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EIT Food – Making Food Innovation Happen

Knowledge & Innovation Community on Food - http://www.eitfood.eu

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EIT Food is Europe's leading agri-food innovation initiative, with the aim to create a sustainable and future-proof food sector. The initiative is made up of a consortium of key industry players, start-ups, research centres and universities from across Europe. EIT Food aims to collaborate closely with consumers to develop new knowledge and technology-based products and services that will ultimately deliver a healthier and more sustainable lifestyle for all European citizens.

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1. Introduction

There have been an array of food safety and food fraud incidents in the previous decade that has resulted in trust in the food chain diminishing. Simultaneously, there has been an increase in the globalisation of the food chain, which has had a proliferation effect of low trust in the food industry. Improving consumer trust in the food chain remains a priority for the food industry, in order to achieve this a reliable measure of trust must be developed and tested. This was achieved in a prior EIT funded project and will be implemented in this project. The food chain has many steps, the majority of which are unseen to the consumer, it is therefore important to assess trust in various aspects of the food chain. Trust can easily be negatively influenced by widely reported incidents of fraud or food safety issues, but it can also be positive influenced by increasing knowledge of the systems in place to eradicate the issues.

Trust is defined as an "assured reliance on the character, ability, strength, or truth of someone or something" (Merriam-Webster, 2020). Consumer trust in the food market is imperative for continued growth, minor declines in trust can have major effects, given that food has profound impacts on health. Consumers expect that food is authentic, safe and of a high quality. Several events have resulted in a decline in confidence in the food industry, including the horsemeat scandal, and the Bovine Spongiform Encephalopathy (BSE) outbreak. Processed and ultra-processed foods now form part of many Europeans habitual diet, this increasing trend has left the consumers feeling dissociated from their food (Coveney *et al.,* 2015). Moreover, given the challenge of sustainably producing food to feed a growing population, trust and consumer engagement with food are arguably more important than ever.

Citizen science refers to the involvement of members of the public with a scientific research project, typically the public aids with sample collection, which affords the benefit of including samples from a large geographic region without members of the research team needing to collect the samples. Projects adopting citizen science involvement are increasing, particularly in the area of food research. It has been reported that citizen science projects increase the public's awareness of the diversity of scientific research, improves their knowledge, and provides a deeper meaning to their hobbies (Bonny *et al.,* 2016). There is a paucity of data available into the effect that contribution to a citizen science project has on levels of trust in the food chain. Transparency in the food chain enhances consumer trust, as does enhanced regulation and scrutiny. It is therefore important to include information on several parts of the food chain in any educational programme that aims to influence consumers trust.

Citizen science projects are being utilised to enhance the reach of a project, and to influence the attitude of the participants, no citizen science projects have been conducted that have utilised a large amount of people to collect food samples and attempted to measure the effect on their level of trust that exposing them to educational material has. We aim to measure trust in two groups of citizen scientists, the groups will then participate in a challenge, and we will measure

their trust again. We will also conduct an evaluation of the study using a subset of participants to better understand the participants experience of the challenge.

This report will show the results of the trust measuring developed within the citizen science initiative on food integrity. It includes the trust measuring strategy, the trust measuring activity through questionnaires and the main conclusions obtained. The aim of this study was to determine the effect that participation in a citizen science project has on participants level of trust.

2. Methods

Recruitment, challenge design and content delivered

Two groups of Citizen Scientists were recruited for the initiative. Potential participants must have been based in the UK or Spain, and able to download an app onto a mobile device. The potential participants were invited to download the FitCash App and make an account. Participants based in the UK were invited to download the FitCash app and join the basmati rice fraud challenge, participants based in Spain were invited to download the FitCash app and join the listeria challenge.

The challenge lasted 10 days, during which the citizen scientists were asked to send a sample of food (basmati rice and ready-to-eat food, respectively) to be analysed. The UK based citizen scientists were instructed to purchase 500g or more of basmati rice, and post it to Queens University Belfast, where it would be analysed for authenticity. The citizen scientists based in Spain were instructed to purchase two pieces of cheese or cold meat, remove a slice and post it to AZTI, where it would be analysed for listeria.

Citizen scientists also received information about the food chain, their respective food, and how the samples will be analysed. The content displayed to the citizen scientists on the listeria challenge was primarily animated videos, with a voiceover, the content displayed to the citizen scientists on the rice challenge was a mix of animated videos, infographics, and a presentation with an audio voice over.

Figure 1: Screenshots of some of the content delivered to the participants in the listeria challenge.

