

Salmonella and Food Safety: Current and Future Strategies



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Salmonella - Why Do We Care?

- **Infection and disease in humans**
 - Mortalities
 - Cost \$billions each year
- **Presence in animals**
 - Birds as carriers
 - Survivability in animal environments
 - Multiple serovars
- **Prevalence and predictability**
 - **Multiple** antimicrobial resistance capability
 - Prevalence, pathogenesis & survivability = **complex problem**

USA
TODAY

Our view on food safety: Egg recalls fit pattern of negligence, lax oversight



Enlarge

By Seth Periman, AP

Here we go again. With the massive recall by two farms in Iowa, eggs now join spinach, hamburger and peanuts on a list of things you thought you could eat without worry but now might have doubts about.

Salmonella Can be Present at all Stages of Food Production = Environment Interface



Farm



Processor



Distributing Center



Retail



Home

truck
railroad
boat

truck
railroad
boat

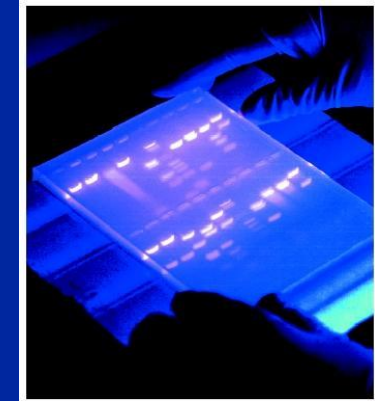
truck
railroad

What makes *Salmonella* pathogenic?

- **Pathogenicity** = Ability to cause disease in the host
- **Virulence** = Potency of infection (direct and indirect factors)
- **Virulence genes** = Anything in the bacterial genome associated with pathogenesis: Attachment, invasion, toxins, and **survival**
- **Complex** = **Need** more comprehensive genetics



Sequencing the *Salmonella* Genome



- **Good news:** Completed for more and more *Salmonella* serotypes
- **Bad news:** Potential information is overwhelming!!
- **How do we use this tool kit for the food industry?**
 - **Functional genomics:** Identifying essential genes with unique functions for establishment in food production environments
 - **Tracking and detection:** Comparing sequences among isolates from isolates
 - **Quantifying** gene expression to understand antimicrobial cross protection

