Food Processing Surface study

Joint work activity of EPTA,VTT and Matis within SAFOODERA- Puffin

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Microbiological reasearch

Presentation overview

- Brief introduction of cleaning agents and cleaning processes

- Presentation of joint work activity evaluation on cleanability and bacterial adhesion to conventional and novel processing surfaces in the industry and on a laboratory scale

- Molecular analysis on the composition of microbial flora in different areas in food processing plant.

Background

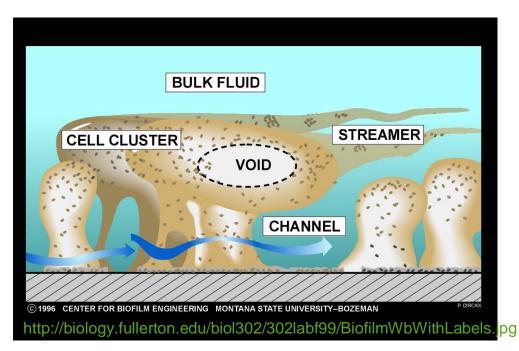## Bacterial contamination of foods

Four major routes

- From raw material
- From humans and animals
- From air
- From food processing environment

Hygienic production of foods increases food safety, quality, shelf life and consequently, VALUE

Background

Biofilms in food processing plants

- Forms preferably on humid surfaces
- Biofilm consist mainly of bacteria and polymers
- Can provide shelter for pathogens

http://biology.fullerton.edu/biol302/302labf99/BiofilmWbWithLabels.jpg

Background

Common surface types

Stainless steel (AISI-304, 316)
E.g. Untreated, glass beaded, electropolished, coated

Plastic
E.g. Polypropylene, polyvinyl chloride, acetyl copolymer, polycarbonate, polyethylene

Rubber
E.g. Hydrogenated nitride butyl rubber, Nitril, ethylene propylene diene monomer, silicon

Requirement for material used for food production (89/109/EEC)
Smooth surface finishing,
Tolerance towards detergents and disinfection agents,
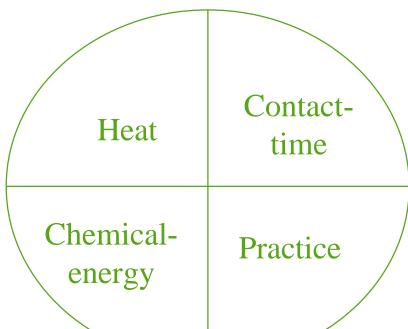Tolerance towards corrosion
Does not exude chemicals to the food

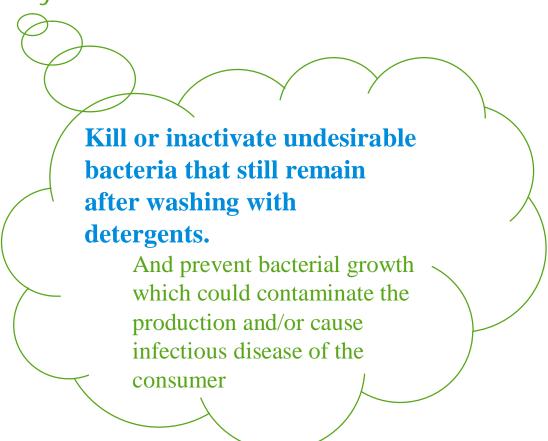# Background

Cleaning efficiency is dependent on:

Heat	Contact-time
Chemical-energy	Practice

Background

Disinfection can be done by:

Heat
Radiation
Chemicals

Kill or inactivate undesirable bacteria that still remain after washing with detergents.

And prevent bacterial growth which could contaminate the production and/or cause infectious disease of the consumer

Background

Classification of cleaning agents

Alkaline detergents
- Most common type of detergents in the food industry
- Have pH above 7,
- Organic impurities (fat/oil/proteins) can be emulsified
- Alkaline substances inhibits growth of bacteria and fungi
  Example of strong alkali detergent, Sodiumhydroxid
  Example of weak alkali detergent, Sodiumkarbonat

Acid detergent
- pH from 0-6
- Mixture of surfactants and acid is good to clean inorganic substances e.g. rust and oxides from metal surface
- Usually have inorganic acids that can cause corrosion of metals and therefore not optimal for food processing
  Nitric acid (strong acid), Acetic acid (weak acid)