Figure 2: Screenshots of some of the content delivered to the participants in the basmati rice challenge

Questionnaire and data analysis

At three timepoints the participants completed questionnaires assessing their levels of trust, four measures of trust were selected from a validated Trust toolkit (Benson *et al.,* 2020). The measures selected were product trust, producer trust, trust in the food chain, and organisational trust. A seven-point Likert scale was used to quantify citizen scientists' level of trust in each of the categories, with 1, indicating a low level of trust, and 7, indicating a high level of trust. Producer

trust refers to how much an individual trusts a specific producer (in this instance manufacturers of cheese/cold meats or basmati rice). Product trust is how much an individual trusts a specific product (in this instance, cheese/cold meats or basmati rice). Food chain trust refers to how much an individual trusts the actors or organisations involved in food production, such as farmers. Organisational trust is how much an individual trusts an organisation that is not directly part of the food chain e.g., European Food Safety Authority, or the World Health Organisation in relation to a specific topic or how much they trust this organisation to perform a specific task related to food, such as food safety regulation.

SPSS version 26 was used for all analysis. Following cleaning and coding of the dataset, a paired T test was used to identify differences between the mean level of trust at baseline and the mean level of trust at the completion of the challenge. An alpha value of 0.05 was set, p values falling below this indicate a significant difference between baseline and endpoint.

3. Results

There was an improvement in mean product trust, producer trust, food chain trust, and organisation trust in citizen scientists following the completion of the **Basmati rice challenge**. This increase was non-significant for all items examined. Participants were asked to rate their trust that basmati rice is high quality, 12 participants (48%) reported a higher response after the challenge, 8 (32%) reported the same response, and 5 (20%) reported a lower response, which increased the trust score from 5.4 to 5.8.

There was a decrease in the mean product trust, producer trust, trust in the food chain, and organisational trust in citizen scientists following the completion of the **Listeria challenge**. On quite a few items, citizen scientists indicated the same response at the completion of the study, and the beginning of the study, however the overall mean still was lower. Participants were asked to rate their level of trust in the quality of their ready-to-eat food (cheese/cold meat), 14 participants (26.41%) indicated a higher response after the challenge, 24 (45.28%) indicated the same response, and 15 (28.30%) indicated a lower response, which decreased the trust score from 5.62 to 5.55.

Table 1, descriptive statistics of participants stratified by challenge

		Rice Fraud Detectives	Listeria Challenge
Gender	Female	64%	75%
	Male	36%	25%
Age	18-29 years	48%	19%
	30-39 years	28%	43%
	40-49 years	16%	28%
	50-59 years	8%	10%
Education	Primary school	N/A	6%
	High school	8%	23%
	Bachelor's degree	36%	19%
	Higher education (not university)	36%	34%
	Master's degree	16%	19%
	PhD	4%	N/A
Children living at home	Yes	68%	53%
	No	32%	47%
How often do you eat rice	Less than once a week	8%	N/A
	Once a week	28%	N/A
	2-3 times a week	36%	N/A
	More than 3 times a week	16%	N/A
	Daily	12%	N/A
How often do you eat "ready-to-eat food" like cold meat (chorizo, spicy sausage), other cold/cured meats like ham and mature/cured cheese	Less than once a week	N/A	2%
	Once a week	N/A	11%
	2-3 times a week	N/A	28%
	More than 3 times a week	N/A	38%
	Daily	N/A	21%

Basmati rice challenge

Citizen scientists that participated in the Basmati rice fraud challenge indicated an improvement in product trust, as shown in figure 3. Participants were asked 7 questions related to product trust.

- When asked to rate their trust that basmati rice is high quality, 12 participants (48%) indicated a higher response after the challenge, 8 (32%) indicated the same response, and 5 (20%) indicated a lower response, which increase the trust score from 5.4 to 5.8.
- When asked to rate their trust that basmati rice is reliable, 11 participants (44%) indicated a higher response after the challenge, 8 (32%) indicated the same response, and 6 (24%) indicated a lower response, which increase the trust score from 5.56 to 5.76.
- When asked to rate their trust that basmati rice is safe, 10 participants (40%) indicated a higher response after the challenge, 9 (39%) indicated the same response, and 6 (24%) indicated a lower response, which increase the trust score from 5.64 to 5.8.
- When asked to rate their trust that basmati rice is trustworthy, 9 participants (36%) indicated a higher response after the challenge, 6 (24%) indicated the same response, and 10 (40%) indicated a lower response, which decreased the trust score from 5.52 to 5.48.

