



# Monitoring of the quality of modified atmosphere packaged poultry with intelligent packaging concepts

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# Intelligent packaging concepts

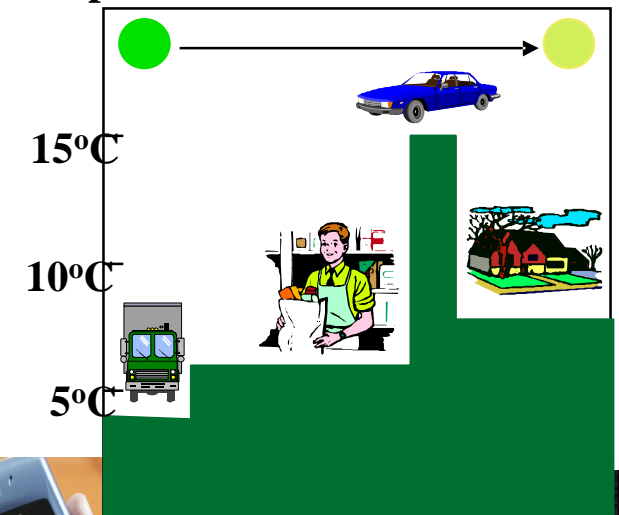
## Concepts indicating the storage conditions (indirect quality indication)

- time-temperature indicators
- indicators for package head-space composition (package leakage)
  - oxygen

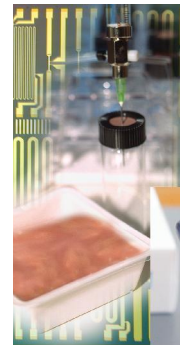
## Direct quality indicators

- indicators and sensors for (volatile) metabolites e.g.  $\text{CO}_2$ ,  $\text{SO}_2$ ,  $\text{NH}_4$ , amines,  $\text{H}_2\text{S}$ , diacetyl, organic acids, ethanol
- pathogen-indicators