Neutral detergents
- Detergents mixed with water with a pH near 7
- Chemicals can be surfactants, rust protective agents and other chemicals

Background

Additives in cleaning agents

Surfactants (emulsion former)

Most chemicals used for cleaning in food industry contain surfactants
- Anionic substance e.g. soaps, usually foam forming
- Non-ionic substance, often contain ethylene oxide, good for cleaning of fat and is used to decrease foam formation with anionic chemicals
- Cationic substance e.g. Quaternary ammonium compounds, inhibits bacterial growth

Sequestering chemicals- (phosphate, EDTA)

Form soluble complexes with metal ions like calcium, magnesium and iron to prevent formation of biofilms on equipment.
- Silica can be used to prevent corrosion of metals
- Abrasives for elimination of tough soil
- Enzymes (e.g. proteases, lipases). Brake down proteins and fats

Disinfectants
- Oxidative chemical – chlorine, iodophor
- Non-oxidative compounds – e.g. quaternary ammonium compounds
- Germicidal detergents – composite chemicals. Different mixtures of detergents, chlorine and acidic anionic compounds

Background

Database for cleaning agents and cleaning processes

http://www.cleantool.org/

(EU funded project)
CLEANTOOL is a Europe wide database for parts cleaning, metal surface cleaning, component cleaning and degreasing, based on real processes in numerous European companies.

Joint study
Processing surfaces

Aim:

To study the adheration of naturally occuring bacterial flora of food processing environment on conventional and novel food processing surfaces.

Laboratory study on different surface materials

Study about the effect of antimicrobial surface materials (coatings) on biofilm formation by different pathogens and cleanability of the different surfaces

- Stainless steel (AISI:304-2B, Manufactured by Marel, Reykjavik Iceland)
- Steal coated with epoxy or polyester containing silver (Manufactured by Marel, coated by Polyhúðun, Reykjavik Iceland)
- Epoxy coated steel (Manufactured by Marel, coated by Polyhúðun, Reykjavik Iceland)
- Plastic with silver particles (Manufactured by Bio Guard Plastics LLC, USA)

Listeria monocytogenes, Bacillus cereus, Salmonella enteritica subsp. *enteritica* serotype Enteritidis and *Klebsiella/Enterobacter* sp