- When asked to rate their trust that basmati rice is authentic, 9 participants (36%) indicated a higher response after the challenge, 7 (28%) indicated the same response, and 9 (36%) indicated a lower response, which decrease the trust score from 5.4 to 5.2.
- When asked to rate their trust that basmati rice is accurately labelled, 11 participants (44%) indicated a higher response after the challenge, 6 (24%) indicated the same response, and 8 (32%) indicated a lower response, which increased the trust score from 4.8 to 5.04.
- When asked to rate their trust that basmati rice is fully traceable back to its origin, 11 participants (44%) indicated a higher response after the challenge, 4 (16%) indicated the same response, and 10 (40%) indicated a lower response, which decreased the trust score from 4.8 to 4.52.

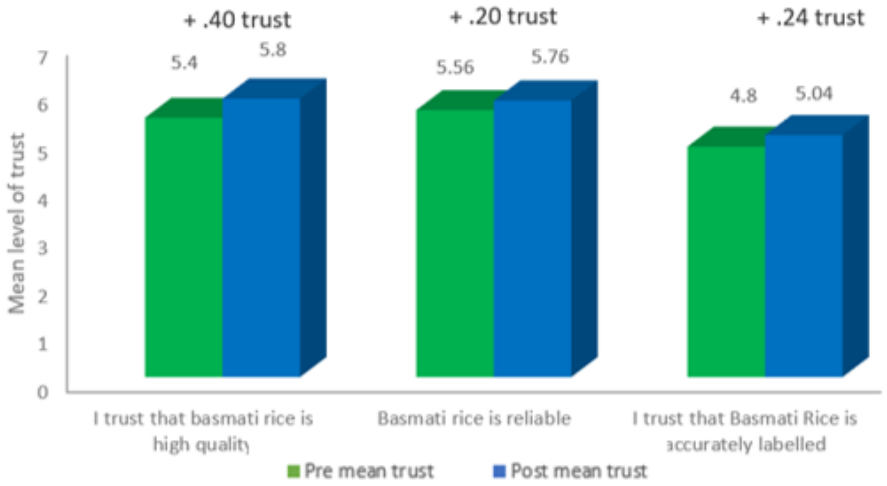

Figure 3: Pre and post mean trust in Basmati rice product

Citizen scientists that participated in the rice fraud challenge indicated an improvement in producer trust, as shown in figure 4. Participants were asked 3 questions related to **producer trust.**

- When asked to rate their trust that basmati rice manufacturers take good care of the safety of our food, 10 participants (40%) indicated a higher response after the challenge, 10 (40%) indicated the same response, and 5 (20%) indicated a lower response, which increase the trust score from 4.84 to 5.0.
- When asked to rate their trust that basmati rice manufacturers give special attention to the safety of our food, 11 participants (44%) indicated a higher response after the challenge, 9 (36%) indicated the same response, and 5 (20%) indicated a lower response, which increase the trust score from 4.88 to 5.12.
- When asked to rate their trust that basmati rice manufacturers have the competence to control the safety of our food, 7 participants (28%) indicated a higher response after the

challenge, 14 (56%) indicated the same response, and 4 (16%) indicated a lower response, which increase the trust score from 4.84 to 5.00.

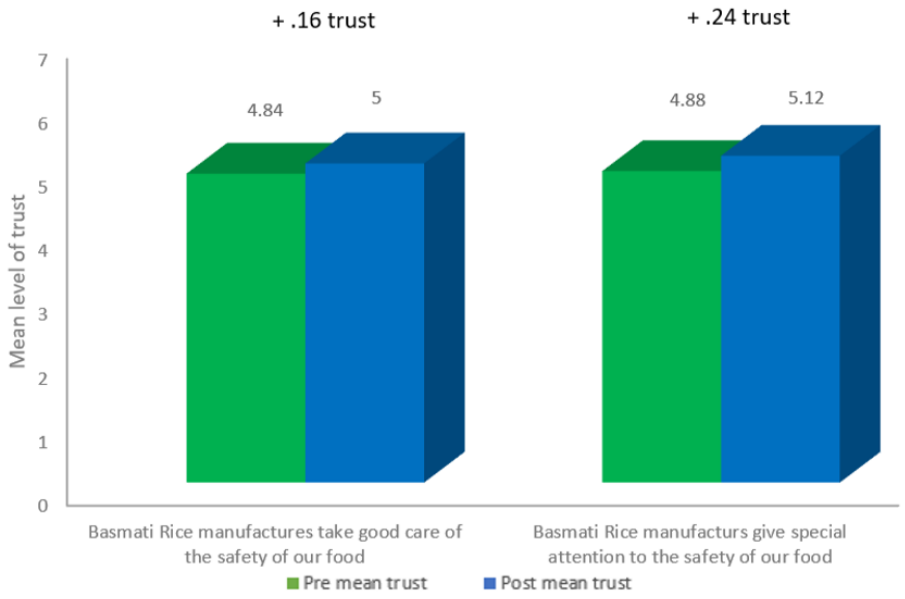

Figure 4: Pre and post mean trust in Basmati rice producers.

