the level of (. . .) education, in schools you learn more about giving the food wheel, and having a balanced diet, but they don't talk much about how to do it."

"In other words, the environment itself also has a great impact, influence, and implications."

From the challenges previously mentioned, participants were asked to identify which sectors and institutions were relevant to support the change into healthier food habits and environments. Several answers were reported, specifically, the government and political

decision-makers, schools, the health sector, namely, health centers, nurses and nutritionists, the food sector, which included industries and supermarkets, all sectors, the general population, and individuals.

"I think all age groups. There should be this continuity, even from daycare."

"All entities."

"Also at the health level, perhaps nutritionists."

"(. . .) the government itself."

"I think the food industries, supermarkets (. . .)"

"I don't know if we can say we are not an entity, but ourselves. Although we are not an entity (. . .)"

In terms of the solutions proposed to face the various challenges identified, the participants mentioned the need to create more awareness-raising actions for the whole community, promote food literacy, support people with economic difficulties, ensure the missing needs in the food system, encourage food farming and production, create subsidized benefits for the production of food, foster digital marketing to target healthy food habits, create clear and accessible food labeling directed to, not only nutrition, but also health, implement vegetable gardens in schools and communities and promote intergenerational knowledge.

All these solutions were put to the vote to select the most relevant. The results showed that clear and accessible food labeling directed not only to nutrition, but also to health, was the most voted solution, with three votes, followed by food farming and production and awareness-raising actions, with two votes each.

"It's really about raising awareness, there's no other way around it."

"Support for poor families, perhaps, for people that don't have the possibilities (. . .) sometimes the more accessible food is also the most deficient."

"Placing it more clearly on the packaging labels (. . .) in a clearer and more accessible way."

"For example, I also think that instead of giving so much emphasis to fast-food marketing, they should give more importance to the part of the vegetable production. In other words, emphasizing the farming itself (. . .)"

4. Discussion

Citizen science is increasingly recognized as a methodology that bridges science and society by actively involving citizens in research. This methodology is based on the involvement of people in different stages of the scientific process, encouraging their active participation in science, which makes citizens feel they actively contribute to expanding their knowledge on several relevant topics, as well as foster change [12,22,23].

Although the participants of this study had little or no prior experience with CS, they expressed a positive attitude towards its principles, highlighting knowledge generation and societal change as key motivators. These findings are consistent with previous studies showing that motivations such as learning, curiosity, and community engagement drive participation in CS initiatives [13,20,21,23]. In the work by Cigarini et al. [24] and Sánchez et al. [25], the vast majority of participants, 92% and 85.2%, respectively, have likewise never participated in a CS project, which highlights the unexplored potential of this research methodology. Although the participants had never been part of a CS project, they were able to define CS as scientific projects and/or studies involving people and citizens. This perception of CS is in accordance with the work by Collins et al. [23], in which 18 of the people partaking in qualitative research have also described CS as the engagement

of people in science who do not work in this field. In addition, one of the participants of this study mentioned the potential of CS to promote collaboration with the community, and consequently, a better understanding of the scientific research process. This vision was not expressed by any of the participants in the focus group.

Several studies have focused on people's motivation to take part in projects of this nature. In the scientific literature, some of the reasons that drive people towards CS initiatives are personal satisfaction, aspirations and ambitions, curiosity, interest, socialization, community engagement, environmental conservation, instigation of change, data collection, contribution to science, career opportunities, acquisition of knowledge, and scientific innovation [13,23,24,26–28]. The focus group participants associated CS with knowledge generation and societal change, motivations consistent with the previously described literature. This supports the argument that participants are willing to engage in CS when it is perceived as meaningful and impactful [22]. Notwithstanding, even though people are willing to participate in CS projects, oftentimes, citizens are not aware that these types of projects even exist. One of the challenges in CS is still the citizens' lack of knowledge and information regarding this methodology, which prevents a larger dissemination and participation in projects [29,30]. The limited awareness of CS observed here mirrors trends in other countries, where most citizens have never participated in such projects [21,22]. This underlines both the potential and the challenges of expanding CS, particularly the need for stronger institutional support and broader outreach beyond already science-friendly audiences [27,28]. The focus group methodology used in this paper has been shown to be a potential means of communication between the scientific community and citizens regarding the topic of CS and the opportunities for participation in projects.

