Exploring the chopping board microbiome – lessons learned.

Part of the Citizen Science for Food Standards Challenges Funding Call

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Contents

Executive Summary

Background

Household surfaces are a well-known source of bacterial contamination, with ~40% of outbreaks of foodborne infections in Europe occurring at home. Whilst disease-causing bacteria may arrive in the home in contaminated food, it is also likely that many disease outbreaks are caused by poor hygiene and cross-contamination from raw food. A key site of such microbial contamination is chopping boards.

Methodology

Participants were invited to cocreate sampling and analysis through workshops. Sampling was mainly designed with ambassadors (Aston students with an interest in the project) with input from their contacts and analysis through ambassadors and participants who attended the laboratory sessions. A sampling kit was developed for ease of use by untrained participants, including swabs (sponges), templates to ensure consistency of sampling and a secure bag in which to return the samples. Once samples were returned to the lab, ambassadors and participants tested them for growth on various agars using cocreated approaches. We had interest from 45 student ambassadors and ~30 of these were actively engaged with aspects of the project. Ambassadors undertook further participant recruitment from their personal contacts and households. Due to attrition during the project, we ended up with 25 samples that were tested.

Key Findings

A total of 25 chopping boards were sampled to evaluate the presence of key foodborne disease-causing bacteria and bacteria originating from the human gut or skin. Out of all chopping boards included in this study, gut bacteria were present on 44% and skin bacteria were present on 52%. Both gut and skin bacteria were isolated from 24% of chopping boards, and 28% of chopping boards harboured neither skin nor gut bacteria.

Outcomes of and Reflections on Citizen Science

Reflecting on the goals we set in our evaluation framework, we can say that we partially achieved our aims. Our success was primarily hindered by the timeline for the project slipping with cyclical ethical approval due to co-creation taking longer than expected. This

meant that the bulk of collection slipped to the summer where fewer students were around and reduced participation levels. It would be good to consider wider sector approaches to dealing with such ethical approvals, and to consider the funding duration of such projects to build in time for true cocreation. The participants certainly benefited from the project, but the breadth and depth of involvement was hindered.

Conclusions

Microbiologcial sampling appears to be an area ripe for citizen science and this project will pave the way to a model of cocreated projects where citizens are involved at all stages and get maximal benefit from this approach.

Background

Household surfaces are a well-known source of microbiological contamination with ~40% of outbreaks of foodborne infections in Europe occurring at home [1]. Whilst pathogens may arrive in the home in contaminated food, it is also likely that many disease outbreaks are caused by poor hygiene and cross-contamination from raw food e.g. *Campylobacter* and *Salmonella* from poultry [2,3]. A key site of such microbial contamination is chopping boards [4]. In this project, we will gain an in-depth understanding of the behaviours around chopping board use and the effects on the associated microbiome. Whilst this has been studied previously, most investigations are conducted under the supervision of researchers e.g. [5] which can lead to changes in participant behaviour. Furthermore, these studies risk only engaging "easy-to-reach" groups with traditionally high participation rates. In the UK, a recent citizen science project worked with a very small group of 14 households to investigate household contamination via molecular approaches eventually co-creating some experiments [6]. However, this again does not address the issue of hard-to-reach communities who may have good practice, or undocumented challenges, in the areas of food hygiene [7].

Aston University has an unusual demographic where 68% of our students identify as minority ethnic (ME) [8]. This is truly representative of our local community. The School of Biosciences has ~700 students across a range of programmes with microbiology being a core discipline. We leveraged our student community as ambassadors to provide us access to two traditionally hard-to-reach groups: ME communities and multioccupancy households (accommodation). This approach ensured that approaches and materials are appropriate for, and sensitive to, our participants. The aim was to target two communities:

1. **ME communities, especially older female participants** who are traditionally under-represented in citizen science projects [10]. Many of our ME students live at home, often in multigenerational households. Engaging our students as ambassadors will allow privileged access into homes and reach these often-underrepresented groups effectively.
2. **Multioccupancy student households.** Those students who do not live at home will traditionally live in student housing with multiple other people, often living away from home for the first time. This provides a real challenge in terms of hygiene and could provide a clear intervention point to improve education and practice for

these lifelong learners (and educators).

Aims and Objectives

The overall aim is to use citizen science approaches to characterise the chopping board microbiome, with a focus on hard-to-reach communities.

The specific objectives of this project are to:

1. Recruit citizen scientists via our students as ambassadors to their households.
2. Co-create methods for sampling bacteria from chopping boards and gathering behavioural observations with our citizens and ambassadors.
3. Deploy these methods to collect data on behaviour and contamination.
4. Enumerate and identify the bacteria present and determine their antimicrobial resistance (AMR) profiles, providing opportunities for ambassadors and citizens to perform lab research.
5. With our ambassadors and citizens, co-design and disseminate educational materials on food hygiene tailored to our target communities and based on the findings of the study. Disseminate the findings of the study to scientific communities.
6. Evaluate the outcomes of the project.

Definition of citizen science

The ‘citizen science for food standards challenges’ required projects to ‘be a collaboration between researchers, a specific group of citizens and, where appropriate, relevant partners from outside academia’ and for citizens and partners to be involved in co-creating the projects. The FSA and UKRI provided the following documents as a guide:

- ECSA’s **ten principles of citizen science (PDF, 193KB)**
- **ECSA characteristics of citizen science**
- the recent FSA publication **citizen science and food: a review**.

