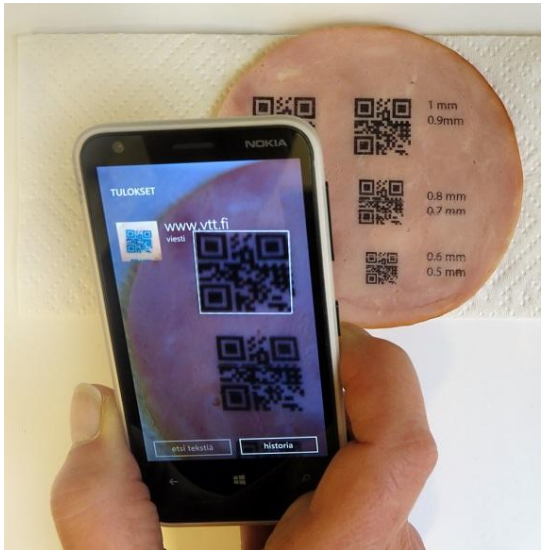

Enhancing product security by using direct marking and QR codes

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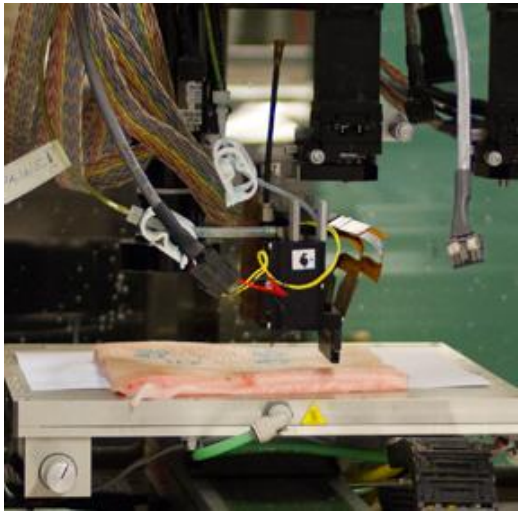
DIGITAL DIRECT MARKING

- Marking directly on product surface
- Inkjet printing and laser marking for decoration and product safety
- Benefits: automation, mass production, customised markings, integration into production lines
- Inkjet printing accepted by EU and FDA for food decoration, printing systems and edible inks available



MOTIVATION

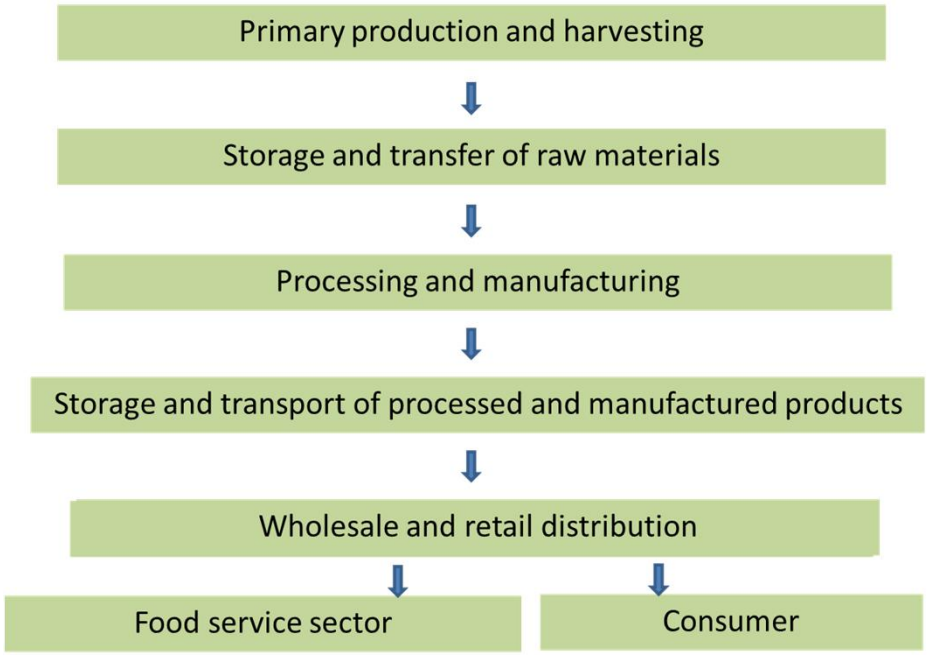
- Typically safety elements on product packages
- One aspect of counterfeiting is replacement of products, but the genuine package is retained
  - ➢Safety elements also on the product itself needed
  - ➢At the same time brand promotion and entertainment features
- More specific traceability in case of product concerns