West et al. [30] also emphasizes the importance of understanding what factors motivate citizens to engage with and remain involved in CS projects, since participant retention is one of the challenges of this methodology.

Moreover, CS is an increasingly recognized pedagogical tool that supports learning outcomes, particularly in environmental and health education [24,31]. Despite this, the literature highlights persistent barriers to broader engagement. CS projects often attract individuals who are already educated and science-friendly [32,33], which limits the democratizing potential of these initiatives [25]. Pateman et al. [34] highlights this problem, showing that CS projects often demonstrate a diversity problem regarding gender, ethnicity, education level, and affluence. Participation equity constitutes one of the barriers of CS, since inequalities can limit perspectives, thus the relevance of promoting diversity among participants of CS projects [34].

In the work by Collins et al. [23], as well as in this study, CS projects were described as projects involving people, reinforcing the idea that citizen participation is essential for the success of such initiatives. Data quality is a concern in CS, as data collection is often conducted by individuals without prior experience in scientific research. While data accuracy, reproducibility, and quality are valid concerns, there are several strategies to minimize errors and bias. Establishing a data collection protocol in CS projects is essential, as well as taking additional measures such as training citizen scientists and validating and verifying the data generated to ensure data quality and reliability [29,35].

Some challenges are amplified by structural issues, such as limited awareness and institutional support, particularly in countries with emerging CS ecosystems [36]. However, initiatives in public spaces, such as libraries [24] and digital platforms [33], show promise in increasing accessibility and participation.

In addition to CS, this study also focused on the challenges of the food system.

Regarding the food system, participants voiced concerns over unhealthy diets, food illiteracy, economic barriers, and the influence of unhealthy food environments.

These concerns are aligned with global literature stressing that unsustainable diets and food systems are major contributors to non-communicable diseases and environmental degradation [35–41]. The current global food system is characterized as unbalanced and unsustainable, leading to the exhaustion of natural resources, environmental deterioration, and insufficient food to feed the world [37,38]. Moreover, these unhealthy and unsustainable food systems contribute to the death of millions of people from non-communicable diseases, such as type 2 diabetes, cardiovascular diseases, cancer, obesity, neurocognitive disorders, and chronic respiratory diseases [39–41]. Regarding the challenges of the food system, the participants expressed concerns related to unhealthy diets and food environments, over-consumption of ultra-processed food products, economic barriers, lack of food and health education, and a practical approach to food literacy for people of all ages. These concerns are portrayed in the scientific literature, echoing broader discussions about unsustainable food systems and the need for transformation [42–48].

The emphasis placed on food literacy by the participants is consistent with Silva et al. [46], Widener & Karides [49], and Sumner [50], who advocate for integrative education to promote healthier and more sustainable choices. Proper food education is essential throughout all stages of life, since food literacy is a multidisciplinary approach that interconnects knowledge, skills, attitudes, and behaviors, aiming to combat poor health outcomes and to positively impact the food systems and food choices [45,46,49,50].

Participants also identified unhealthy diets and food environments as one of their main concerns. Food environments are defined as the context in which people interact with the food system, which, together with diet and food patterns, influences the food system and people's health. Unhealthy food environments and diets can lead to malnutrition in all its forms, undernutrition, obesity, and nutrient deficiency. Therefore, it is imperative to create effective policies and implement actions to prioritize healthy eating and promote the sustainability of the food system [42,43].

The participants' recognition that multiple actors, namely, governments, educational institutions, health departments, industries, and retail, must collaborate to create healthier and more sustainable food systems aligns with the multi-stakeholder approaches advocated by Zurek et al. [48] and Soria-López et al. [51]. The works by Barbour et al. [52], Bryant et al. [53], Parsons et al. [54], and Miller et al. [55] also highlight the importance and role of local governments, schools, food industries, and the health system in providing opportunities and implementing policies to change unhealthy and unsustainable food systems. Public food procurement is defined as the process of acquiring food products and services by schools and other public institutions. Food procurement plays an essential role in the nutritional quality of the meals served. In Portugal, as in other European countries, food procurement has been recognized as a strategy to promote healthier and more sustainable eating, with policies designed to promote and prioritize local, sustainable, and nutritious food products. However, such policies remain significantly underdeveloped in the Portuguese context [56].