In this project, we used citizen science methodology in the following ways. Our team of scientists, led by our Project Manager, co-created a chopping board sampling and survey methodology with one group of citizens: our student ambassadors. This team of student ambassadors then guided a second group of citizen participants recruited from their

households in collecting samples and completing an associated survey. The student ambassadors were then further engaged in laboaratory analysis of samples, data analysis and interpretation of results.

Methodology

Participants were invited to cocreate sampling and analysis through workshops. Sampling was mainly designed with ambassadors with input from their contacts and analysis through ambassadors and participants who attended the laboratory sessions. A sampling kit was developed for ease of use by untrained participants, including swabs (sponges), templates to ensure consistency of sampling and a secure bag in which to return the samples. The full sampling process was documented as a set of instructions that can be found in Annex 1. Once samples were returned to the lab, ambassadors and participants tested them for growth on various agars using cocreated approaches. The full testing protocol can be found in Annex 2. Various media were selected to allow enumeration of microbes and putative identification of common pathogenic organisms, some of which are common gut organisms e.g. *Enterococcus* and coliforms:

- Blood agar plates – enumeration of microbes.
- Campylobacter Blood Free CCDA agar plates – selection of a common pathogen.
- Mannitol Salt agar plates – selection of some Gram positives e.g. *Staphylococcus*, *Enterococcus* and *Micrococcaceae*.
- Tryptose Sulfite Cycloserine agar plates – isolation of *Clostridium perfringens*.
- Violet Red Bile Glucose agar plates – selection of coliforms.

Statistical tests were conducted using GraphPad Prism.

Citizen Scientist profile and recruitment

We had interest from 45 student ambassadors across the College of Health and Life Sciences at Aston University, with a core from the Biosciences disciplines. Approximately 30 of these were actively engaged with aspects of the project. Ambassadors were recruited through announcements via our virtual learning environment (Blackboard) to ensure an unbiased approach and, from there, via word of mouth between students. Further to this, “shout outs” were done in microbiology focussed lectures across all stages of study at Aston. Amabassadors registered by email with the project manager and their details were securely stored throughout the project.

Ambassadors undertook further participant recruitment from their personal contacts and households.

Ethics

Ethical approval was obtained through Aston University's Research Ethics Committee. An initial ethical approval application was submitted for work with the Ambassadors, including recruitment and participation. Further to this, additions to the application were made to cover participant recruitment and involvement of all parties in the sampling, testing and dissemination elements of the project. As standard, ethical approval was granted before any active work on the project began. We note that, due to a restructure in Aston processes, this took longer than expected and impinged on the time available to conduct the main study. Ethical approval was given on 24/2/22 with project number 1851; full details can be provided on request. Data sharing agreements were established between institutions to provide reassurance over data use with due consideration of GDPR.

Evaluation

The project team developed an evaluation framework (Annex 4). We started by articulating our goals for the project under three themes:

(1) For science: to develop an **unbiased**, in depth understanding of the behaviours around chopping board use by previously understudied groups (minority ethnic groups; households of multiple occupancy) and the effects of these behaviours on the associated chopping board microbiome
(2) For participants: To meaningfully engage traditionally underrepresented groups in citizen science (minority ethnic groups; women; women from minority ethnic groups) and for student participants to develop a greater understanding of, interest in and skills related to science (including microbiology and citizen science) and the scientific process
(3) For wider society: For communities to implement safe food hygiene practices, in particular around chopping board use and to develop a blueprint for future larger scale studies of this kind (key features: co-created, microbiology, underrepresented groups, student ambassadors)

These goals were used these to develop our desired outcomes for the project. Outcomes are more specific and measureable than goals and some goals have more than one outcome. Our outcomes were used to define the activities and outputs needed to achieve them.

Finally, we developed indicators to measure our success in achieving these outcomes and described the methods we would use to measure these indicators. Our primary methods for evaluation were:

(1) A pre- and post-participation survey with our student ambassadors to measure changes in metrics such as confidence in talking about science and desire to pursue a career in science.
(2) A pre- and post-participation focus group with student ambassador to explore ambitions for and outcomes from their participation in the project in more depth.
(3) A post-participation survey with our citizen participants to assess their experience with the project and any influence the project had to, for example, behaviours related to kitchen hygiene.
(4) Ongoing internal evaluation within the scientific team to capture reflections on what was going well, challenges and lessons learnt relating to our methodology.

Alignment with citizen science principles

Principle 1: Citizen science projects actively involve citizens in scientific endeavour that generates new knowledge or understanding. Citizens may act as contributors, collaborators, or as project leader and have a meaningful role in the project.

Our project actively involved two groups of citizens. Our student ambassadors were deeply engaged throughout all stages of the project whereas our citizen participants were engaged only as contributors at the data collection stage. However they were actively engaged at this stage as they were collecting samples and completing surveys.

Principle 2. Citizen science projects have a genuine science outcome.

Our project aimed to add to the understanding of the microbes present on choppings boards and the factors affecting this including the composition of the board and the behaviour of the user. Our project aimed to extend the existing knowledge by obtaining this information from previously understudied groups.

Principle 3. Both the professional scientists and the citizen scientists benefit from taking part.

As outlined in the evaluation section above, we had clear aims for both the professional scientists in the project (e.g. publication of research outputs), the student ambassadors (gaining scientific skills, confidence and experience) and our citizen participants (tailored information about kitchen hygiene best practice).

Principle 4. Citizen scientists may, if they wish, participate in multiple stages of the scientific process.