EDEN PROJECT

- 3 themed end-user demonstrations (Food Industry, Multi Chemical, Radiological) covering multiple hazards (CBRNe)

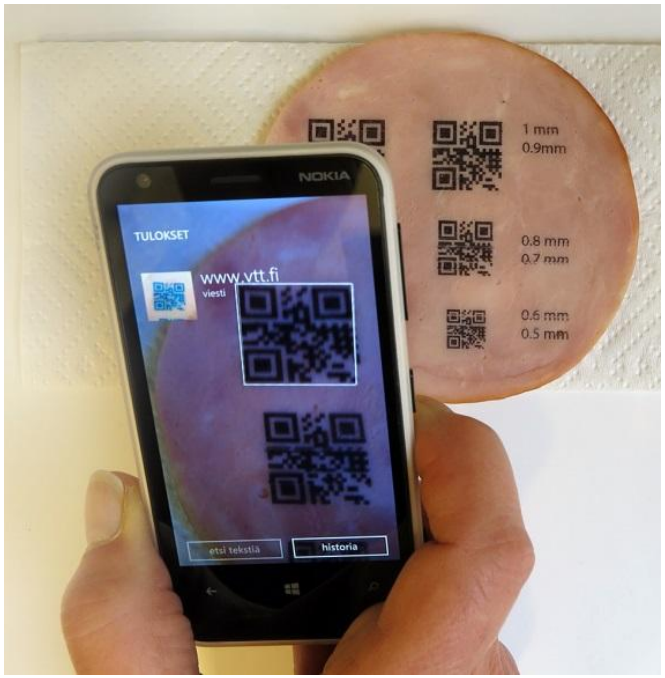
- The Food Industry demonstrator is about contamination on the food chain and focuses on guarantee and assessment of food safety during extreme situations



- The food chain is vulnerable to natural, accidental and deliberate contamination. Therefore security and safety of food has a major role in the global public health.

OBJECTIVES

- Evaluation of the potential of inkjet printing based direct marking to provide security elements – specifically QR codes – on food products
- Do QR codes remain readable during storage despite ink spreading in cold and humid conditions (+4 ^{o}C, 1 week)?
- QR codes inkjet printed with edible commercial inks on ham slices and read with a mobile phone



MATERIALS AND METHODS

- Inkjet printing: drop-on-demand industrial printheads (Fujifilm Dimatix, 80 pl, 300 dpi, 150 mm/s)
- Four inks that differ in main solvent and colorant
- Three substrates: 1) sliced ham, 2) copy paper (Staples Europe B.V., 80 g/m^2), 3) photographic paper (Intelicoat Technologies, 250 g/m^2)
- Printing layout: QR Codes with different cell size between 0.25-1.50 mm, code content “www.vtt.fi” with 21 x 21 cells
- After printing vacuum packaging & putting into pouches, storage in +4 ^{o}C
- Code reading after printing, after packaging, 1 day after packaging, 7 days after packaging with mobile phone (Lumia 800 with 8 Mpix camera)

Ink	**Trade name**	**Manufacturer**	**Main solvents**	**Colorant**
Edible ink 1	Tapestry	Fujifilm Dimatix	Glycols, glycerol	Dye-based cyan
Edible ink 2	6120	Linx Printing Technologies	Ethyl acetate	Cyan
Edible ink 3	76000-00102	Leibinger Group	Ethanol	Cyan
Solvent based ink	Jetrion	Jetrion	Glycols	Pigment based black