In relation to the abovementioned challenges, participants proposed solutions, such as promoting food literacy and awareness-raising actions, supporting local food production, state support for low-income population and producers, clearer food labels, promoting healthier digital marketing, and implementing community and school gardens. The solutions proposed are consistent with evidence-based strategies. For example, simple and clean food labels have demonstrated measurable influence and impact on consumers' behavior; hence, many countries are implementing mandatory legislation for simple and accessible front-of-package labels [57–59]. Moreover, several studies have shown that school gardens can improve food literacy with a more practical approach and encourage healthy eating, dietary habits, and food knowledge. Fresco [47] also highlights the role of

the state in providing the conditions to support and promote a healthy and sustainable food system.

Several of the solutions suggested have already been supported by scientific literature, which validates their potential effectiveness to promote change towards a healthier and more sustainable food system.

Regarding the transformation of the food system in Portugal towards a more sustainable one, a study by Galli et al. [60] identifies several gaps that compromise that change. In terms of food consumption, the Portuguese population utilizes nearly three times more resources than its available capacity; thus, national and local interventions are essential to address the challenges of the Portuguese food system. Although several awareness and food literacy initiatives exist in Portugal, there is a great need to create projects that lead to action, without requiring a large financial investment. In this sense, CS can play an important role in promoting actions at the community and societal level in order to promote a sustainable change.

A study from 2022 [11] has identified 37 CS projects in Portugal, many of which aimed to promote collective decision-making, primarily among young people. The study shows that Portugal is still in the process of raising awareness and promoting literacy in regard to CS, fostering dialogue between citizens, stakeholders, academic institutions, and government, which is consistent with the lack of experience demonstrated by the participants in this study about this type of methodology.

Nevertheless, there is a continued need to promote CS and to foster the development of action-oriented projects that can lead to systemic and societal change, while ensuring the evaluation of short- and long-term impacts.

5. Conclusions

This pilot study provides insights into how young university students perceive and engage with CS and food system challenges. They have limited awareness of CS, thus confirming the first research Hypothesis (1). In general, citizens are not familiar with the concept of CS and have little experience with projects of this nature. The results indicate a high potential for engagement, particularly when citizens feel that their contributions are relevant and impactful. Knowledge generation and societal change emerged as the main motivators for participation. Participants' perception regarding CS, along with efforts to enhance the understanding of the concept, may contribute to citizen empowerment, which, in turn, can foster a larger participation in CS projects or potentially lead to the creation of projects of this nature by the citizens themselves. The main motivators highlighted by the participants can also constitute a driver to stimulate and promote the use of this type of collaborative methodology to incite societal change.

Participants also identified multiple concerns within the food system, particularly unhealthy diets, lack of food literacy, and the influence of unbalanced food environments, confirming the second hypothesis (which is that challenges related to the current food system are perceived by citizens). They proposed practical and actionable solutions, such as transparent labeling, local food production, and intersectoral awareness campaigns, validating the third hypothesis (which is that citizens are able to propose solutions to the previously presented challenges). These results demonstrate the participants' awareness of the current challenges within the food system, while the focus group methodology encouraged critical thinking regarding these problems and potential solutions and opportunities to overcome them. Several CS projects have been initiated by critical reflection and dialogue among citizens, or collaboration between citizens and academic institutions, thus fostering this type of qualitative methodology to encourage the creation of CS projects.

The solutions presented reinforce the relevance and potential of citizen-led approaches to solving complex food-related issues.

Citizen science emerges as a powerful approach to engage citizens in both scientific inquiry and food system transformation. Its application in educational and community contexts may foster not only scientific literacy but also critical food awareness and civic empowerment.

Nevertheless, this study has clear limitations: the small sample size, restricted to students from one institution, limits generalization. Expanding this research to more diverse demographic groups is essential to capture broader perspectives and to assess the long-term impact of implementing CS methodologies in food and nutrition research. Expanding participation is essential to enhance inclusiveness and support the co-creation of equitable, resilient, and sustainable food systems.