Cleaning and disinfection procedures

The foam cleaning agent was spread on the surfaces and after 15 min the surfaces were rinsed with 20 bar pressure for 5 s.
The washed sampled coupons were placed for 5 min into 1.0% HYPO disinfectant solution so that half of the coupon was immersed into the disinfectant.
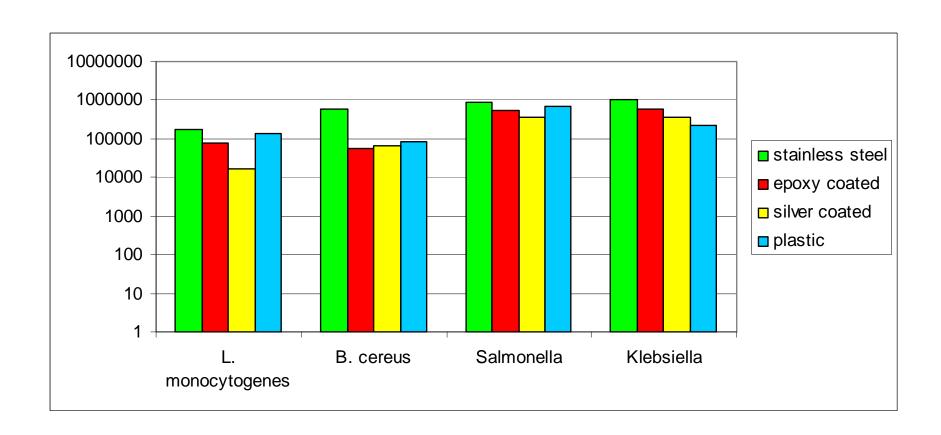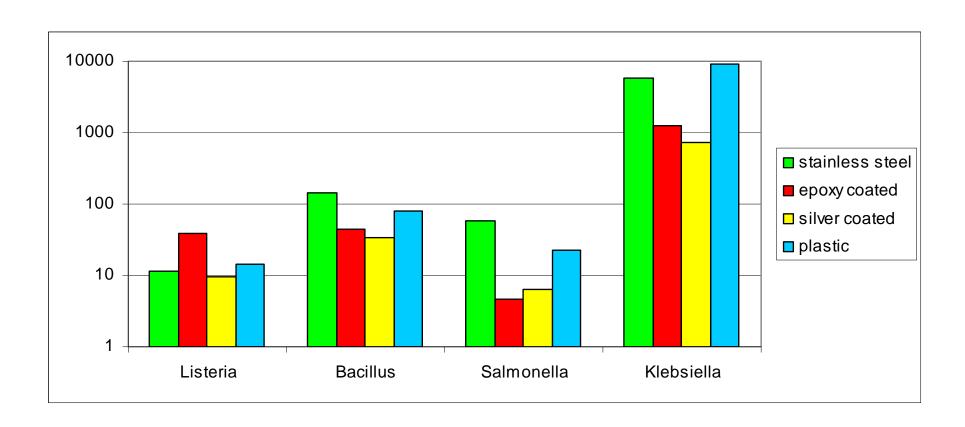
Biofilm growth on surfaces (4 days biofilm) before cleaning
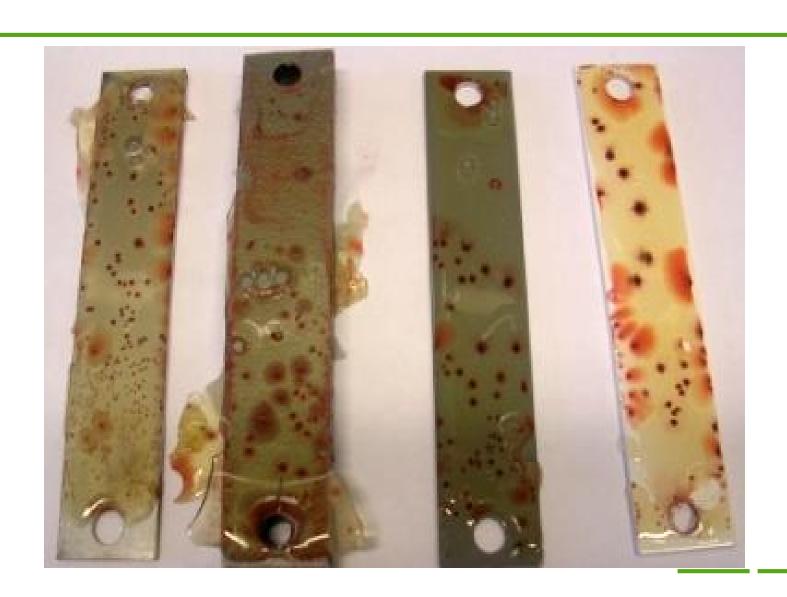
Microbes detected from surface after cleaning

Listeria monocytogenes

Bacillus cereus

Salmonella

Klebsiella

Industrial study on different surface materials

• **Industries**

Iceland –   Fish processing plant
Finland –   Diary processing
Cyprus –   Meat processing

Surface types

Stainless steel   (AISI:304-2B)
● (Manufactured by Marel, Reykjavík Iceland)

Steel coated with epoxy containing silver
● (Manufactured by Marel, coated by Polyhúðun, Reykjavík, Iceland)

Epoxy coated steel
● (Manufactured by Marel, coated by Polyhúðun, Reykjavík, Iceland)

Plastic with silver particles
● (Manufactured by Bio Guard Plastics LLC, USA)
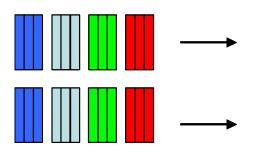
Location 1-3

Four materials in triplicate

Surface material tested after 2 month incubation
Before and after washing (same coupons)

Surface material tested after 4 month incubation
Before and after washing (same coupons)

Total of 24 test qoupons on each location.