Student ambassadors had the chance to select one or more of many stages of the scientific process (project design, data collection, laboratory analysis, data analysis, dissemination) to take part in. Citizen participants were primarily engaged in the data collection phase although we aimed to also offer them the opportunity to take part in laboratory processing and analysis of samples.

Principle 5. Citizen scientists receive feedback from the project.

Feedback was provided through an end of project report which included results of the project and kitchen hygiene advice. An example is provided in Annex 3.

Research Findings

We did not collect demographic information from our ambassadors but, anecdotally, they were representative of our student body (~70% BME, ~65% female). Due to attrition during the project, we ended up with 25 samples that were tested. Again, the profile of participants at this stage was reflective of our student body.

Chopping board results: Whole project overview

Below are the results collected using all of the chopping board samples received for this project:

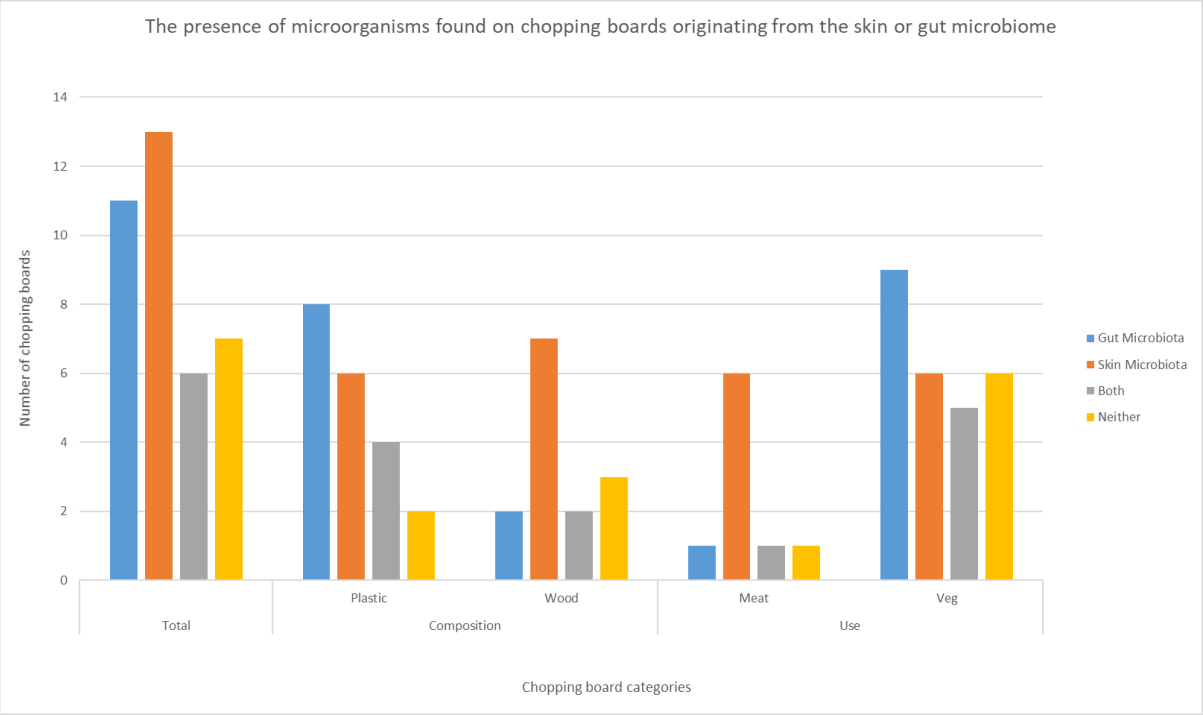


Figure 1 The abundance of gut and skin microbiota isolated from 25 chopping boards, separated to show the effect of chopping board composition and use on the presence of these microorganisms.

A total of 25 chopping boards were sampled to evaluate the presence of key foodborne pathogens and organisms originating from the human gut or skin microbiome. Out of all chopping boards included in this study, gut microbiota were present on 44% and skin microbiota were present on 52%. Both gut and skin microbiota were isolated from 24% of chopping boards, and 28% of chopping boards harboured neither skin nor gut microbiota.

The composition of the chopping board was assessed to investigate its effect on the chopping board microbiome (Table 1). There was a significant association between the composition of the chopping board (plastic or wood) and the abundance of bacteria isolated (Chi square 11.151, $p<0.05$). Gut microbiota were present on 66.67% of plastic and 20% of wooden chopping boards. Skin microbiota were present on 50% of plastic and 70% of wooden chopping boards.

Composition	Abundant	Common	Frequent	Occasional	Rare	None
Plastic	2	2	5	4	6	5
Wood	5	1	1	2	11	0

Table 1: Effect of chopping board composition on bacterial abundance.

Whether the chopping board was used for meat or vegetables was also significantly associated with bacterial abundance (Table 2; Chi square 13.819, $p<0.02$). Gut microbiota were present on 14.2% of the chopping boards that were used for meat and 58% of those that were used for vegetables; this may be indicative of the care with which people clean after meat compared to vegetables. Skin microbiota were present on 85.71% of the chopping boards that were used for meat and 35.29% of those that were used for vegetables.

Use	Abundant	Common	Frequent	Occasional	Rare	None
Meat	6	1	0	1	5	1
Vegetables	1	2	6	5	10	6

Table 2: Use of chopping board and its effect on bacterial abundance.