Future research should focus on enabling co-created CS projects that foster collaborative initiatives between citizens, local governments, and stakeholders in the food sector to address several of the identified challenges and contribute to the transformation of the current food system into a more sustainable one. Future CS projects about the food system should explore themes related to circularity, promotion of nutritious and sustainable diets, food safety and security, prevention and reduction in food waste, sustainable rural and farming development, governance of food systems, and food consumption behaviors.

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References

1. Çakmakçi, R.; Salik, M.A.; Çakmakçi, S. Assessment and Principles of Environmentally Sustainable Food and Agriculture Systems. *Agriculture* **2023**, *13*, 1073. [CrossRef]
2. de Sousa, R.; Bragança, L.; da Silva, M.V.; Oliveira, R.S. Challenges and Solutions for Sustainable Food Systems: The Potential of Home Hydroponics. *Sustainability* **2024**, *16*, 817. [CrossRef]
3. Galanakis, C.M. The Future of Food. *Foods* **2024**, *13*, 506. [CrossRef]

4. Notarnicola, B.; Sala, S.; Anton, A.; McLaren, S.J.; Saouter, E.; Sonesson, U. The role of life cycle assessment in supporting sustainable agri-food systems: A review of the challenges. *J. Clean. Prod.* **2017**, *140*, 399–409. [CrossRef]
5. Willett, W.; Rockstrom, J.; Loken, B.; Springmann, M.; Lang, T.; Vermeulen, S.; Garnett, T.; Tilman, D.; DeClerck, F.; Wood, A.; et al. Food in the Anthropocene: The EAT-Lancet Commission on healthy diets from sustainable food systems. *Lancet* **2019**, *393*, 447–492. [CrossRef]
6. Chen, P.J.; Antonelli, M. Conceptual Models of Food Choice: Influential Factors Related to Foods, Individual Differences, and Society. *Foods* **2020**, *9*, 1898. [CrossRef] [PubMed]
7. Ryan, S.F.; Adamson, N.L.; Aktipis, A.; Andersen, L.K.; Austin, R.; Barnes, L.; Beasley, M.R.; Bedell, K.D.; Briggs, S.; Chapman, B.; et al. The role of citizen science in addressing grand challenges in food and agriculture research. *Proc. R. Soc. B Biol. Sci.* **2018**, *285*, 20181977. [CrossRef] [PubMed]
8. Varzakas, T.; Smaoui, S. Global Food Security and Sustainability Issues: The Road to 2030 from Nutrition and Sustainable Healthy Diets to Food Systems Change. *Foods* **2024**, *13*, 306. [CrossRef]
9. Lee, K.A.; Lee, J.R.; Bell, P. A review of Citizen Science within the Earth Sciences: Potential benefits and obstacles. *Proc. Geol. Assoc.* **2020**, *131*, 605–617. [CrossRef]
10. Liu, H.Y.; Ahmed, S.; Passani, A.; Bartonova, A. Understanding the role of cities and citizen science in advancing sustainable development goals across Europe: Insights from European research framework projects. *Front. Sustain. Cities* **2023**, *5*, 1219768. [CrossRef]
11. Alvim, L.; da Silva, A.M.D. Open Access Citizen Science Projects: A (non) reality in Portugal. *Rev. Ibero-Am. Cienc. Da Inf.* **2022**, *15*, 572–591. [CrossRef]
12. Finger, L.; van den Bogaert, V.; Schmidt, L.; Fleischer, J.; Stadtler, M.; Sommer, K.; Wirth, J. The science of citizen science: A systematic literature review on educational and scientific outcomes. *Front. Educ.* **2023**, *8*, 1226529. [CrossRef]