Locations in the processing line:
- Reception area – 1
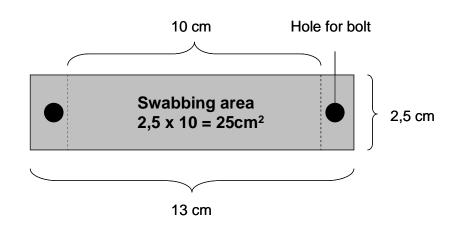- Trimming area – 2
- Packaging area – 3

Surface coupon installation

Fish processing facility - Iceland

Meat processing facility - Cyprus

Sampling

- Sampling performed after 2 and 4 months incubation, before and after washing

- Bacteria swabbed of the surface before and after wash, using non-woven cloths

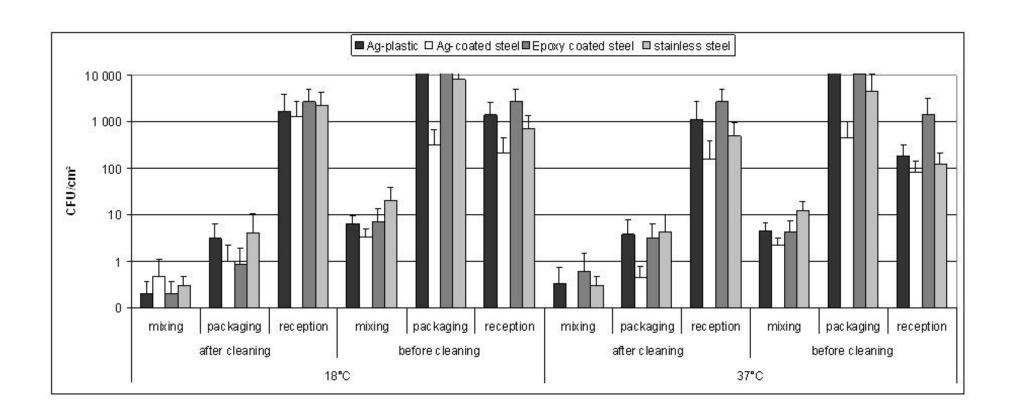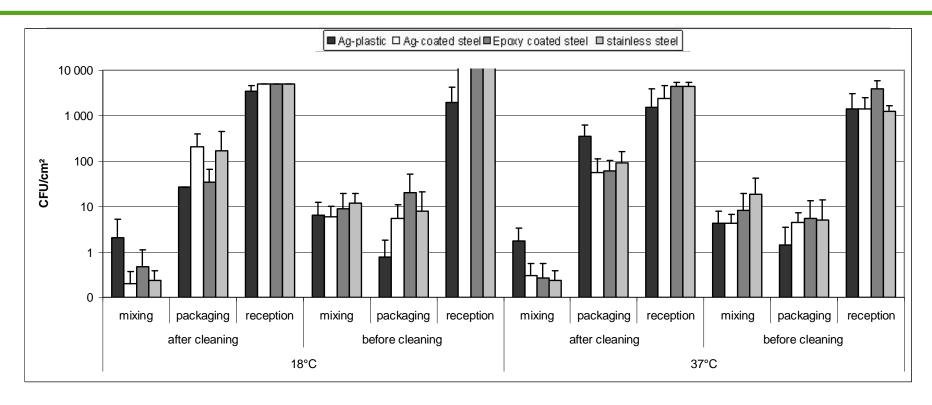- Microbiological adhesion was determined by plate count of total bacterial flora on Compact dry disks or iron agar

10 cm   Hole for bolt

Swabbing area
2,5 x 10 = 25cm²

2,5 cm

13 cm

Diary results, 10 weeks incubation in processing line
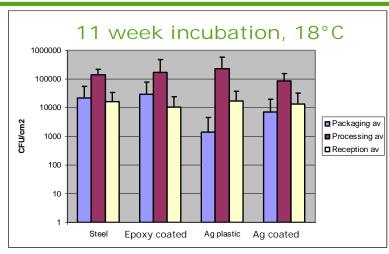
Results

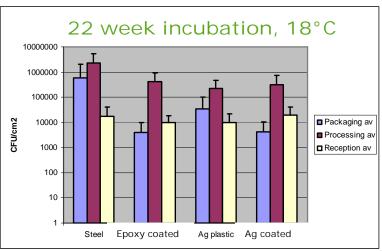## Diary results, 20 weeks incubation in processing line