Outcomes of and Reflections on Citizen Science

Reflecting on the goals we set in our evaluation framework, we can say that we partially achieved our aims. Our success was primarily hindered by the timeline for the project slipping. This was because of the very long time it took to obtain ethical approval for the project and, due to the co-created nature of the project, needing to go back through

ethics review once we had co-designed our final methodology with our student ambassadors. Unfortunately this slippage had significant implications for our project. Instead of being able to carry out the main data collection phase of the project during the spring term when most students are around and regularly coming into the university campus, it was delayed until the summer term when regular teaching has reduced and so students are less present on campus and also when students are focused on their exams. Unfortunately this meant that fewer students were available to support citizen participants with data collection. This limited the number of samples we collected and so the conclusions we were able to draw. This was disappointing. However, we have been able to provide a proof of concept for this model of citizen science project.

Reflecting on each of our project goals:

(1) **For science: To develop an unbiased, in depth understanding of the behaviours around chopping board use by previously understudied groups (minority ethnic groups; households of multiple occupancy) and the effects of these behaviours on the associated chopping board microbiome**
Unfortunately because of the challenges outlined above and the relatively small number of samples that were collected we cannot say that we added to the scientific understanding here. As stated above, however, we have demonstrated that citizen science is a useful methodology for collecting this sort of data and so our study acts as a proof of concept.

(2) **For participants: To meaningfully engage traditionally underrepresented groups in citizen science (minority ethnic groups; women; women from minority ethnic groups) and for student participants to develop a greater understanding of, interest in and skills related to science (including microbiology and citizen science) and the scientific process.**
Unfortunately we had a very low response rate to our post-participation evaluation survey from our citizen participants. As such we are not sure whether we engaged our target groups and we were unable to capture these participants reflections on their participation in the project. Similarly, despite 30+ students responding to the pre-participation questionnaire, only 3 responded to the post-participation version meaning we were unable to capture changes in scientific skills, confidence etc. However, a focus group run at the end of the project with three student ambassadors revealed their reflections on what they gained from taking part. This was primarily related to getting hands on experience which they saw as a really

valuable addition to the activities they engage in as part of their degree, particularly as lab experience had been limited at times due to the pandemic. They reflected that the more informal setting and smaller groups meant they felt more comfortable to ask questions and that this had in turn built their confidence. They reported applying the learning from within the project to other parts of their degree. They also commented that they had gained skills that they could put on their CV and talk about in interviews and for one student, who already had an interest in research, the experience further revealed their interest in research and their desire to pursue this as a career.

(3) For wider society: For communities to implement safe food hygiene practices, in particular around chopping board use and to develop a blueprint for future larger scale studies of this kind (key features: co-created, microbiology, underrepresented groups, student ambassadors) While we were not able to extend the existing kitchen hygiene advice through learnings from the project, we were able to share this existing advice with participants. We have also shown the potential of using citizen science in the field of microbiology and to use co-created citizen science approaches with university students. We are currently developing an academic paper to share these learnings with the microbiology and citizen science research communities.

Conclusions and Implications

Overall, our key scientific findings are that:

- Out of all chopping boards included in this study, gut microbiota were present on 44% and skin microbiota were present on 52%. Both gut and skin microbiota were isolated from 24% of chopping boards, and 28% of chopping boards harboured neither skin nor gut microbiota.
- There was a significant association between the composition of the chopping board (plastic or wood) and the abundance of bacteria isolated. Gut microbiota were present on 66.67% of plastic and 20% of wooden chopping boards. Skin microbiota were present on 50% of plastic and 70% of wooden chopping boards.
- Whether the chopping board was used for meat or vegetables was also significantly associated with bacterial abundance. Gut microbiota were present on

14.2% of the chopping boards that were used for meat and 58% of those that were used for vegetables. Skin microbiota were present on 85.71% of the chopping boards that were used for meat and 35.29% of those that were used for vegetables.

Overall, our key learnings about using citizen science approaches have been:

- There was huge enthusiasm for the student population at the beginning of the project. This and the feedback from the end of project focus group revealed the potential for citizen science as a tool for deepening students' engagement with and enthusiasm for science. Feedback indicates that participation only dropped off because of the slippage in our timeline into the summer term.
- Significant time and resources are needed to effectively run citizen science projects. We employed a fantasitic Project Manager but only for two days a week for 7 months. Having someone dedicated to the project and being the point of contact for students was invaluable but having more of her time for longer would have been preferable.
- Challenges arise from using co-created methods, in particular the uncertainty this brings to a project. This method adds time to a project timeline and a need for flexibility which can't be planned for and this can be difficult when there are external constraints that can't be changed.

Bibliography

[1] https://doi.org/10.2903/j.efsa.2019.5926

[2] https://doi.org/10.1017/S0950268811002676

[3] https://doi.org/10.1017/S0950268811002172

[4] https://doi.org/10.1093/jaoac/89.2.538

[5] https://doi.org/10.1016/j.ijfoodmicro.2021.109172

[6] https://doi.org/10.1042/BIO03903035

[7] https://old.food.gov.uk/

[8] https://www2.aston.ac.uk/

Annex 1: Sampling method

Exploring the chopping board microbiome: Sampling protocol

Sampling kits contents:

- Hydrated sponges x 5
- Swabbing templates – 5 x 5 cm sampling standard x 5
- Gloves
- Information leaflet – easy to follow instructions

Preparation of the sample

Place the chopping board on a flat surface and remove contents of sampling kit. Wear the gloves included in the sampling kit before continuing, remove sampling template and place in the centre/ main area of use of the chopping board.