Temperature

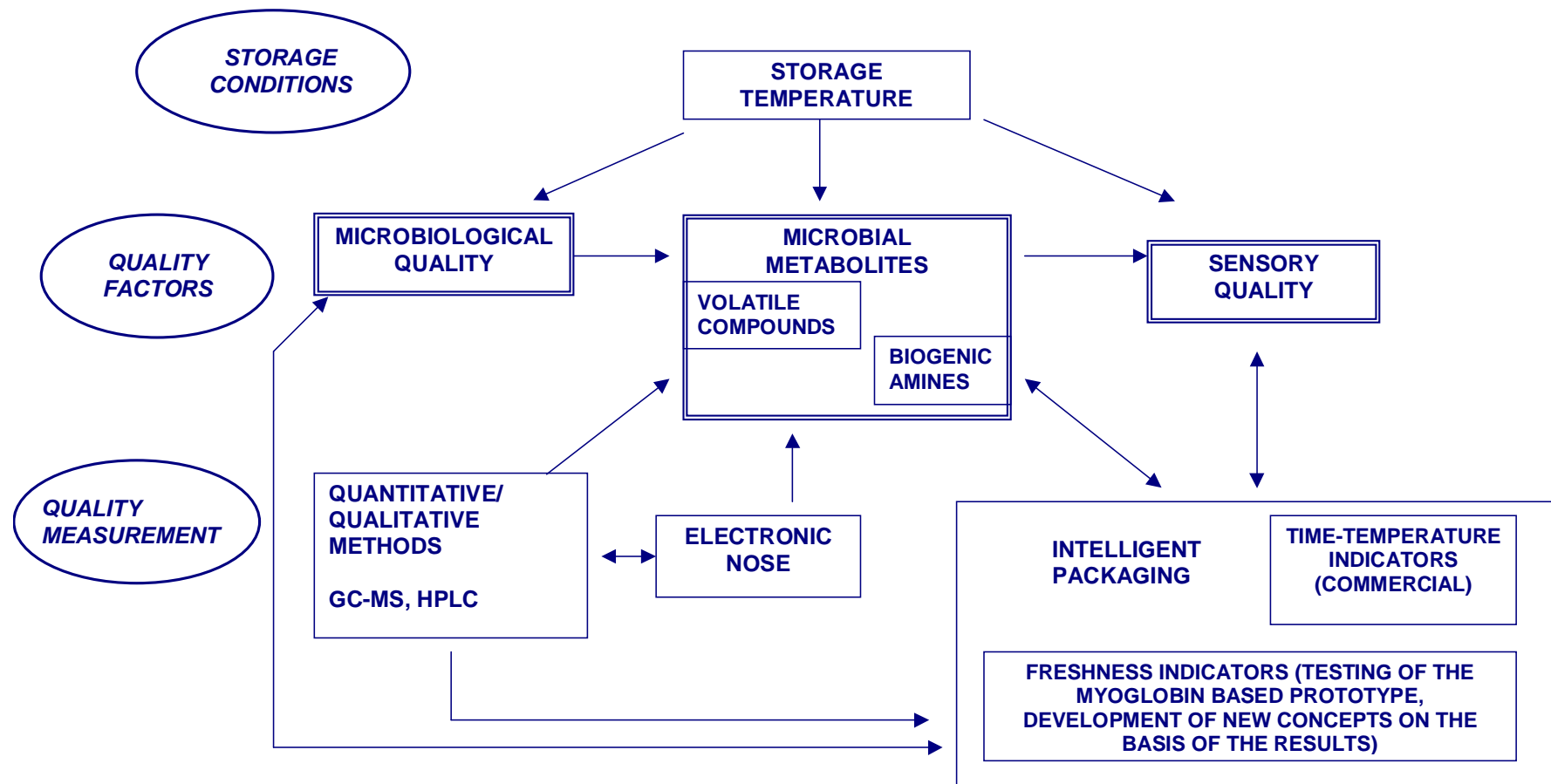


Time



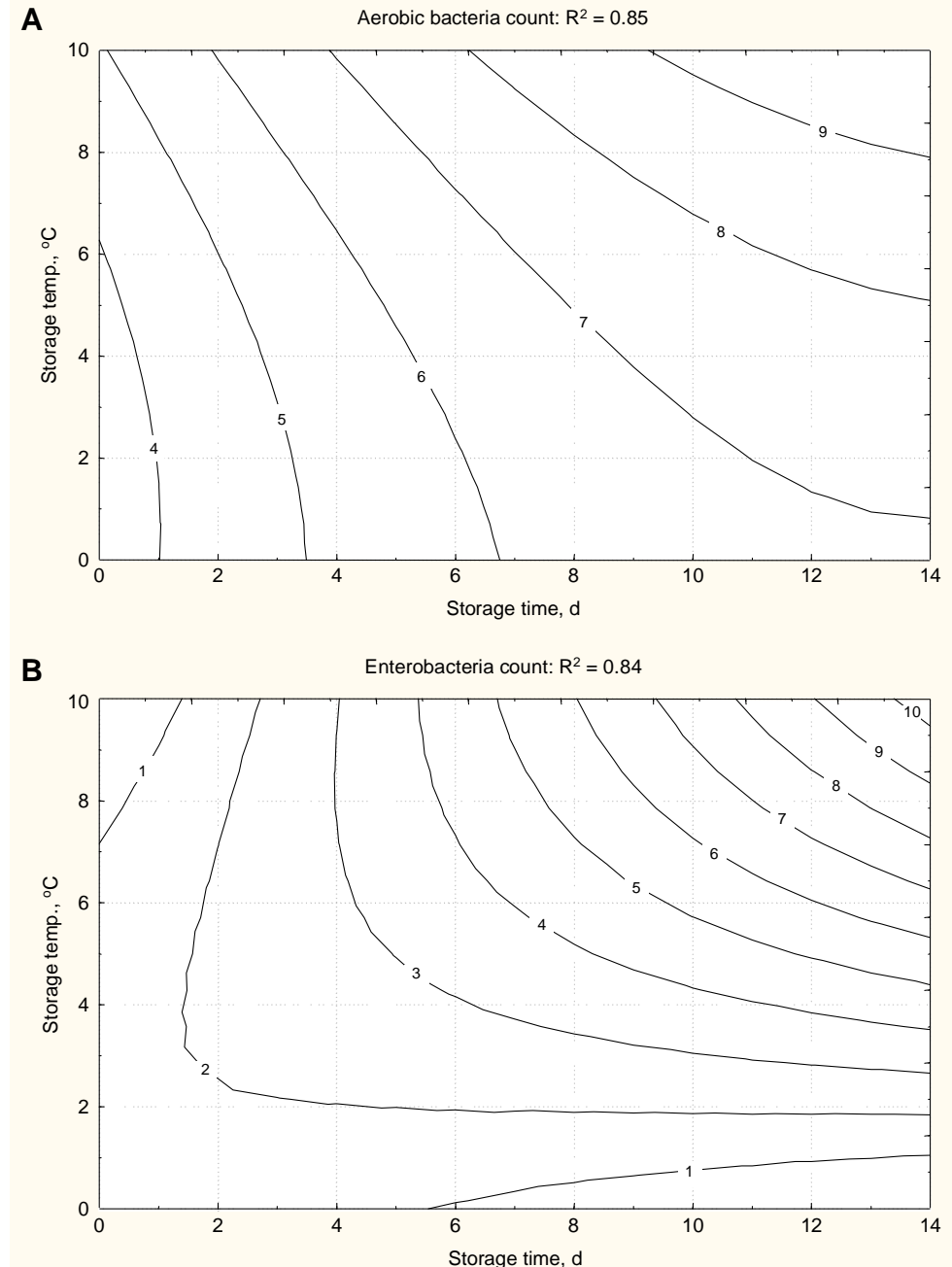
## Case 1: Modified atmosphere packaged broiler chicken cuts