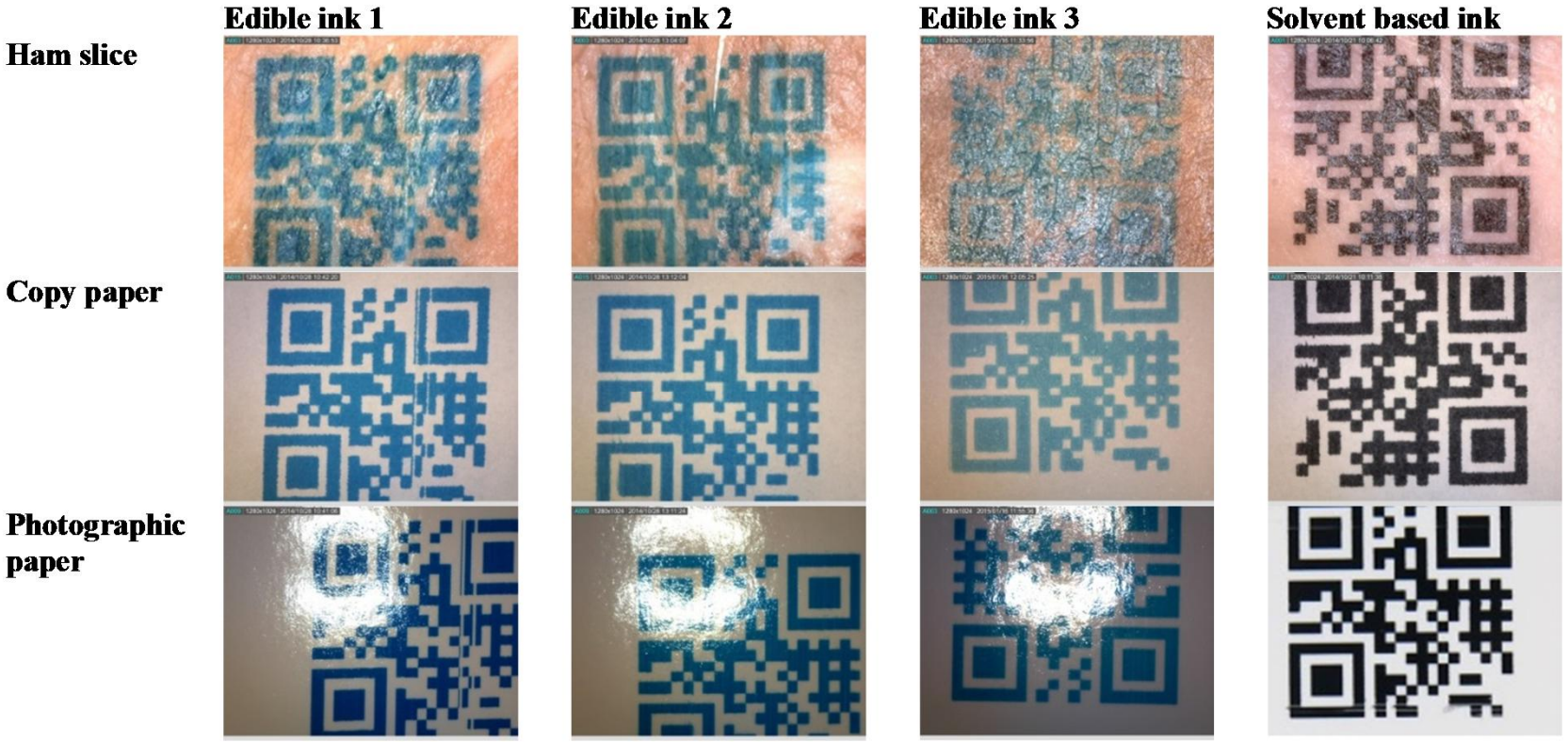
SMALLEST READABLE CELL SIZE

- The smallest readable cell size after printing 0.20-0.50 mm → final cell sizes used 0.25-1.50 mm due to expected spreading
- Contrast with Edible ink 3 poor → not used for further tests

Edible ink 1, Edible ink 2, Edible ink 3, Solvent based ink (cell size 1.00 mm)