13. Lotfian, M.; Ingensand, J.; Brovelli, M.A. A Framework for Classifying Participant Motivation that Considers the Typology of Citizen Science Projects. *ISPRS Int. J. Geo-Inf.* **2020**, *9*, 704. [CrossRef]
14. Somerwill, L.; Wehn, U. How to measure the impact of citizen science on environmental attitudes, behaviour and knowledge? A review of state-of-the-art approaches. *Environ. Sci. Eur.* **2022**, *34*, 18. [CrossRef]
15. Alfaro-Ponce, B.; Durán-González, R.; Morales-Maure, L.; Sanabria-Z, J. Citizen science as a relevant approach to the challenges of complex thinking development in higher education: Mapping and bibliometric analysis. *Humanit. Soc. Sci. Commun.* **2024**, *11*, 341. [CrossRef]
16. Torán-Pereg, P.; Mora, M.; Vázquez-Araújo, L.; Novoa, S. Citizens driving the transition to sustainable urban food systems. *J. Clean. Prod.* **2023**, *429*, 139571. [CrossRef]
17. Kitzinger, J. Qualitative Research: Introducing focus groups. *BMJ* **1995**, *311*, 299. [CrossRef] [PubMed]
18. Then, K.L.; Rankin, J.A.; Ali, E. Focus group research: What is it and how can it be used? *Can. J. Cardiovasc. Nurs.* **2014**, *24*, 16–22. [PubMed]
19. Wilkinson, S. Focus group methodology: A review. *Int. J. Soc. Res. Methodol.* **1998**, *1*, 181–203. [CrossRef]
20. Bengtsson, M. How to plan and perform a qualitative study using content analysis. *NursingPlus Open* **2016**, *2*, 8–14. [CrossRef]
21. Ahmed, S.K.; Mohammed, R.A.; Nashwan, A.J.; Ibrahim, R.H.; Abdalla, A.Q.; Ameen, B.M.M.; Khdhir, R.M. Using thematic analysis in qualitative research. *J. Med. Surg. Public Health* **2025**, *6*, 100198. [CrossRef]
22. Aivelo, T.; Huovelin, S. Combining formal education and citizen science: A case study on students' perceptions of learning and interest in an urban rat project. *Environ. Educ. Res.* **2020**, *26*, 324–340. [CrossRef]
23. Collins, S.A.; Sullivan, M.; Bray, H.J. Exploring scientists? Perceptions of citizen science for public engagement with science. *J. Sci. Commun.* **2022**, *21*, A01. [CrossRef]
24. Cigarini, A.; Bonhoure, I.; Vicens, J.; Perelló, J. Citizen science at public libraries: Data on librarians and users perceptions of participating in a citizen science project in Catalunya, Spain. *Data Brief* **2022**, *40*, 107713. [CrossRef]
25. Sánchez, F.; Casani, F.; Olmos, R. Public Perception of Citizen Science in Spain: Sociodemographic Analysis. *Rev. Esp. Doc. Cient.* **2024**, *47*, e392. [CrossRef]
26. Celino, I.; Calegari, G.R.; Scrocca, M.; Zamorano, J.; Guardia, E.G. Participant motivation to engage in a citizen science campaign: The case of the TESS network. *JCOM-J. Sci. Commun.* **2020**, *20*, A03. [CrossRef]
27. Mintz, K.K.; Arazy, O.; Malkinson, D. Multiple forms of engagement and motivation in ecological citizen science. *Environ. Educ. Res.* **2023**, *29*, 27–44. [CrossRef]
28. O'Grady, M.; Mangina, E. Citizen scientists—Practices, observations, and experience. *Humanit. Soc. Sci. Commun.* **2024**, *11*, 469. [CrossRef]
29. Fritz, S.; See, L.; Grey, F. The grand challenges facing environmental citizen science. *Front. Environ. Sci.* **2022**, *10*, 1019628. [CrossRef]
30. West, S.; Pateman, R. Recruiting and Retaining Participants in Citizen Science: What Can Be Learned from the Volunteering Literature? *Citiz. Sci. Theory Pract.* **2016**, *1*, 15. [CrossRef]