- several storage tests including different temperature profiles were performed with modified atmosphere (80% CO<sub>2</sub>/20% N<sub>2</sub>) packaged unmarinated broiler chicken cuts



## The effect of temperature on the quality of the broiler chicken cuts

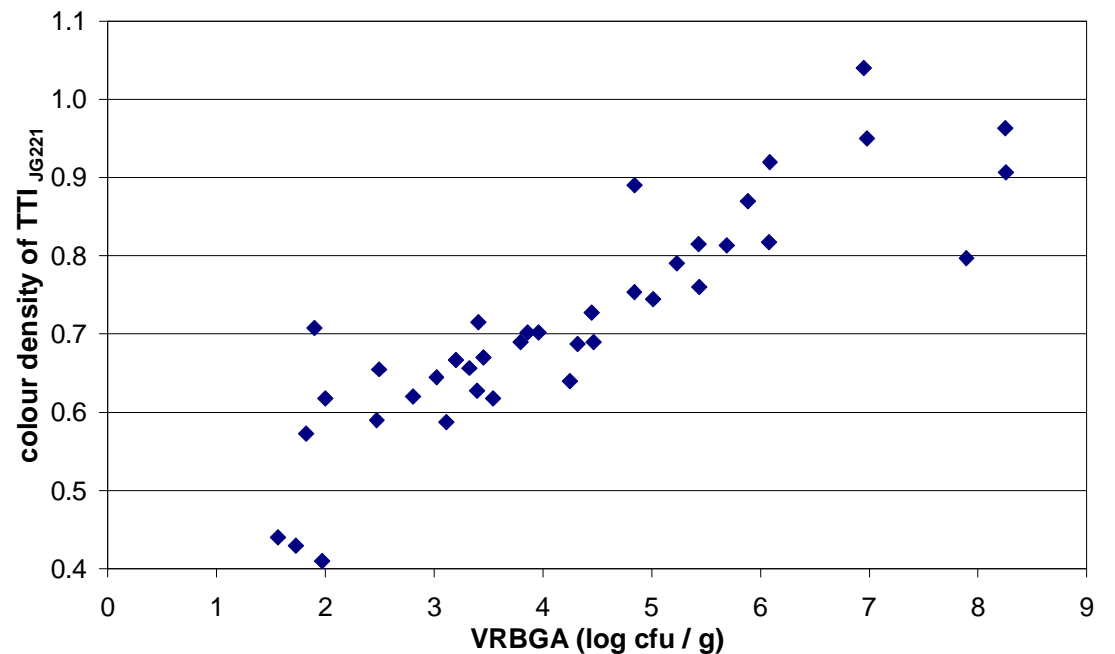
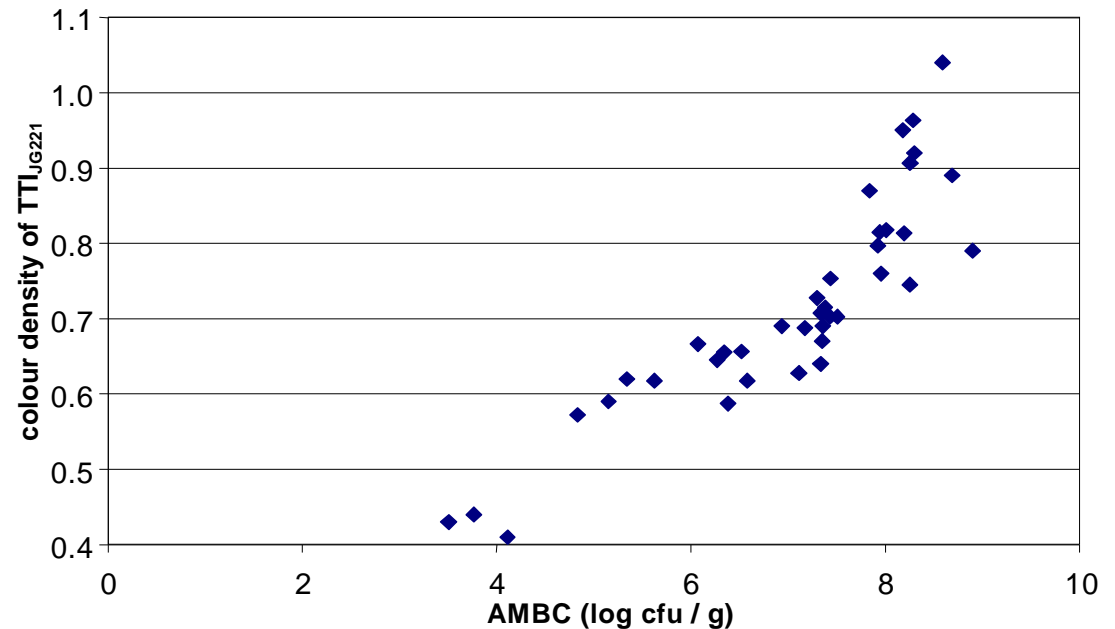
- microbiological shelf-life could be considerably improved in ideal, unbroken cold chain.
- time to reach aerobic mesophilic bacterial count (AMBC) of  $10^7$  cfu/g - doubled when temperature shifted from 8.3°C to 3.4°C.
- even more critical effects were seen in the numbers of *Enterobacteriaceae*, proteolytic bacteria, hydrogen sulphide producing bacteria and clostridia
- strong effect of temperature also on the sensory quality of broiler chicken cuts