Sampling the chopping board

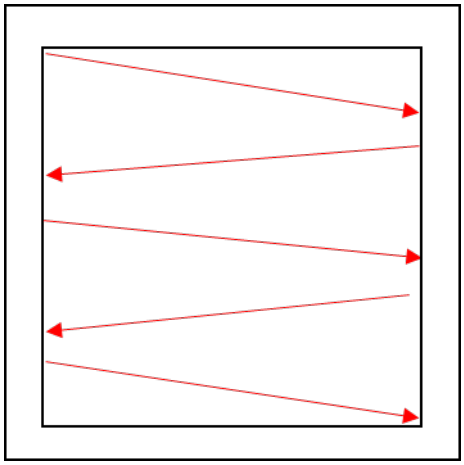


Figure 1 Diagram illustrating horizontal sampling technique.

Remove the hydrated sponge from the packaging, ensuring not to squeeze to all retention of neutralising buffer. Begin sampling by swabbing inside the template. Starting at the top left corner of the template and moving horizontally down the sampling area five times to end in the bottom right corner.

Alternate the side of the sponge to now use the other side as a fresh surface to sample the chopping board and begin vertically swab inside the template, starting at the top left

of the template swabbing vertically across the sampling area five times to end at the bottom right corner.

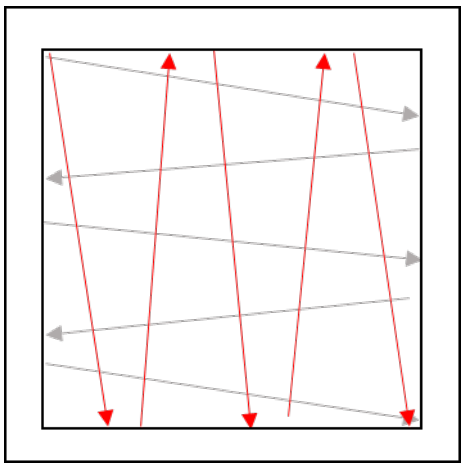


Figure 2 Diagram illustrating vertical sampling technique.

Storage and transport of the sample

Insert the swab back into the packaging and seal the bag. Store the sealed sample in the fridge until transport.

Sample must be taken to the laboratory for testing within 24 hours of sample collection, to ensure maximum yield of microbiome.

If participant lives nearby Aston University samples may be transferred in their own bag. Participants who require to travel longer to the University will be provided with a cool bag to transport the sample to the laboratory.

Experimental replicates of chopping board samples

Place a new sampling template on another area of the centre of the chopping board and begin sample collection with a new hydrated sponge following the sampling method. Repeat the process once more to give three samples collected from the centre of the chopping board.

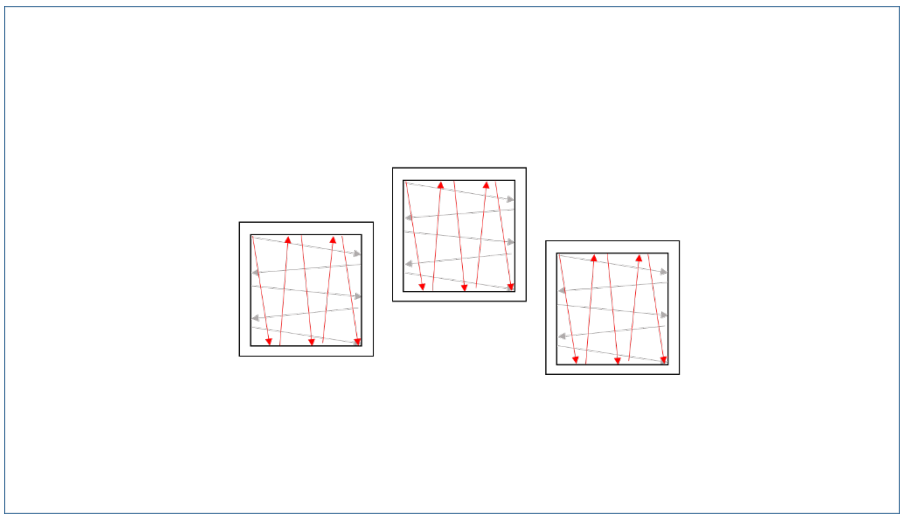


Figure 3 Diagram highlighting experimental replicates for the samples conducted on the centre of the chopping board.