31. Lüsse, M.; Brockhage, F.; Beeken, M.; Pietzner, V. Citizen science and its potential for science education. *Int. J. Sci. Educ.* **2022**, *44*, 1120–1142. [CrossRef]
32. Füchslin, T.; Schäfer, M.S.; Metag, J. Who wants to be a citizen scientist? Identifying the potential of citizen science and target segments in Switzerland. *Public Underst. Sci.* **2019**, *28*, 652–668. [CrossRef]
33. Strasser, B.J.; Tancoigne, E.; Baudry, J.; Piguet, S.; Spiers, H.; Marquez, J.L.F.; Kasparian, J.; Grey, F.; Anderson, D.; Lintott, C. Quantifying online citizen science: Dynamics and demographics of public participation in science. *PLoS ONE* **2023**, *18*, e0293289. [CrossRef] [PubMed]
34. Pateman, R.; West, S. Citizen Science: Pathways to Impact and why Participant Diversity Matters. *Citiz. Sci. Theory Pract.* **2023**, *8*, 50. [CrossRef]
35. Balázs, B.; Mooney, P.; Nováková, E.; Bastin, L.; Jokar Arsanjani, J. Data Quality in Citizen Science. In *The Science of Citizen Science*; Vohland, K., Land-Zandstra, A., Ceccaroni, L., Lemmens, R., Perelló, J., Ponti, M., Samson, R., Wagenknecht, K., Eds.; Springer International Publishing: Cham, Switzerland, 2021; pp. 139–157.
36. Galanos, C.; Vogiatzakis, I.N. Environmental citizen science in Greece: Perceptions and attitudes of key actors. *Nat. Conserv.* **2022**, *48*, 31–56. [CrossRef]
37. Araújo, R.G.; Chavez-Santoscoy, R.A.; Parra-Saldívar, R.; Melchor-Martínez, E.M.; Iqbal, H.M.N. Agro-food systems and environment: Sustaining the unsustainable. *Curr. Opin. Environ. Sci. Health* **2023**, *31*, 100413. [CrossRef]
38. Holden, N.M.; White, E.P.; Lange, M.C.; Oldfield, T.L. Review of the sustainability of food systems and transition using the Internet of Food. *NPJ Sci. Food* **2018**, *2*, 18. [CrossRef]
39. Cena, H.; Calder, P.C. Defining a Healthy Diet: Evidence for The Role of Contemporary Dietary Patterns in Health and Disease. *Nutrients* **2020**, *12*, 334. [CrossRef]
40. Hutchinson, J.M.; Raffoul, A.; Pepetone, A.; Andrade, L.; Williams, T.E.; McNaughton, S.A.; Leech, R.M.; Reedy, J.; Shams-White, M.M.; Vena, J.E.; et al. *Advances in Methods for Characterizing Dietary Patterns: A Scoping Review*; Cambridge University Press: Cambridge, UK, 2024. [CrossRef]
41. Global Burden of Disease Collaborative Network. *Global Burden of Disease Study 2021 (GBD 2021)*; Institute for Health Metrics and Evaluation (IHME): Seattle, WA, USA, 2024.
42. Fanzo, J.; Rudie, C.; Sigman, I.; Grinspoon, S.; Benton, T.G.; Brown, M.E.; Covic, N.; Fitch, K.; Golden, C.D.; Grace, D.; et al. Sustainable food systems and nutrition in the 21st century: A report from the 22nd annual Harvard Nutrition Obesity Symposium. *Am. J. Clin. Nutr.* **2022**, *115*, 18–33. [CrossRef]
43. Goh, E.V.; Sobratee-Fajurally, N.; Allegretti, A.; Sardeshpande, M.; Mustafa, M.; Azam-Ali, S.H.; Omari, R.; Schott, J.; Chimonyo, V.G.P.; Weible, D.; et al. Transforming food environments: A global lens on challenges and opportunities for achieving healthy and sustainable diets for all. *Front. Sustain. Food Syst.* **2024**, *8*, 1366878. [CrossRef]
44. Madzorera, I.; Jaacks, L.; Paarlberg, R.; Herforth, A.; Bromage, S.; Ghosh, S.; Myers, S.S.; Masters, W.A.; Fawzi, W.W. Food Systems as Drivers of Optimal Nutrition and Health: Complexities and Opportunities for Research and Implementation. *Curr. Dev. Nutr.* **2021**, *5*, nzab062. [CrossRef]
45. McManus, S.; Pendergast, D.; Kanasa, H. The Intersection Between Food Literacy and Sustainability: A Systematic Quantitative Literature Review. *Sustainability* **2025**, *17*, 459. [CrossRef]
46. Silva, P.; Araújo, R.; Lopes, F.; Ray, S. Nutrition and Food Literacy: Framing the Challenges to Health Communication. *Nutrients* **2023**, *15*, 4708. [CrossRef] [PubMed]
47. Fresco, L.O. Challenges for food system adaptation today and tomorrow. *Environ. Sci. Policy* **2009**, *12*, 378–385. [CrossRef]
48. Zurek, M.; Ingram, J.; Bellamy, A.S.; Goold, C.; Lyon, C.; Alexander, P.; Barnes, A.; Bebber, D.P.; Breeze, T.D.; Bruce, A.; et al. Food system resilience: Concepts, issues, and challenges. *Annu. Rev. Environ. Resour.* **2022**, *47*, 511–534. [CrossRef]
49. Widener, P.; Karides, M. Food system literacy: Empowering citizens and consumers beyond farm-to-fork pathways. *Food Cult. Soc.* **2014**, *17*, 665–687. [CrossRef]
50. Sumner, J. Reading the world: Food literacy and the potential for food system transformation. *Stud. Educ. Adults* **2015**, *47*, 128–141. [CrossRef]
51. Soria-Lopez, A.; Garcia-Perez, P.; Carpena, M.; Garcia-Oliveira, P.; Otero, P.; Fraga-Corral, M.; Cao, H.; Prieto, M.A.; Simal-Gandara, J. Challenges for future food systems: From the Green Revolution to food supply chains with a special focus on sustainability. *Food Front.* **2023**, *4*, 9–20. [CrossRef]
52. Barbour, L.R.; Woods, J.L.; Brimblecombe, J.K. Local government policy to facilitate healthy and sustainable diets and the broader policy hierarchy: Insights from Milan Urban Food Policy Pact cities. *Health Res. Policy Syst.* **2023**, *21*, 35. [CrossRef] [PubMed]
53. Bryant, M.; Burton, W.; O'Kane, N.; Woodside, J.V.; Ahern, S.; Garnett, P.; Spence, S.; Sharif, A.; Rutter, H.; Baker, T.; et al. Understanding school food systems to support the development and implementation of food based policies and interventions. *Int. J. Behav. Nutr. Phys. Act.* **2023**, *20*, 29. [CrossRef]
54. Parsons, A.; Spurrell-Huss, E.; Lucan, S.C. How Health Systems Can Promote Healthier Eating. *Ann. Fam. Med.* **2017**, *15*, 583. [CrossRef]