Citizen scientists that participated in the rice fraud challenge indicated an improvement in trust in the food chain, as shown in figure 5. Participants were asked 6 questions related to **trust in the food chain**.

- When asked to rate their trust that basmati rice manufacturers give special attention to the quality of food, 10 participants (40%) indicated a higher response after the challenge, 10 (40%) indicated the same response, and 5 (5%) indicated a lower response, which increase the trust score from 5.28 to 5.32.
- When asked to rate their trust that basmati rice manufacturers have competence to control the quality of food, 9 participants (36%) indicated a higher response after the challenge, 11 (44%) indicated the same response, and 5 (20%) indicated a lower response, which increase the trust score from 5.32 to 5.48.
- When asked to rate their trust that basmati rice manufacturers have sufficient knowledge to guarantee the quality of food, 12 participants (48%) indicated a higher response after the challenge, 4 (16%) indicated the same response, and 9 (36%) indicated a lower response, which increase the trust score from 5.24 to 5.40.
- When asked to rate their trust that basmati rice manufacturers are honest about the quality of food, 11 participants (44%) indicated a higher response after the challenge, 7 (28%) indicated the same response, and 7 (28%) indicated a lower response, which increased the trust score from 5.08 to 5.12.

- When asked to rate their trust that basmati manufacturers are sufficiently open regarding the quality of food, 11 participants (44%) indicated a higher response after the challenge, 6 (24%) indicated the same response, and 8 (32%) indicated a lower response, which resulted in the score remaining at 5.00.
- When asked to rate their trust that basmati rice manufacturers can be trusted to protect the consumer from poor quality food, 11 participants (44%) indicated a higher response after the challenge, 5 (20%) indicated the same response, and 9 (36%) indicated a lower response, which decreased the trust score from 5.24 to 5.16.

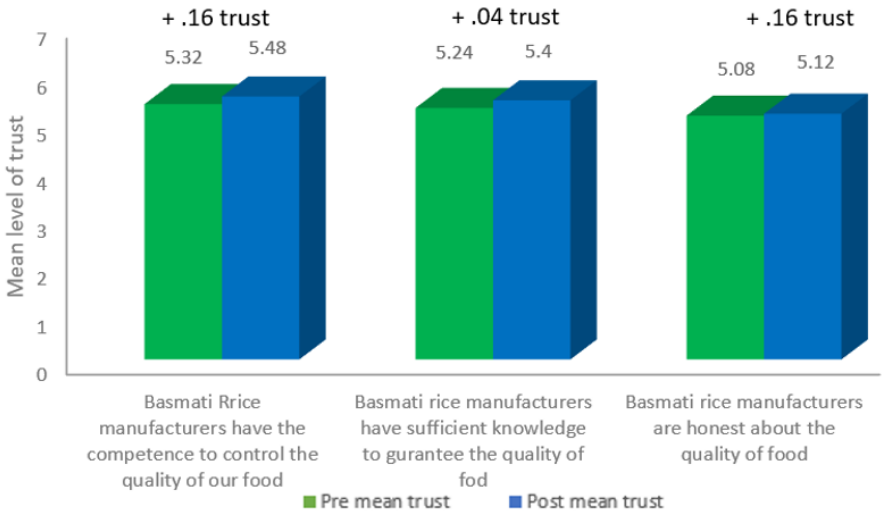

Figure 5: Pre and post mean trust in the food chain (UK Basmati rice fraud challenge).

Citizen scientists that participated in the rice fraud challenge indicated an improvement in **organization trust,** as shown in figure 6. Participants were asked 8 questions related to organization trust.

- When asked to rate their trust that they can count on the European Food Safety Authority, 11 participants (44%) indicated a higher response after the challenge, 6 (24%) indicated the same response, and 8 (32%) indicated a lower response, which increase the trust score from 5.32 to 5.72.
- When asked to rate their trust that they can count on the World Health Organization, 11 participants (44%) indicated a higher response after the challenge, 7 (28%) indicated the same response, and 7 (28%) indicated a lower response, which increase the trust score from 5.40 to 5.64.
- When asked to rate their trust in the European Food Safety Authority, 13 participants (52%) indicated a higher response after the challenge, 2 (8%) indicated the same response, and 10 (40%) indicated a lower response, which increase the trust score from 5.24 to 5.88.