- No significant differences between the materials (epoxy slightly better?)
- After cleaning results: all surfaces were cleaned similarly; none of the surfaces were easier to clean than the others
- Cleaning procedure used in the reception area was not efficient (milk went directly in pipes and thereafter to pasteurizer – lower hygiene area than mixing and packaging)
- Cleaning in mixing area was efficient – lots of direct food contact surfaces
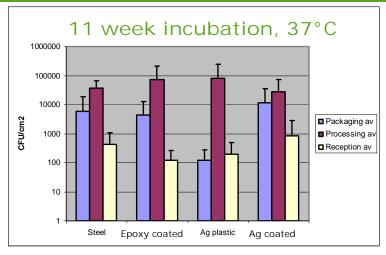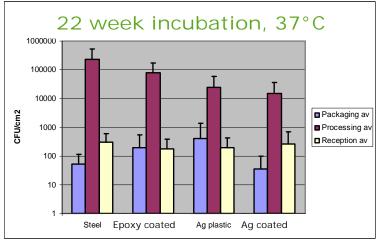- Humidity and temperature varied a lot in packaging area – variations in microbe counts
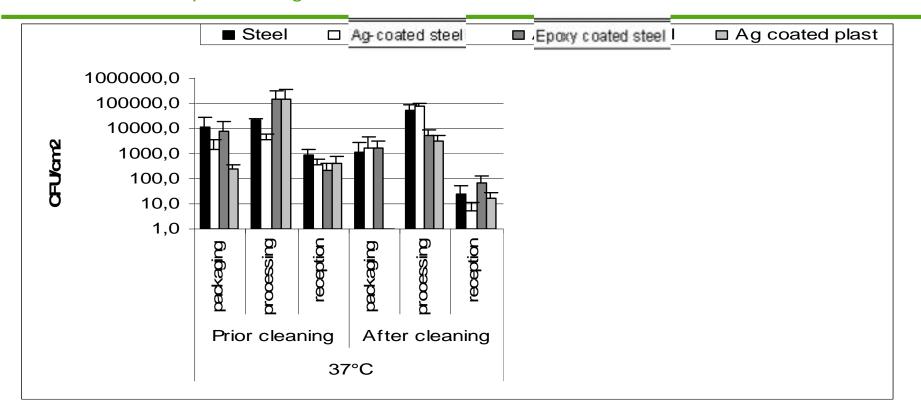
Fish processing results

Temperature monitoring:
Reception   11,6°C ± 1,2
Processing   16,4°C ± 2,8
Packaging   8,1°C ± 1,2

Results

Fish processing results, 11 weeks incubation
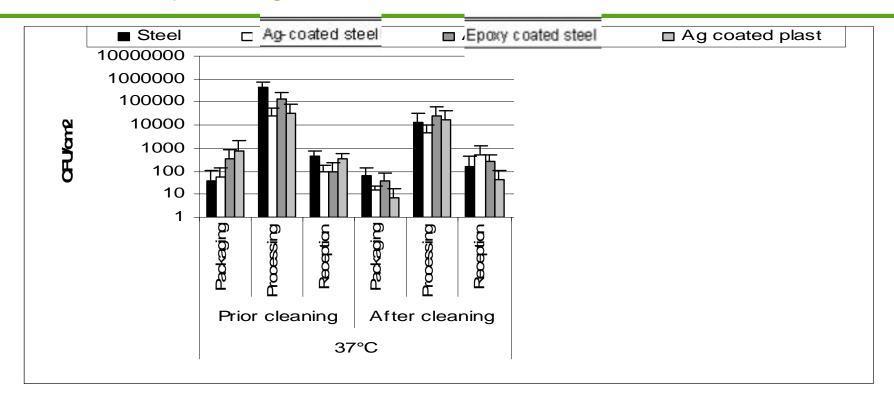
Temperature monitoring:
Reception   11,6°C ± 1,2
Processing   16,4°C ± 2,8
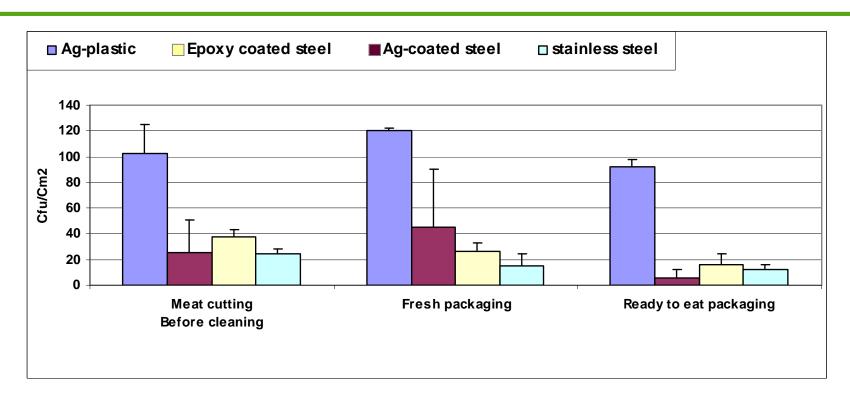Packaging   8,1°C ± 1,2