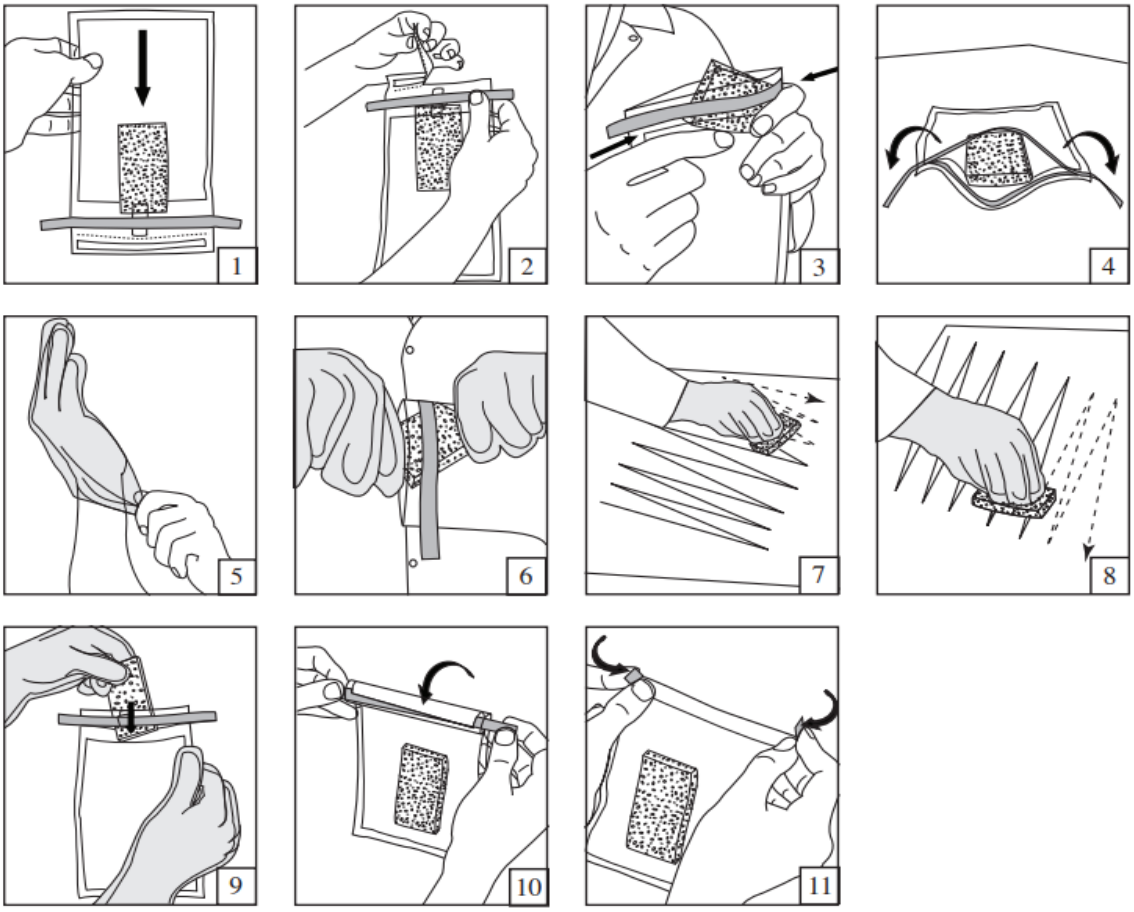
Sampling the corners of the chopping board

Place new sampling template on the top left corner of the chopping board, ensuring that the sampling area reaches the edge of the chopping board. Using a new hydrated sponge begin the sampling method again.

Place the final sampling template to the bottom right corner of the chopping board, ensuring that the sampling area inside the template reaches the edge of the chopping board. Use the final hydrated sponge to sample the area.

Figure 4 Diagram highlighting experimental replicates for edge samples of the chopping board.

Instructions for opening and closing sample bag



1. Shake sponge to end of bag.

2. Tear bag open.

3. Push sponge to extend from bag.

4. Bend blue wires, using red tags to form open bag.

5. Put on gloves.

6. Remove sponge.

7. Sample chopping board following the **sampling protocol provided.**

8. Continue to follow **sampling protocol.**

9. Place sponge back into the same bag.

10. Fold bag to close.

11. Fold ends of blue wires inward.

Annex 2: Plating protocols

Spread plate protocol

Station checklist:

- Blood agar plates x10
- Campylobacter Blood Free CCDA agar plates x5
- Mannitol Salt agar plates x5
- Tryptose Sulfite Cycloserine agar plates x5
- Violet Red Bile Glucose agars plate x5
- Woodstick Hygiene Swabs x30
- Bunsen Burner
- Waste bin

Experimental set up:

1. Before you start ensure you are wearing your lab coat and gloves
2. Remove the sample sponges from your sample kit and number your sponges: **M1, M2, M3, E1, E2**
    a. ***This will allow us to keep the agar plates grouped correctly once they have been incubated, and ensure we keep each replicate to the correct chopping board sample***
3. Group agar plates for each sample to be tested:
    a. **Per sample sponge ensure you have:** ***(you should have <u>five sets</u> per sample kit, one for each sample sponge)***
        i. **Blood agar plates x2**
        ii. **Campylobacter Blood Free CCDA agar plate x1**
        iii. **Mannitol Salt agar plate x1**
        iv. **Tryptose Sulfite Cycloserine agar plate x1**
        v. **Violet Red Bile Glucose agar plate x1**
4. Label the agar plates
    a. **Label the back of the agar plate (*Not on the lid, if the lids are only labelled and they are mixed up/knocked over we will no longer know which sample kit the agar plate belongs to)***

i. **Around the edge of the plate write: the date, sample kit number, sponge number e.g. 21/06/22, Kit1, M1**
    1. **Select one of the Blood agar plates and write: <u>Anaerobic</u> on one and <u>Aerobic</u> on the other**

5. Once you are ready to start, light your Bunsen burner using the electric lighter provided
    a. **Ensure the gas tap connected to the Bunsen burner is turned on**
    b. **If you do not wish to light your own Bunsen burner or are having issues lighting it, request assistance and it will be lit for you**

