Novel Use of Omic Technology to Evaluate the Hygienic Design of Equipment and the Impact of Dry Versus Wet Cleaning

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Introduction

Evaluating the hygienic design and operation of equipment is a significant challenge for the food industry as current techniques are not suitable for use during standard production operations. It was proposed that omics technology could provide such a solution.

Purpose

The purpose of this study was to conduct proof of concept to evaluate the use of 16S rRNA sequencing as a suitable technique for assessing the occurrence and persistence of microorganisms in a live factory environment in a way that was intuitive and meaningful

Methods

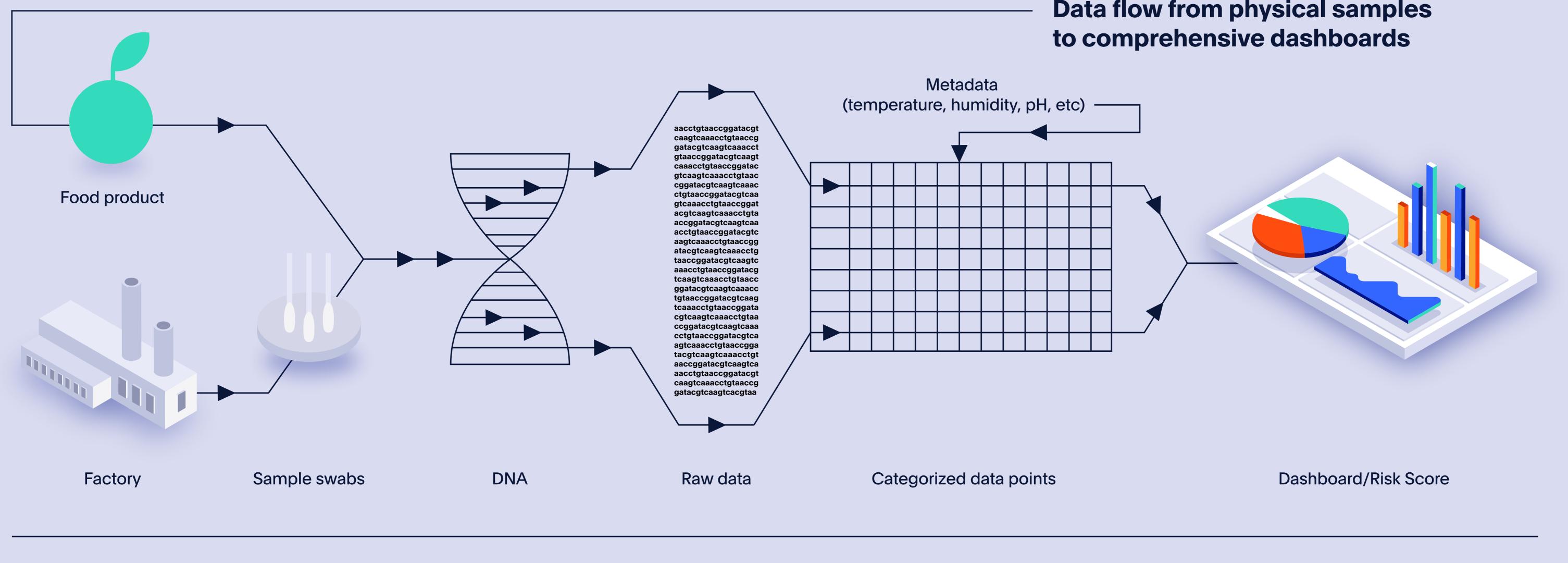
A total of three projects were conducted over an 11 month period in order to evaluate the use of Omics as a viable tool. Each project followed a standard operating procedure (SOP) for swabbing.

Project one involved comparing two 2 locations within the same care zone. Three sampling points were identified.

Project two was to perform an operational evaluation on the impact of wet cleaning in a dry environment. Ten sampling points were identified in two sampling locations and samples were collected pre and post cleaning, over three cleaning cycles.

Project three compared equipment that had been upgraded to improve air flow to reduce condensation. Three banks of equipment were identified and sampled, one upgraded and two not upgraded. Each bank contained five units, three sampling points were collected per unit. In total 47 samples were swabbed.

In all three projects, sterile and contaminated swabs were used as controls and swabs were preserved for transportation to the sequencing facility. The DNA samples were prepared for targeted sequencing and particular primers were used in order to provide the best coverage of the 16S gene while maintaining high sensitivity. The final library was sequenced on Illumina® MiSeqTM with a v3 reagent kit (600 cycles). Bioinformatics was conducted to produce the relative abundance taxonomic breakdown.



Results

Significance

In project one, a significant difference in the microbiome was observed between the

two locations, with one location having higher abundance in spore formers as well as a greater number of species that are more likely to dominate the others. For project two (wet vs dry cleaning) more species of concern were identified in the wet cleaned equipment, with less diversity of bacteria and higher dominance. For project three, the differences between upgraded and non upgraded equipment showed minimal differences under a variety of parameters, indicating the upgrade had limited benefit to the hygienic design.

Significant effort was made to simplify the relevant taxonomy.

This information was translated into an interactive graphical interface, combining the microbiome analysis with the associated metadata that was recorded during the project. Resolving the analysis to a single score served as a key tool for communicating what can be highly complex data to the diverse stakeholders in the manufacturing environment in a simple and intuitive manner.

This project has demonstrated that omics is a useful tool for hygienic design validation. Food production is a complex and fast moving industry. Food safety is of paramount importance, however significant challenges remain. There is a critical need to move to a more predictive and preventative approach and the use of genomics is enabling this change. While further studies are recommended, this project has demonstrated it provides a unique, timely and powerful insight into hygienic design and operation of equipment. This has been almost impossible to achieve in a live production environment here to date.