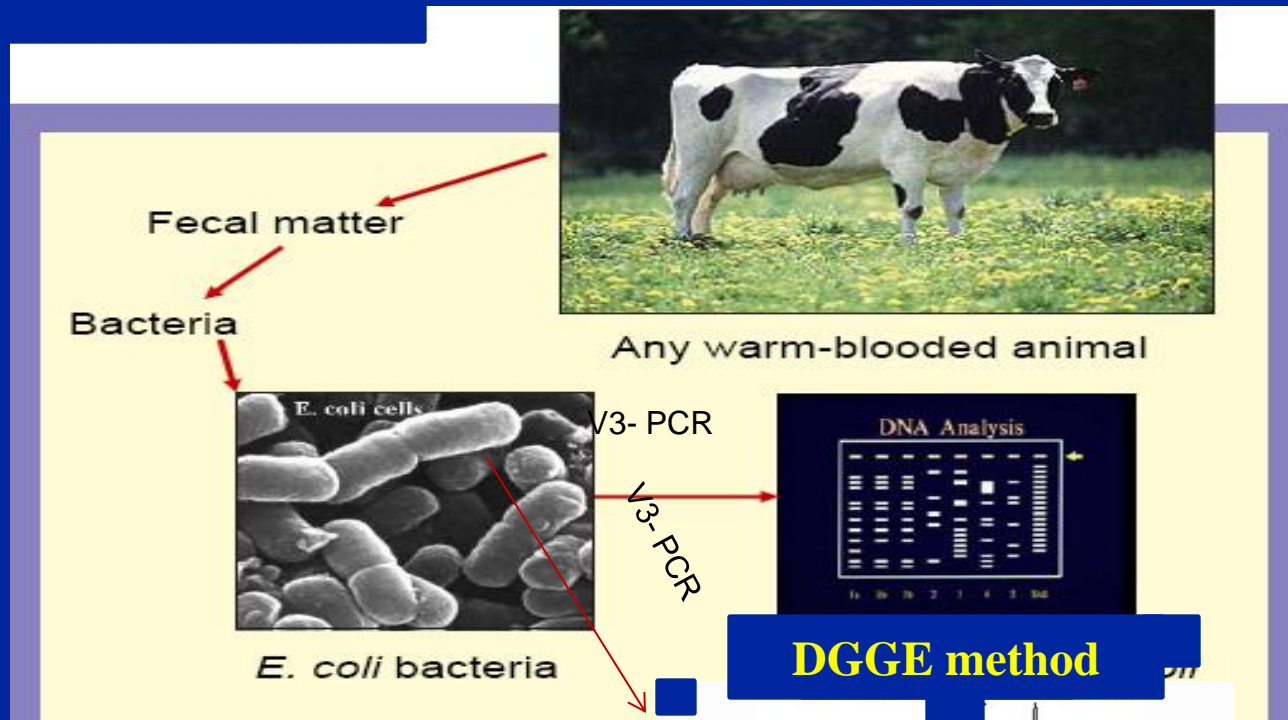
Tracking pathogens

Prescreen method



full sequencing approach

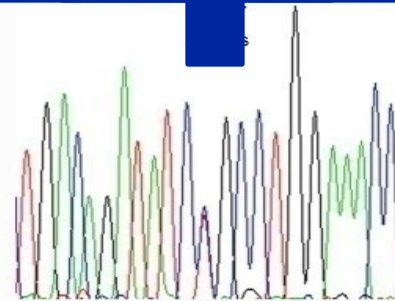
- **Initial DGGE profile**
- **Sequencing isolates:**
- **Compare sequences with established data**
- **Use unique small genome differences to track isolates**
- **Identify origin/source**



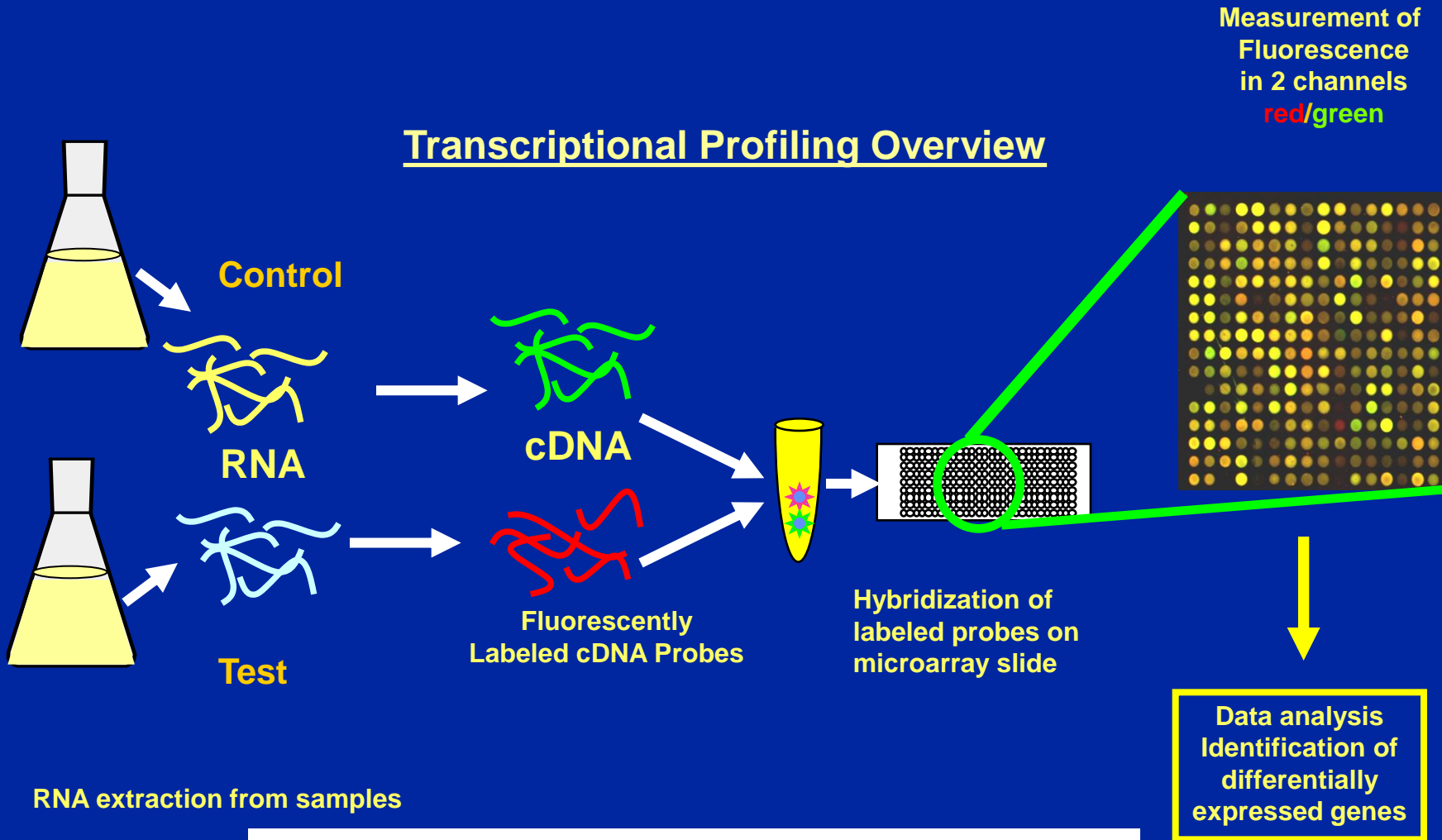
FOODBORNE PATHOGENS AND DISEASE
Volume 7, Number 7, 2010
© Mary Ann Liebert, Inc.
DOI: 10.1089/fpd.2009.0482