- When asked to rate their trust that the public can always rely on the European Food Safety Authority, 13 participants (52%) indicated a higher response after the challenge, 4 (16%) indicated the same response, and 8 (32%) indicated a lower response, which increased the trust score from 5.24 to 5.76.
- When asked to rate their trust that the public can always rely on the World Health Organization, 13 participants (52%) indicated a higher response after the challenge, 6 (24%) indicated the same response, and 6 (24%) indicated a lower response, which increased the trust score from 5.32 to 5.76.
- When asked to rate their trust that the European Food Safety Authority keep their promises, 13 participants (52%) indicated a higher response after the challenge, 6 (24%) indicated the same response, and 6 (24%) indicated a lower response, which increased the trust score from 5.20 to 5.72.
- When asked to rate their trust that World Health Organization keep their promises, 10 participants (40%) indicated a higher response after the challenge, 6 (24%) indicated the same response, and 9 (36%) indicated a lower response, which increased the trust score from 5.48 to 5.60.

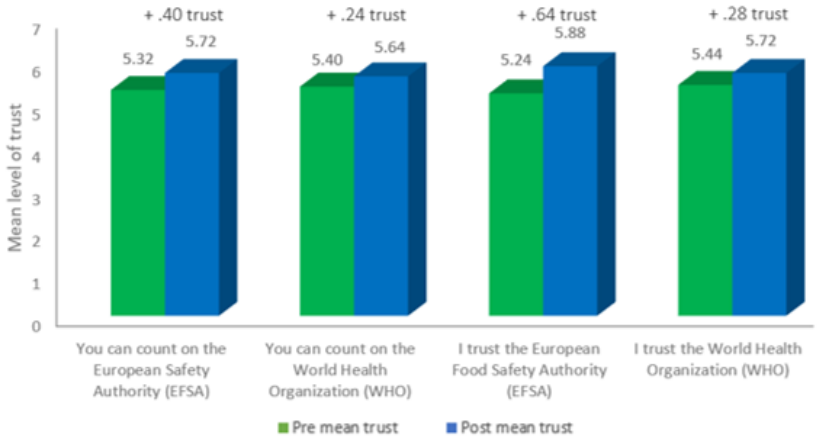

Figure 6: Pre and post mean trust in food safety international organizations.

Listeria challenge

Citizen scientists that participated in the **listeria challenge** indicated a general decline in **product trust**, as shown in figure 7. Participants were asked 7 questions related to product trust.

- When asked to rate their trust that cheese/cold meat is high quality, 14 participants (26.41%) indicated a higher response after the challenge, 24 (45.28%) indicated the same response, and 15 (28.30%) indicated a lower response, which decreased the trust score from 5.62 to 5.55.
- When asked to rate their trust that cheese/cold meat is reliable, 16 participants (30.18%) indicated a higher response after the challenge, 22 (41.50%) indicated the

same response, and 15 (28.30%) indicated a lower response, which increased the trust score from 5.53 to 5.55.

- When asked to rate their trust that cheese/cold meat is safe, 10 participants (18.86%) indicated a higher response after the challenge, 23 (43.39%) indicated the same response, and 20 (37.73) indicated a lower response, which decreased the trust score from 5.94 to 5.62.
- When asked to rate their trust that cheese/cold meat is trustworthy, 12 participants (22.64%) indicated a higher response after the challenge, 19 (35.84%) indicated the same response, and 22 (41.50%) indicated a lower response, which decreased the trust score from 5.81 to 5.55.
- When asked to rate their trust that cheese/cold meat is authentic, 17 participants (32.07%) indicated a higher response after the challenge, 17 (32.07%) indicated the same response, and 19(35.84%) indicated a lower response, which increased the trust score from 5.04 to 5.08.
- When asked to rate their trust that cheese/cold meat is accurately labelled, 18 participants (33.96%) indicated a higher response after the challenge, 20 (37.73%) indicated the same response, and 15 (28.30%) indicated a lower response, which increased the trust score from 5.57 to 5.60.
- When asked to rate their trust that cheese/cold meat is fully traceable back to its origin, 16 participants (30.18%) indicated a higher response after the challenge, 19 (35.84%) indicated the same response, and 18 (33.96%) indicated a lower response, which increased the trust score from 5.09 to 5.11.
- Figure 7: Pre and post mean trust in ready-to-eat food products.