Fish processing results, 22 weeks incubation

- Not statistically significant difference between surface types (p=0.05)
- Highest counts during processing

Results

Meat processing results, 22 week incubation, cultivated at 37°C

Meat processing results, 22 week incubation, cultivated at 37°C

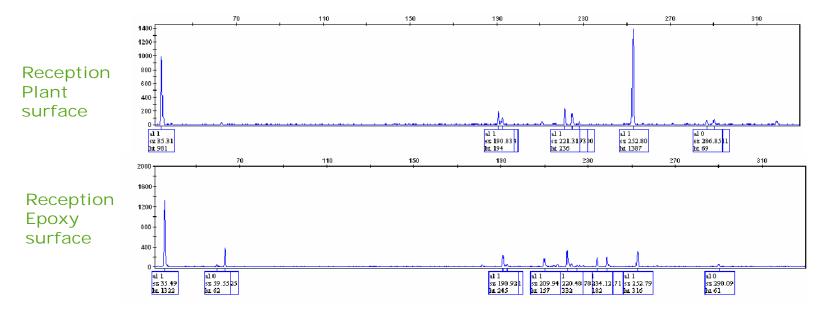Legend: ■ Ag-plastic   □ Epoxy coated steel   ■ Ag-coated steel   □ stainless steel

- Ag plastic contains significally higher numbers of bacteria before and after washing compared to other surfaces
- Not significant difference among other surface types

- Surprisingly low bacterial counts

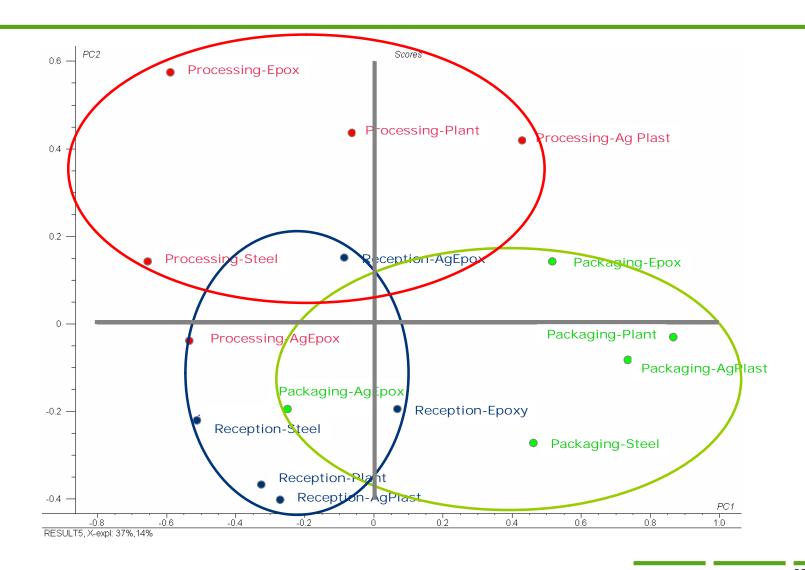# Fingerprinting microbial flora in fish processing plant

Method
- T-RFLP (Terminal restriction length polymorphsm)

- Based on PCR amplification of the 16S rRNA gene of bacteria

Reception
Plant
surface

Reception
Epoxy
surface

- T-RFLP patterns analysed by PCA (principal component analysis) in order to identify similar patterns

Results
Fingerprinting microbial flora in fish processing plant

Conclusions

- No significant difference between surfaces when bacterial adheranse was tested in controlled conditions using bacterial strains

- No significant difference between surfaces when bacterial tested in industrial environment
  - Indications of superior properties of antibacterial surfaces.

- Significantly higher numbers of bacteria adhere to silver containing plastic in meat processing surfaces.

- Bacterial flora in fish processing plant is of different composition in each processing area

- In general: The results do not indicate a superior antibacterial properties of the novel surfaces tested compared to stainless steel