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Biofilms and surface hygiene

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BIOFILMS AND SURFACE HYGIENE

Theme Day "Hygienic Design"
at DTU on 26th of August 2015

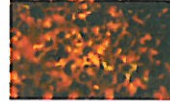
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DTU Food
National Food Institute



Biofilm consists of:

- **Microbes**
- **Water** (85 - 98%)
- **Extracellular polymers (EPS)**; polysaccharides, glycoproteins etc. from microbes)
- Captured **particles** and other dissolved materials from the process stream



a) 6 d biofilm of *Lactobacillus brevis*



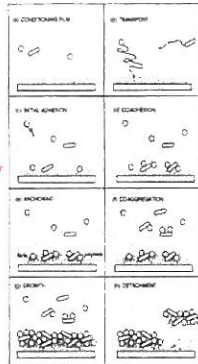
b) the same biofilm after swabbing

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Phases in the formation of biofilms

according to Busscher & van der Mei (2000) in "Initial microbial adhesion events: mechanisms and implications"

In Proc. 59th SGM Symposium, p. 25-36, Cambridge University Press, ISBN 0 521 79302 5.



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Biofilm Effects in Processing

- **energy losses** in processing e.g. prolonged pasteurisation
- **deterioration on specific chemical reactions** e.g. contamination of immobilised cell systems
- **deterioration of products** e.g. the product can be of lowered quality already after production
- **limited shelf-life** of the products
- occurrence of **pathogenic microbes** which increase the risks of **foodborne poisoning**

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Biofilm Effects in Food Processing

- **cleaning and disinfection processes are affected and the choice of chemicals, flow, time and temperature must be altered**
- **increased need of maintenance** in process lines and equipment e.g. prolonged down-time or **laborious demounting of equipment** e.g. heat exchangers in the process lines, in water supply systems, in granular activated carbon columns, in reverse osmosis membranes, in ion exchange systems, in degasifiers, in water storage tanks and in microporous membrane filters due to **cleaning and hygiene, energy losses & blockages**.

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Biofilm Problems on Food Contact Surfaces:

- on food contact surfaces of stainless-steel
- on conveyors,
- on gaskets,
- on blancher extractor surfaces,
- in air handling systems,
- on floors and in drains,
- in manufacturing of paper-based packaging material
- in packaging machines,
- in milk transfer lines,
- in heat exchangers - pasteurizers and cooling systems,
- in ultrafiltration and reverse osmosis membranes
- on mixers and slicers,
- on rubber fingered pluckers,
- in poultry processing equipment and
- on vegetable processing lines etc.

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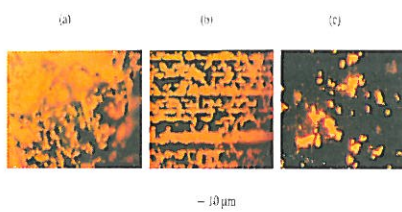
Biofilm Problems in Food Products:

- ready-to-eat (RTE) products,
- fermented meat sausages,
- fish cakes,
- unpasteurized milk,
- dairy products e.g. ice-cream & cheese,
- iceberg lettuce, minimally processed vegetable salads & various deli salads,
- vegetables,
- spices & herbs,
- caramel apples,
- canned products,
- pastries, biscuits & pizza,
- fruit juices, apple cider & beer etc.

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We can see that **biofilm** can generate problems anywhere in the food process if the design and maintenance is improper!

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Microscopy of 5 d *Pseudomonas fragi* biofilm stained with acridine orange on various stainless steel surfaces (AISI 304): (a) glass blasted, b) lapped and c) mechanically polished (according to Wirtanen, Saarela, Mattila-Sandholm, 2000, *Biofilms – Impact on hygiene in food industries*. In: Bryers (Ed.) *Biofilms II: Process analysis and applications*. Wiley-Liss Inc. Pp. 327-372.)