Streak plate protocol

6. Select one of your chopping board sample sponges and ensure you have the corresponding agar plates. While the sponge is still secure in its bag, move the sponge up to the top and squeeze the sponge to remove as much liquid as possible from the sponge to be collected into the bottom of the bag. Carefully open the bag and keep the sponge in the bag but away from the collected liquid at the bottom of the bag
7. Insert a sterile swab into the liquid at the bottom of the sample bag and begin to transfer the sample onto a selected agar plate. Starting in the centre of the agar plate and move vertically across the left side of the agar plate, ending at the left end of the agar plate (Figure 1A)
    a. Rotate the swab to use a previously unused surface area of the swab and transfer the remaining sample on the sponge onto the right side of the agar plate, starting from the centre and vertically moving across the right side of the plate (Figure 1B)
    b. Alternate the swab and starting from the centre, horizontally move the swap up to the end at the top of the agar plate (Figure 1C)
    c. Rotate the swab once more and from the centre of the agar plate, horizontally swab down the agar and end at the bottom of the agar plate (Figure 1D)
8. Repeat spread plate technique (Figure 1) for each agar plate required for the sample sponge

9. Repeat process for each sample sponge in sample kit

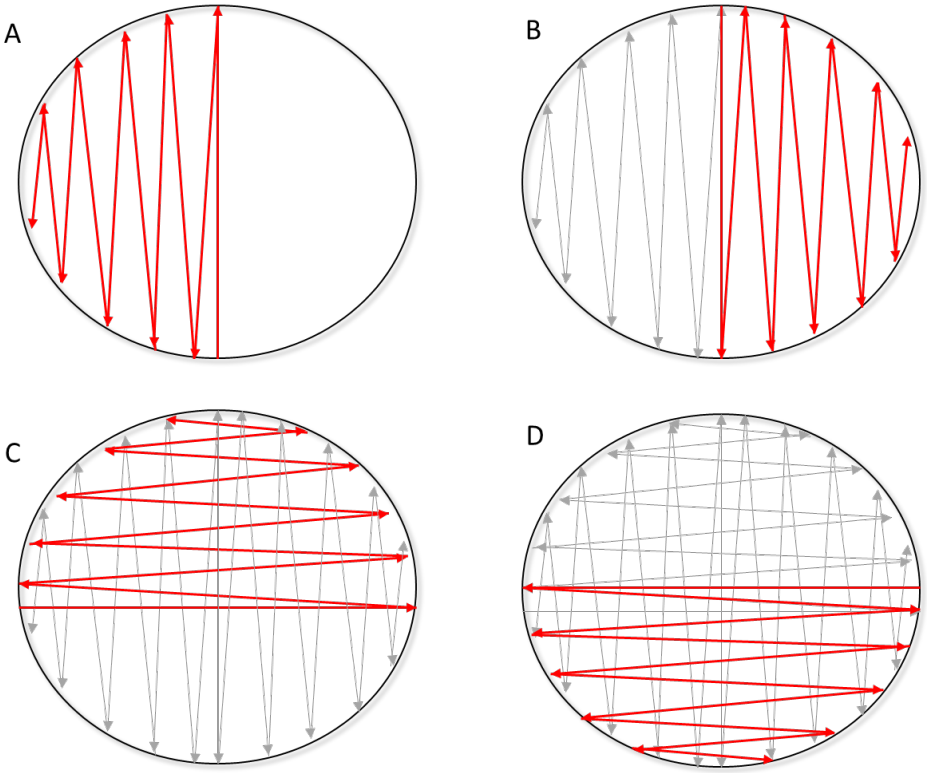


Figure 5 Diagram illustrating spread plate technique, broken down in the four main stages of using the sponge. Red lines indicate the current direction of swab movement and grey lines indicate previously swabbed area**.**

Storage of spread plates

Following the completion of spread plates for the sampling kits the agar plates need to be incubated.

10. Group up the blood agar plates labelled ‘anaerobic’ and the Tryptose Sulfite Cycloserine agar plates. Bring these plates up to the front of the laboratory. There you will be shown how to add a metronidazole disc onto the centre of the agar plates using tweezers.
    a. Once the discs have been added to all the plates. Tape the plates together and label the tape with the: date and sample kit number
        i. **Remember to stack the agar plates so they are upside down**
    b. These plates will be taken to be stored in an anaerobic cabinet
11. Group and tape together the following agar plates: Blood agar labelled ‘Aerobic’, Mannitol Salt agar plates and the Violet Red Bile Glucose agar plates
    a. These plates will be stores in a 37°C incubator
12. Group together the remaining Campylobacter Blood Free CCDA agar plates and bring them to the front of the laboratory
    a. Place the plates into an anaerobic jar
    b. Once the jar is full a gas pack will be added in, the jars will be sealed and stored in a 37°C incubator

Annex 3: Feedback exemplar

Exploring the chopping board microbiome: Chopping board findings

Chopping board sample number:1

Microbiome abundance:

The microbiome abundance was determined using the ACFOR scale, where the total number of colonies found on the chopping board was quantified into one of the five classifications: Abundant, Common, Frequent, Occasional and Rare.

The abundance of the microbiome was segmented into two locations: the middle and the edges.

Middle	Edge
Common/abundant	Frequent

Microbiome composition:

This section contains a breakdown of the composition of your chopping board, the study involved looking for the presence of specific microorganisms, all associated with food borne infections and to determine the potential origin of the bacteria present on the chopping board.

Bacterial species of interest:

Clostridium perfringens, Salmonella spp. and *Campylobacter jejuni* are some of the most prominent bacteria associated with foodborne illnesses. *Clostridium perfringens* is commonly found on raw meat and poultry; infections occur when food is kept at an unsafe temperate that allows the bacteria to grow and multiply. Infections involving *Clostridium perfringens* include meats, poultry and gravies, but also in food that is cooked in large batches and then kept in unsafe temperatures.

