Investigating the presence of SARS-CoV-2 in selected foods and food production environments using harmonised RT-qPCR and WvGS protocols.

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INTRODUCTION

The COVID-19 pandemic has had an impact on food systems. Despite the control measures applied, the final stages of the farm-to-fork continuum present the greatest risk to public health. Several food-processing sites and meat-processing plants (MPPs) in Europe and elsewhere suspended operations when workers tested positive, though no food recalls were instituted. Food safety regulators around the world remain cautious, continuing to gather and evaluate information describing the potential persistence of SARS-CoV-2 on food. International food trade was disrupted when SARS-CoV-2 from packaging material on fish products and poultry was isolated, although there is no evidence to support the food matrix as a transmission route for SARS-CoV-2. The virus can be transmitted by asymptomatic hosts who harbour the virus during its early incubation period before symptoms appear. Considering that the infection is easily transmitted from person to person via coughing, sneezing, respiratory droplets or aerosols and close contact with infected people, food matrices along with their packaging could potentially expose susceptible individuals to infection with SARS-CoV-2.

METHODOLOGY

Food samples representing diverse types (including soft fruits; raw meats of poultry, pork and beef origin; seafood and ready-to-eat products) available for retail sale in Ireland were sourced from domestic and foreign producers. RNA was purified from these matrices using standardised protocols and subjected to RT-qPCR testing for the detection of SARS-CoV-2. Further, all surfaces of the packaging material and skin from the fruits and vegetables were tested. Two dairy food processing facilities implementing COVID-19 controls also participated in the study by providing high-touch surface swabs and composite samples from sewage outlets. An experimental approach for studying survival of the virus based on meat and fish matrices was also included and a strategy was developed for recovering viral particles from positive, spent rapid antigen detection tests (RADT), suitable for direct whole virus genome sequencing. Samples that tested positive for SARS-CoV-2 RNA were

sequenced using a tiling amplicon sequencing approach and the data were used for detecting variants and lineages.

RESULTS

In total, 1 261 samples were obtained and tested. These included: RNA purified from food matrices (713 samples), swabs originating from packaging and the skin of fruit (467 samples) and from high-touch surfaces (75 samples) and six concentrated wastewater samples. All samples tested negative for the presence of RNA of SARS-CoV-2, including associated food packaging and food production samples. Additionally, the SARS-CoV-2 survival studies carried out under laboratory conditions and designed to simulate contaminated meat and fish matrices showed that virus population numbers reduced quickly when the matrix was incubated at 4°C. In contrast, at -20°C, the virus could be recovered in a culturable state. To evaluate whether virus recovered from positive RADT devices provides high-quality sequence data, six RADTs were spiked with diluted suspension of cultured virus and the protocol for extracting virus particles was adopted. The RNA extracted was used as a template for the RT-qPCR and the samples resulted positive while the sequencing made it possible to assign the lineages to all the tested RADT.

DISCUSSION

No SARS-CoV-2 was detected in foods, their packaging materials or the wastewater systems tested. Findings from this study suggest that the food chain does not represent a risk to human health for the transmission of SARS-CoV-2. This virus could be recovered from food stored at -20°C, but not at higher temperatures. Virus particles suitable for whole virus genome sequencing could be recovered from positive spent RADTs, extending their diagnostic utility as a risk management tool that could also be deployed in an MPP setting. The approaches and the protocols developed here provide an effective and comprehensive toolkit for overcoming the challenges during a pandemic to ensure food safety by implementing scientifically justified countermeasures and to assess risk. More broadly, the establishment of the methodology and infrastructure necessary to enable this level of risk analysis is equally important in mitigating the threat posed by other zoonotic spill-over events that are almost inevitable. The One Health paradigm provides a framework for anticipating, understanding, preventing and controlling any such future events.