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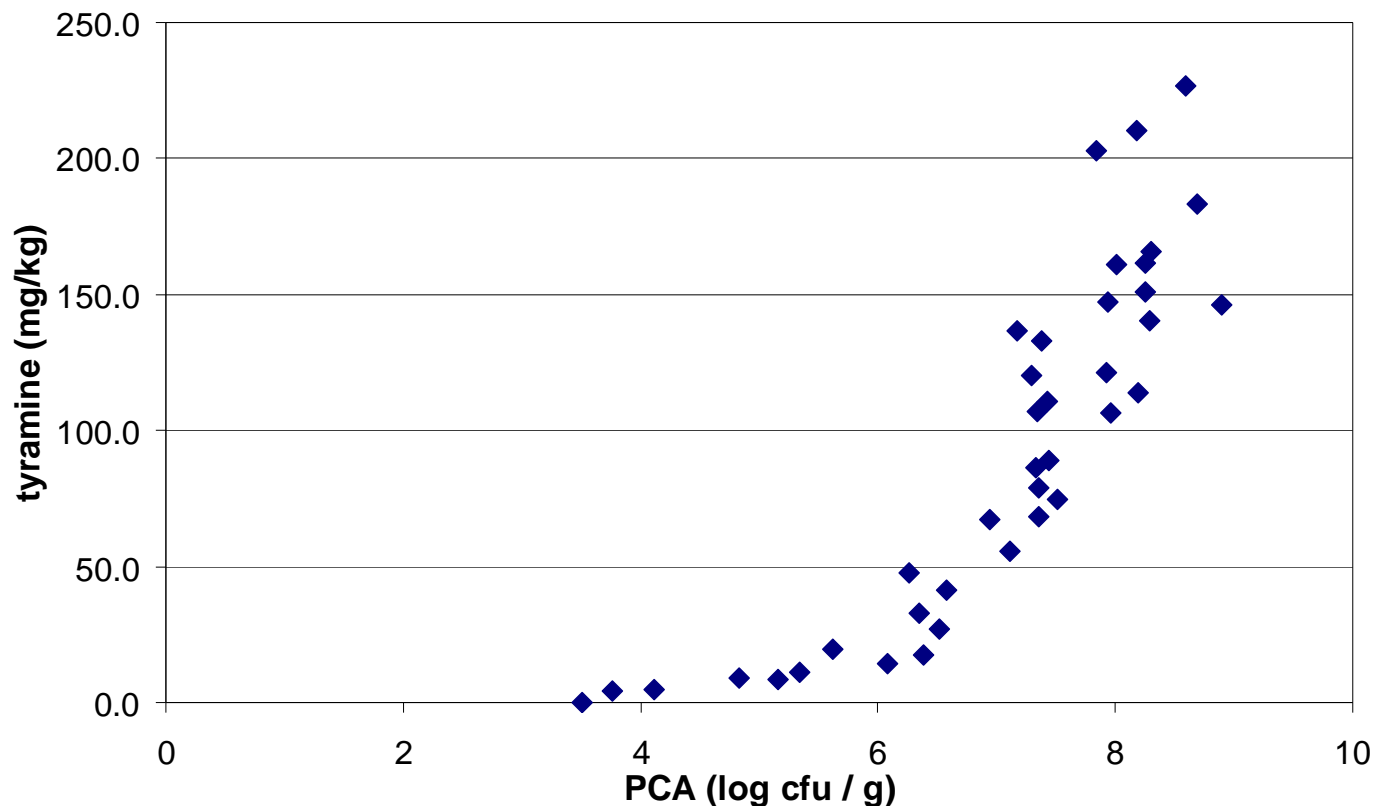
## Time-temperature indicators as quality indication tools for MA-packaged broiler chicken cuts