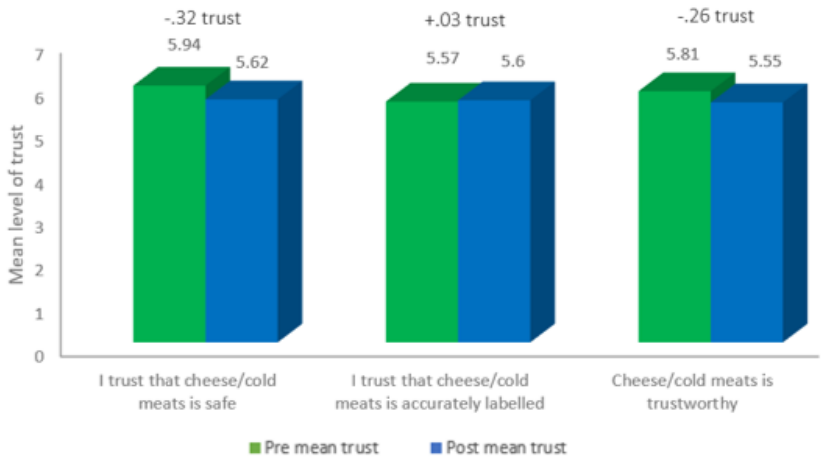

Figure 7: Pre and post mean trust in ready-to-eat food products.

Citizen scientists that participated in the listeria challenge indicated a decline in **producer trust**, as shown in figure 8. Participants were asked 3 questions related to producer trust.

- When asked to rate their trust that cheese/cold meats manufacturers take good care of the safety of our food, 18 participants (33.96%) indicated a higher response after the challenge, 18 (33.96%) indicated the same response, and 17 (32.07%) indicated a lower response, which decreased the trust score from 4.47 to 4.43.
- When asked to rate their trust that cheese/cold meat manufacturers give special attention to the safety of our food, 16 participants (30.18%) indicated a higher response after the challenge, 21 (39.62%) indicated the same response, and 16 (30.18%) indicated a lower response, which decreased the trust score from 5.53 to 5.43.
- When asked to rate their trust that cheese/cold meats are free from listeria, 10 participants (18.86%) indicated a higher response after the challenge, 16 (30.18%) indicated the same response, and 27 (50.94%) indicated a lower response, which decreased the trust score from 6.02 to 5.51.

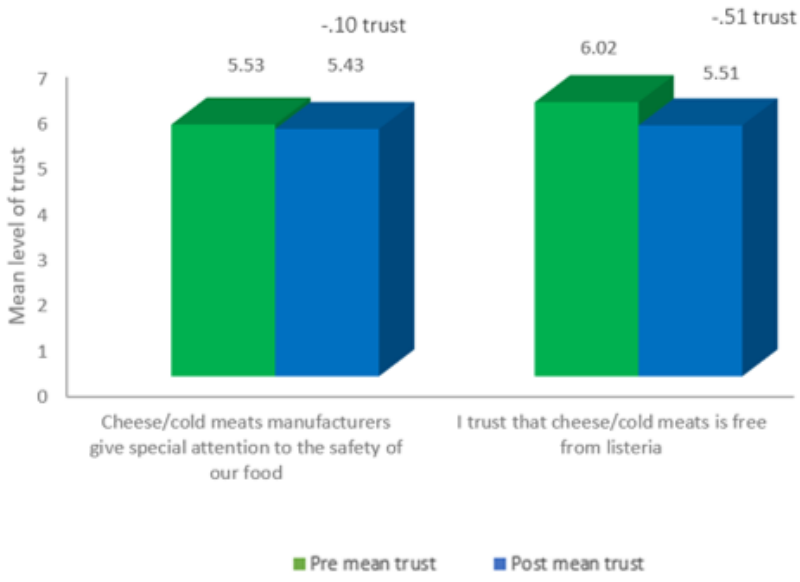

Figure 8: Pre and post mean trust in ready-to-eat food producers.

Citizen scientists that participated in the rice fraud challenge indicated a general decline in **trust in the food chain**, as shown in figure 9. Participants were asked 6 questions related to trust in the food chain.

- When asked to rate their trust that cheese/cold meat manufacturers give special attention to the quality of food, 15 participants (28.30%) indicated a higher response after the challenge, 24 (45.28%) indicated the same response, and 14 (26.41%) indicated a lower response, which decreased the trust score from 5.58 to 5.43.
- When asked to rate their trust that cheese/cold meat manufacturers have competence to control the quality of food, 14 participants (26.41%) indicated a higher response after the challenge, 23 (43.39%) indicated the same response, and 16 (30.18%) indicated a lower response, which decreased the trust score from 5.96 to 5.72.