Microarray Analysis and Draft Genomes
of Two *Escherichia coli* O157:H7 Lineage II Cattle
Isolates FRIK966 and FRIK2000 Investigating Lack
of Shiga Toxin Expression

Scott E. Dowd,¹ Tawni L. Crippen,² Yan Sun,¹ Viktoria Gontcharova,¹ Eun Youn,³
Arunachalam Muthaiyan,⁴ Randall D. Wolcott,¹ Todd R. Callaway,² and Steven C. Ricke^{4,5}



Quantifying Gene Expression: Transcriptional profiling of pathogens



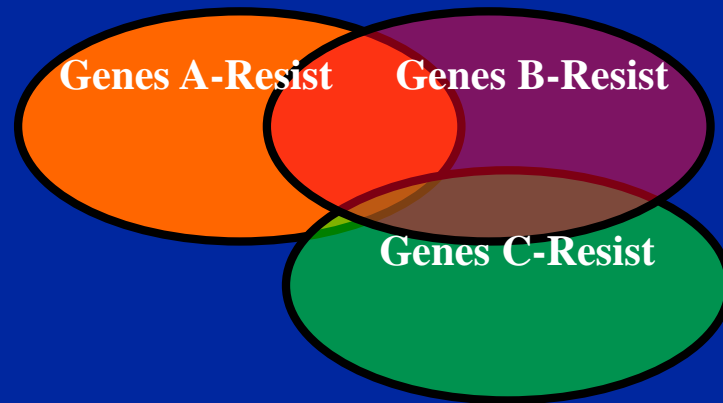
Application of microarray analysis of foodborne *Salmonella* in poultry production:

A review. S.C. Ricke , A. Khatiwara , and Y.M. Kwon. 2013. Poultry Science 92

:2243–2250.

Quantifying Genes for Cross-Protection Potential in *Salmonella* to Interventions A, B, or C

Extensive Cross protection = **Not good**

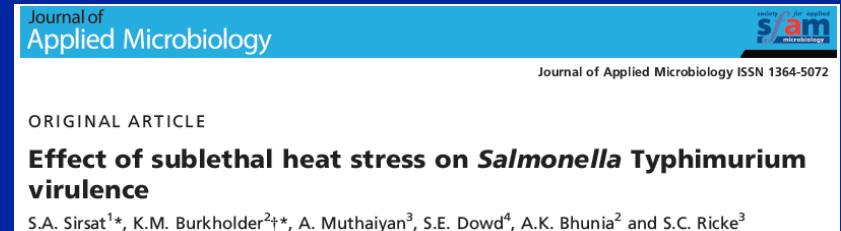


No Cross protection = **Optimal**



Genomic Studies - Applications for Food Products

- Sudden shifts in pH may increase *S. Typhimurium* virulence level in a food matrix
 - How long?
 - Acid type
- Thermal interaction with virulence should be considered
- Chemical composition of food products before and after physical processing may be a factor in virulence response

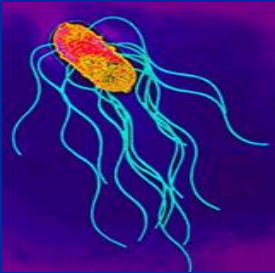


Growth and transcriptional response of *Salmonella* Typhimurium LT2 to glucose-lysine-based Maillard reaction products generated under low water activity conditions. V. I. Chalova, O. Hernández-Hernández, A. Muthaiyan, S.A. Sirsat, S. Natesan, M. L. Sanz, F. J. Moreno, C. A. O'Bryan, P. G. Crandall, S.C. Ricke. **2012.** Food Res. International. 45: 1044-1053.



Future: How Do We Use The Results?

Examples for Application of *Salmonella* Genomics



- **Cost effective control measures = High throughput screening for designing optimal multiple hurdles with minimal cross protection**

- **Improvement of detection technologies: Achieve “real time” assessment**



- **Impact of *Salmonella* “in situ” status: Designing interventions based on metabolic state in the environment**





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Thank You

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