COMPARISON BETWEEN SUBSTRATES

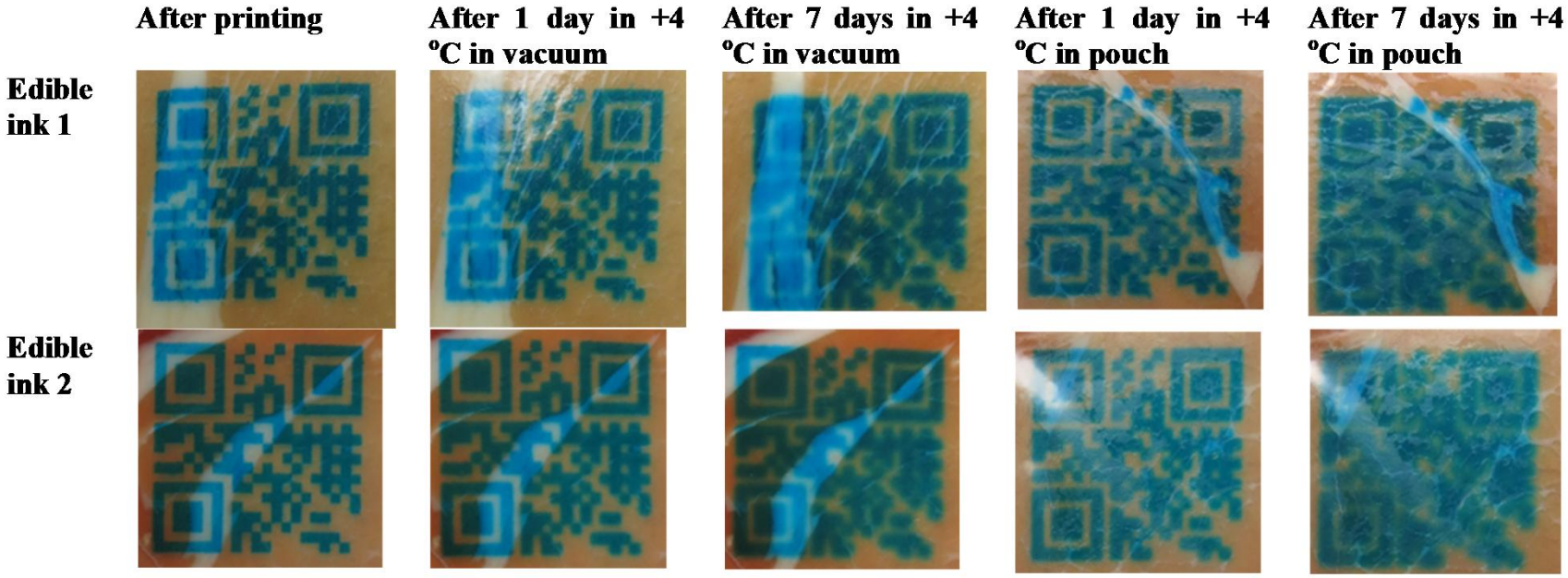
- Print quality on ham slices poorer than on paper as a result of ink spreading



Cell size 1.00 mm

INK SPREADING DURING STORAGE

- Ink spreading during storage
- Edible ink 2 spreads less
- More spreading in pouches than in vacuum packages



Cell size 1.50 mm

CODE READABILITY AFTER STORAGE

Ink	**Edible ink 1**						**Edible ink 2**					
Cell size (mm)	1.50	1.25	1.00	0.75	0.50	0.25	1.50	1.25	1.00	0.75	0.50	0.25
Ham slices												
After printing	13/13	13/13	13/13	12/13	12/13	0/13	8/8	8/8	8/8	5/8	0/8	0/8
After packaging	4/5	3/5	2/5	1/5	0/5	0/5	2/4	2/4	2/4	0/4	0/4	0/4
After pouching	1/5	4/5	2/5	0/5	0/5	0/5	4/4	4/4	4/4	4/4	0/4	0/4
Packages after 1 day in +4 ^{o}C	1/5	0/5	0/5	0/5	0/5	0/5	2/4	2/4	0/4	0/4	0/4	0/4
Packages after 7 days in +4 ^{o}C	1/5	0/5	0/5	0/5	0/5	0/5	0/4	0/4	0/4	0/4	0/4	0/4
Pouches after 1 day in +4 ^{o}C	1/5	0/5	0/5	0/5	0/5	0/5	2/4	1/4	0/4	0/4	0/4	0/4
Pouches after 7 days in +4 ^{o}C	0/5	0/5	0/5	0/5	0/5	0/5	0/4	0/4	0/4	0/4	0/4	0/4
Copy paper												
After printing	3/3	3/3	3/3	3/3	2/3	0/3	3/3	3/3	3/3	3/3	3/3	0/3
Photographic paper												
After printing	3/3	3/3	3/3	3/3	1/3	0/3	3/3	3/3	3/3	3/3	3/3	0/3

CONCLUSIONS

- Commercial edible inks suitable for printing on ham slices → suitable to be used for security solutions
- However, the inks spread during cold storage, even when vacuum packaged → careful optimisation of the code cell size required
- Very small cell sizes readable with optical microscope integrated into mobile phone

ACKNOWLEDGEMENTS

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TECHNOLOGY FOR BUSINESS

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