- good correlation between colour change of time-temperature and
  - aerobic plate count
  - *Enterobacteriaceae*
  - odour of broiler chicken cuts
- it was possible to find indicators with end-points matching the microbiological and sensory shelf-life of broiler chicken cuts



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## Biogenic amines as quality indicating metabolites for MA -packaged broiler chicken cuts



- biogenic amines found only in small concentrations in fresh food
- storage temperature had a significant effect on the formation of tyramine – formation highly consistent with the aerobic mesophilic count
- below +6°C no formation of putrescine and cadaverine

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Monitoring of the quality of modified atmosphere  
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## Electronic nose as quality evaluation tool for poultry



- measures the headspace gas profiles of the samples with different non-specific sensors (e.g. metal oxide semiconductors, conducting polymers)
- classifies the samples on the basis of their volatile "fingerprints"
- the applicability of NST device has been evaluated in our work
- hand-held, battery operated devices also available (e.g. SensorfreshQ™)

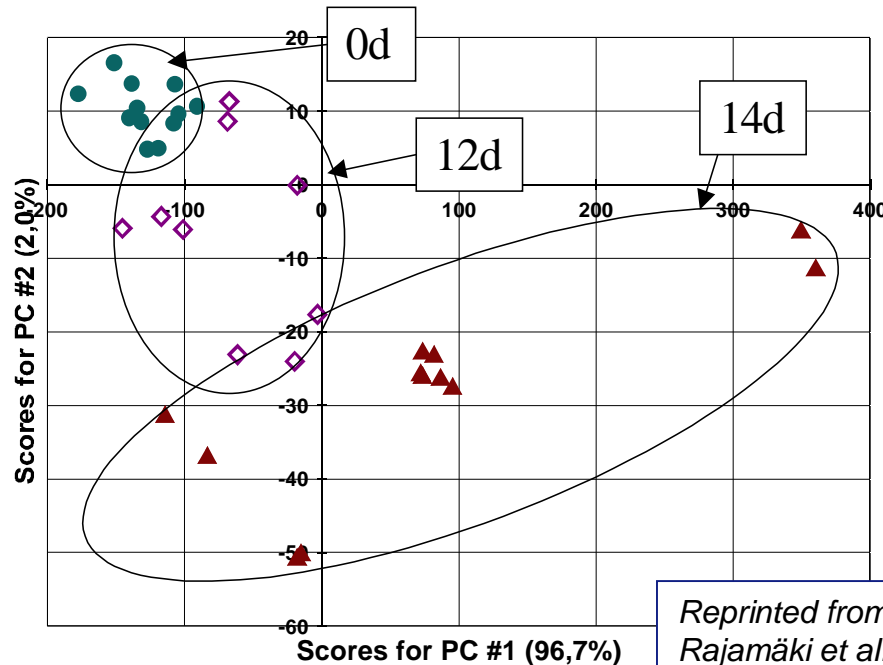


Figure: Food Quality Sensor International, Inc.