55. Miller, K.B.; Eckberg, J.O.; Decker, E.A.; Marinangeli, C.P.F. Role of Food Industry in Promoting Healthy and Sustainable Diets. *Nutrients* **2021**, *13*, 2740. [CrossRef] [PubMed]
56. Dinis, I.; Guilherme, R. Farm-to-School Programs in Portuguese Low-Density Rural Areas: How to Engage Farmers. *Eur. Countrys.* **2023**, *15*, 18–33. [CrossRef]
57. Araya, S.; Elberg, A.; Noton, C.; Schwartz, D. Identifying food labeling effects on consumer behavior. *Mark. Sci.* **2022**, *41*, 982–1003. [CrossRef]
58. Ljusic, N.; Fagerstrøm, A.; Pawar, S.; Arntzen, E. Effects of digitalized front-of-package food labels on healthy food-related behavior: A systematic review. *Behav. Sci.* **2022**, *12*, 363. [CrossRef] [PubMed]
59. Maruyama, S.; Streletskaya, N.A.; Lim, J. Clean label: Why this ingredient but not that one? *Food Qual. Prefer.* **2021**, *87*, 104062. [CrossRef]
60. Galli, A.; Moreno Pires, S.; Iha, K.; Alves, A.A.; Lin, D.; Mancini, M.S.; Teles, F. Sustainable food transition in Portugal: Assessing the Footprint of dietary choices and gaps in national and local food policies. *Sci. Total Environ.* **2020**, *749*, 141307. [CrossRef]