- When asked to rate their trust that cheese/cold meat manufacturers have sufficient knowledge to guarantee the quality of food, 11 participants (20.75%) indicated a higher response after the challenge, 24 (45.28%) indicated the same response, and 18 (33.96%) indicated a lower response, which decreased the trust score from 5.96 to 5.66.
- When asked to rate their trust that cheese/cold meat manufacturers are honest about the quality of food, 21 participants (39.62%) indicated a higher response after the challenge, 14 (26.41%) indicated the same response, and 18 (33.96%) indicated a lower response, which increased the trust score from 5.17 to 5.25.
- When asked to rate their trust that cheese/cold meat manufacturers are sufficiently open regarding the quality of food, 19 participants (35.84%) indicated a higher response after the challenge, 17 (32.07%) indicated the same response, and 17 (32.07%) indicated a lower response, which resulted in an increased score of 5.19 to 5.21.
- When asked to rate their trust that cheese/cold meat manufacturers can be trusted to protect the consumer from poor quality food, 23 participants (43.39%) indicated a higher response after the challenge, 13 (24.52%) indicated the same response, and 17 (32.07%) indicated a lower response, which decreased the trust score from 4.83 to 4.98.

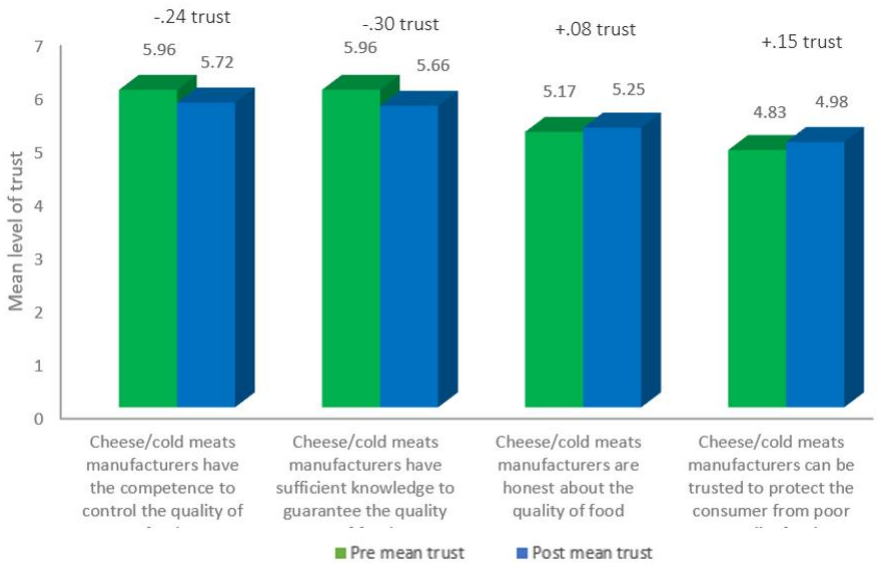

Figure 9: Pre and post mean trust in the food chain (Spain Listeria challenge).

Citizen scientists that participated in the listeria challenge indicated a mixed result in **organization trust,** as shown in figure 10. Participants were asked 8 questions related to organization trust.

- When asked to rate their trust that they can count on the European Food Safety Authority, 16 participants (30.18%) indicated a higher response after the challenge, 26 (49.05%) indicated the same response, and 11 (20.75%) indicated a lower response, which did not change the mean trust value of 5.92.

- When asked to rate their trust that they can count on the World Health Organization, 15 participants (28.30%) indicated a higher response after the challenge, 21 (39.62%) indicated the same response, and 17 (32.07%) indicated a lower response, which decreased the trust score from 5.36 to 5.23.
- When asked to rate their trust in the European Food Safety Authority, 17 participants (32.07%) indicated a higher response after the challenge, 28 (52.83%) indicated the same response, and 8 (15.09%) indicated a lower response, which increased the trust score from 5.77 to 5.92.
- When asked to rate their trust that they can count on the World Health Organization, 12 participants (25%) indicated a higher response after the challenge, 28 (58.33%) indicated the same response, and 8 (16.66%) indicated a lower response, which decreased the trust score from 5.34 to 5.13.
- When asked to rate their trust that the public can always rely on the European Food Safety Authority, 15 participants (28.30%) indicated a higher response after the challenge, 24 (45.28%) indicated the same response, and 14 (26.41%) indicated a lower response, which increased the trust score from 5.68 to 5.75.
- When asked to rate their trust that the public can always rely on the World Health Organization, 15 participants (28.30%) indicated a higher response after the challenge, 21 (39.62%) indicated the same response, and 17 (32.07%) indicated a lower response, which decreased the trust score from 5.09 to 5.06.
- When asked to rate their trust that the European Food Safety Authority keep their promises, 21 participants (39.62%) indicated a higher response after the challenge, 21 (39.62%) indicated the same response, and 11 (20.75%) indicated a lower response, which increased the trust score from 5.38 to 5.64.
- When asked to rate their trust that World Health Organization keep their promises, 17 participants (32.07%) indicated a higher response after the challenge, 19 (35.84%) indicated the same response, and 17 (32.07%) indicated a lower response, which resulted in no change to the mean trust value of 4.92.