Salmonella infections can be caused by a variety of foods, ranging from meats/ poultry, vegetables and fruits. Warmer weather and unrefrigerated foods creates an ideal environment for the growth of *Salmonella*. Infections have also been found in processed

foods. *Salmonella* can spread between animals to humans and is also recorded to be spread between humans.

Campylobacter infections occur in people mainly through consuming raw or undercooked poultry, but it is also found in other foods, including other meats and seafood. Food that has also come into contact with contaminated food may also spread the infection.

Microorganism	**Present/ Absent**
Clostridium perfringens	Absent
Salmonella spp.	Absent
Campylobacter jejuni	Absent

Potential origin of microbiome:

The gut microbiota is a classification of microorganisms that are located in the digestive tract of: mammals, birds, reptiles, amphibians and fish.

The skin microbiota is the name given to the collection of microorganisms that live on our skin.

Location	**Present/ Absent**
Gut microbiota	Present
Skin microbiota	Present

Annex 4: Evaluation Framework

Goals	Activities	Outputs	Outcomes and impacts	Indicators	Monitoring/evaluation method
To develop an **unbiased**, in depth understanding of the behaviours around chopping board use by previously understudied groups (minority ethnic groups; households of multiple occupancy) and the effects of these behaviours on the associated chopping board microbiome	Recruit student ambassadors Co-design data collection methods appropriate for target groups with student ambassadors Recruit community participants from target groups through student ambassadors Student ambassadors guide active participation of community	High quality behavioural and microbial data Scientific publication on results Conference presentation on results	Shape the current understanding of chopping board microbiome Influence future research into	Volume of data collected sufficient to answer scientific questions Data of sufficient quality to answer scientific questions Number and demographics of participants Numbers of publications and other scientific dissemination	Monitor amount of data collected Monitor the demographics of participants Monitor data quality Monitor number of publications and other scientific outputs

Goals	Activities	Outputs	Outcomes and impacts	Indicators	Monitoring/evaluation method
	participants in data collection Analysis of data				
To meaningfully engage traditionally underrepresented groups in citizen science (minority ethnic groups; women; women from minority ethnic groups)	Recruit student ambassadors Co-design data collection methods appropriate for target groups with student ambassadors Recruit community participants from target groups through student ambassadors Student ambassadors guide active	Citizens from underrepresented groups completing data collection and analysis	Active and positive engagement of target groups in citizen science activities	Members of target communities actively engage in project activities Members of target communities report high quality engagement in project	Monitor the demographics and activities of participants Post-participation questionnaire to assess quality of engagement

Goals	Activities	Outputs	Outcomes and impacts	Indicators	Monitoring/evaluation method
	participation of community participants in data collection				
For participants to develop a greater understanding of, interest in and skills related to science (including microbiology and citizen science) and the scientific process	Student ambassadors engaged in all stages of the scientific process Community participants engaged in data collection and analysis	Student ambassadors/ community participants completing scientific research	Student ambassadors demonstrate skillset in microbiology research, increase in research techniques, communication and presentation of research – preparation for postgraduate positions Community participants demonstrate a	Changes in knowledge / confidence in science	Pre- post-questionnaire with student ambassadors. Post-participation questionnaire with community participants. Focus groups pre and post study to fully understand the impact of the project on the student ambassadors

Goals	Activities	Outputs	Outcomes and impacts	Indicators	Monitoring/evaluation method
			greater understanding of scientific research and its relevance to their lives		
For communities to implement safe food hygiene practices, in particular around chopping board use	Co-production and dissemination of educational materials based on results of data analysis Reports to the Food Standards Agency based on results	Educational materials produced, disseminated and accessed by target groups Report to FSA Scientific publications of methods and results	Participants understand good food hygiene practices Participants show adherence to best practice behaviour in food and kitchen hygiene Use of results by FSA…	Number of people materials reached Participants demonstrate knowledge of good food hygiene practices Participants report implementation of good food hygiene practices	Monitor e.g. views/downloads/households/universities in which materials are displayed Post-participation questionnaire to assess knowledge of and behaviour around kitchen hygiene Most significant change method

Goals	Activities	Outputs	Outcomes and impacts	Indicators	Monitoring/evaluation method
			Reduction in foodborne infection		
To develop a blueprint for future larger scale studies of this kind (key features: co-created, microbiology, underrepresented groups, student ambassadors)	Evaluation of methods by citizen participants, student ambassadors and the scientific team.	Scientific publication on methods. Conference presentation on methods	Uptake of methods by wider communities including microbiology researchers and citizen science practitioners	Numbers of projects and associated outputs	Continued monitoring of the literature

Terminology

Goals are broad project aims.

Activities are the tasks that will contribute to the stated outputs and outcomes.

Outputs are direct products of activities e.g. data; publications; dissemination materials.

Outcomes are more specific than goals and each goal can have more than one outcome. They are used to assess the extent to which goals have been achieved and should be articulated in concrete, SMART (specific, measurable, attainable, relevant and time-bound)

statements. They can be articulated as short-, medium- and long-term. **Impacts** are broad long-term outcomes which are often difficult to measure.

Indicators are criteria for measuring whether outcomes have been achieved (outcomes may have more than one indicator).

Evaluation of goals:

Yellow scientific impact

Green learning and empowerment of participants

Blue impact for wider society

References

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