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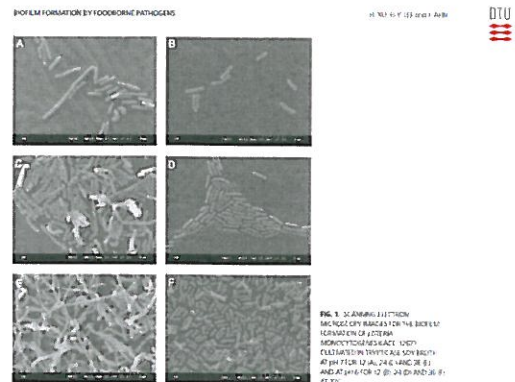


FIG. 1. SCANNING ELECTRON MICROSCOPY IMAGES FOR THE BIOFILM FORMATION OF *STREPTOCOCCUS THERMOPHILUS* ON STAINLESS STEEL SURFACES AT pH 7.0 AND 4.0. (A) AND (B) AT pH 7.0 AND (C) AND (D) AT pH 4.0. (E) AND (F) AT pH 7.0 AND (G) AND (H) AT pH 4.0.

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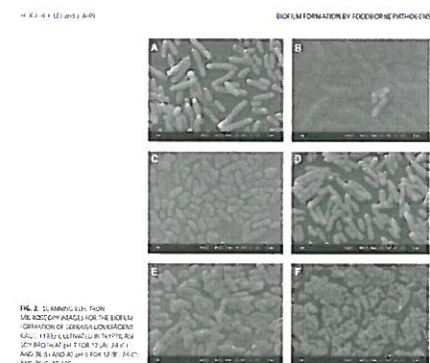
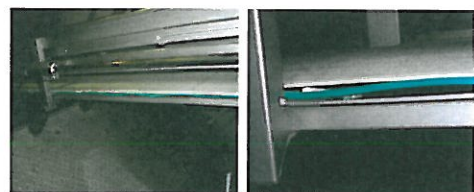


FIG. 2. SCANNING ELECTRON MICROSCOPY IMAGES FOR THE BIOFILM FORMATION OF *STREPTOCOCCUS THERMOPHILUS* ON STAINLESS STEEL SURFACES AT pH 7.0 AND 4.0. (A) AND (B) AT pH 7.0 AND (C) AND (D) AT pH 4.0. (E) AND (F) AT pH 7.0 AND (G) AND (H) AT pH 4.0.

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Bad Example on Equipment Hygiene



The figure to the left shows a plastic slide bar (with crevices) which has been deformed by extension. To the right biological material is seen underneath the plastic slide bar (DairyNET, 2004).

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All microbes, which are in **wrong places**, cause **problems**, which can lead to:

- **contamination of food contact surfaces**,
- **spoilage of products** (withdrawals, shortened shelf-life etc.) and
- **illness of consumers**:
 - due to **toxin production** (intoxications) and
 - **living cells** (amount needed for **infection(s)** depend on the microbe)

Efficient Microbial Process Hygiene & Removal of Biofilms:

- 1) **minimising the incoming microbial load**,
- 2) **efficient microbial maintenance at vulnerable sites and**
- 3) **keeping up adequate hygiene by using appropriate cleaning and disinfection programmes**

GLOSSARY

PHYSICAL CLEANLINESS

means that there is no visible waste, foreign matter or slime on the equipment surfaces.

CHEMICAL CLEANLINESS

means that surfaces are free from undesirable chemical residues.

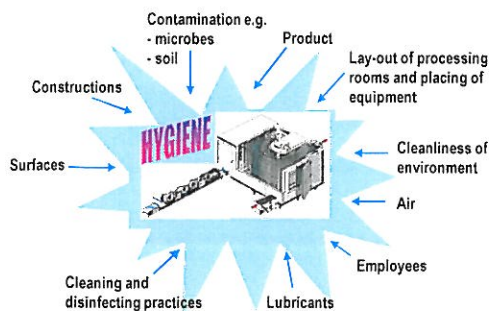
MICROBIOLOGICAL CLEANLINESS

means that surfaces are free from spoilage microbes and pathogens (incl. spores)

⇒ **The key to effective cleaning and disinfection of food plants is the understanding of the type and nature of the soil (sugar, fat, protein, mineral salts etc.) and the microbial growth to be removed from the surfaces.**



FACTORS AFFECTING THE HYGIENE IN PROCESS EQUIPMENT



PARTIES INVOLVED IN HYGIENIC FOOD PROCESSING