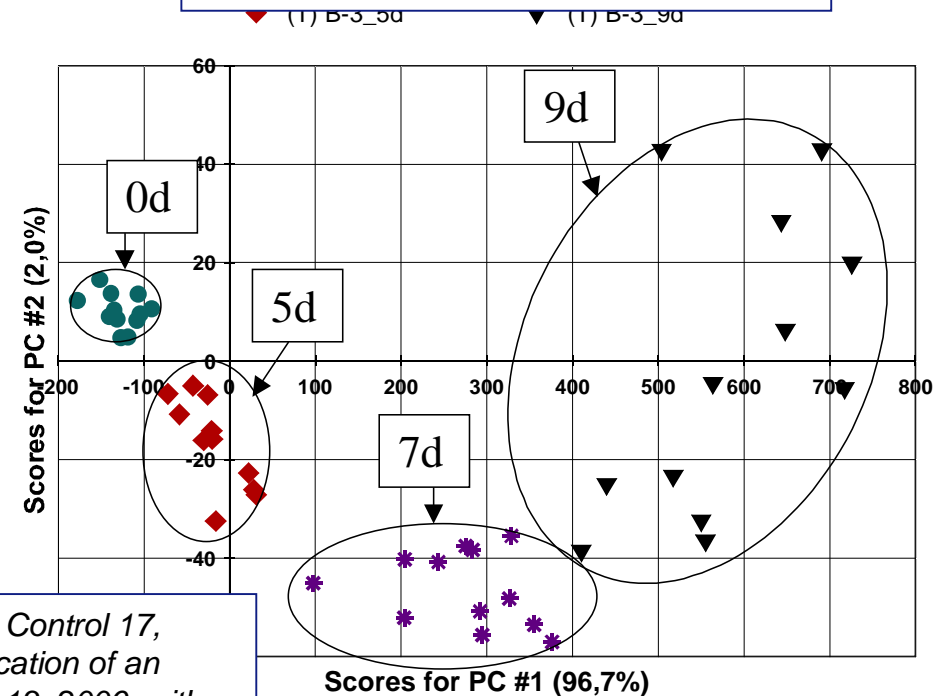
# Electronic nose as quality evaluation tool for poultry

- the results obtained by microbiological examination, sensory analysis and electronic nose were highly consistent
- electronic nose appeared to be capable of detecting even the early signals of spoilage in poultry meat
- possibility to develop single-use, package integrated spoilage indicating sensors?

PCA of variable temperature  
with mean +2.9°C



PCA of variable temperature  
with mean +7.4°C



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## Case 2: Hydrogen sulphide indicator - visual freshness indicator for poultry

- nanolayer of silver reacts with hydrogen sulphide and forms silver sulphide - sensitivity of the indicator can be tailored by modifying the silver layer

→ a visually detectable colour change from opaque light brown to transparent



## Example of quality of MA-packaged poultry and indicator colour change at different storage conditions

### **Controlled temperature storage** for 23 d

- Microbiological quality acceptable
- Odour at opening still acceptable
- $\text{H}_2\text{S} < 2 \text{ mg/l}$
- Indicators – no colour change

### **Abused temperature storage** for 17 d

- Microbiological quality not acceptable
- Odor at opening clearly spoiled
- $\text{H}_2\text{S} < 2 \text{ mg/l}$
- Indicators – complete change

## Conclusions

- storage temperature has very strong effect on the quality of poultry products
- typically a more pronounced effect can be seen on the numbers of H<sub>2</sub>S - producing bacteria, proteolytic bacteria, clostridia and *Enterobacteriaceae* than on the numbers of aerobic mesophilic bacteria
- strong effect of temperature
  - TTIs seem to be a feasible tool to indirectly evaluate the sensory and microbiological quality of poultry
- the growth of the microbial groups being enhanced by elevated temperature is typically followed by production of (volatile) metabolites
  - freshness indicators & electronic nose appear to be promising tools for direct quality indication of poultry
    - indicator for hydrogen sulphide already available
    - other indicator/ sensor concepts?