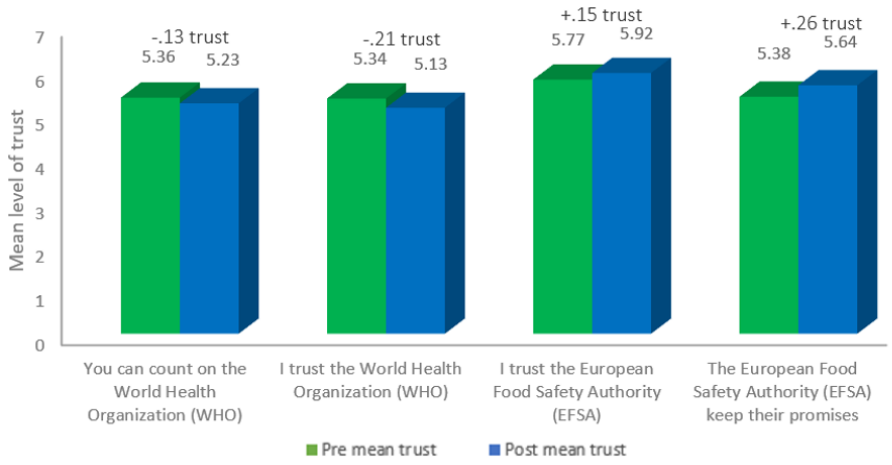

Figure 10: Pre and post mean trust in food safety international organizations.

4. Conclusions

This project aimed to evaluate the effect that participating in a citizen science challenge had on consumer trust in food. Overall, there appears to be a non-significant improvement in trust following the basmati rice challenge, whilst the listeria challenge elicited a slight non-significant decrease in trust. There is a disparity between the effects of the rice fraud challenge and the listeria challenge on measures of trust. In general, participants involved in the rice challenge displayed an improvement in their level of trust, however this was non-significant. The participants involved in the listeria challenge showed no change in their levels of trust and a non-significant decline in many of the items.

There was a difference in the content delivered to both groups, and a difference in the format of the content, it is possible that this disparity impacted upon the results. Furthermore, both challenges did not meet recruitment targets, only 25 participants completed both trust questionnaires on the basmati rice project, and 53 completed both trust questionnaires on the listeria challenge. Previous research has shown that consumers have a high level of expectation in food safety, and food authenticity. The consequences of poor food safety have been highlighted by numerous high-profile incidences, some which resulted in fatalities. Whilst there has been increasing number of food fraud cases, their outcome has not been fatal. Therefore, increasing citizen scientist's knowledge of food safety may lead to concern for their health, whilst increasing their knowledge of food fraud may lead to concern that they are being deceived. Increasing the publics involvement in food related science enhances their knowledge, but also serves as a reminder of how vulnerable the food chain is to manipulation. Future challenges should include more information on the role of regulatory bodies in preventing fraud and enforcing food safety standards.

It is possible that both challenges taught participants about concepts they were previously unaware of, and whilst the fraud challenge raised concerns about being deceived, the listeria challenge may have raised concerns about adverse health events. This may have potentially impacted upon their level of trust. No measure better illustrates this than the question "listeria can be a deadly disease", prior to the challenge only 66% of participants believed this to be true, and post challenge 83% of participants believed this to be true. Steps were taken to mitigate the risk of concerning the citizen scientists, they were given information on ways to prevent the growth of listeria, *i.e.* washing hands, and cooking using temperatures above 65ºC. The existing literature suggests that to improve consumers trust, the consumer must believe that the service provider has expertise in their product (Frewer and Miles, 2003) integrity, displays openness and honesty (Connolly and Bannister, 2007). Future challenges could include virtual tours of food factories, and interviews with those involved in developing products, and ensuring quality in products. A further consideration is the complexity of the food chain, this has been suggested to have had an adverse effect on consumer trust (Giampietri *et al.,* 2018). Food manufacturers have introduced high levels of automation, which has resulted in a sophisticated efficient food chain that is globalised, this has served to distance consumers from processing methods. There has also been a literal distance from food manufacturers, as there has been an increase in urban

dwelling, whilst food processing and manufacturing tends to be completed in rural areas. Collectively, these two factors have decreased knowledge of food processing, which has subsequently decreased trust in the food chain (Giampietri *et al.,* 2018). Therefore, future challenges should education the citizen scientists on specifics about food processing.

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