Emerging Foodborne Pathogens with Potential Significance to the Middle East

Ahmed E. Yousef

Department of Food Science and Technology
(and Department of Microbiology)
The Ohio State University
Columbus, Ohio, USA

{Email: yousef.1@osu.edu}

International Food Safety Events With Middle Eastern Connections

2011

Enterohemorrhagic *Escherichia coli* O104:H4 caused a large and deadly disease outbreak in Europe

- **3,950 people were affected, from 16 countries, but the majority were Germans**
- **800 people suffered hemolytic uremic syndrome (HUS)**
- **53 died (mainly adults)**
- **Cucumber from Spain was the believed to be culprit, but this assessment was proven false**
- **Epidemiological analysis: Sprouts made from seed imported from Egypt in 2009 was the source.**

References:

CDC. 2013. http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6250a3.htm

Choffness et al., 2012. National Academies Press, Washington, D.C.

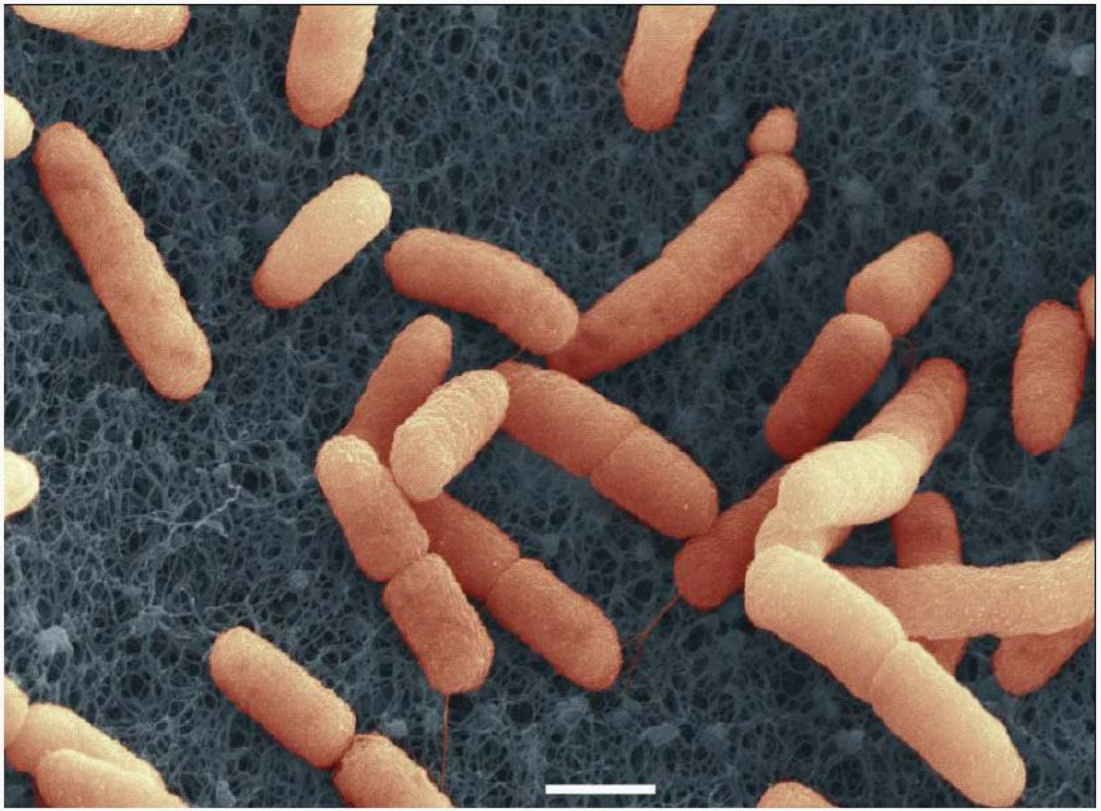
Water

Incubation for days

Fenugreek Seeds

Sprouts

Microbiological characterisation of EHEC O104:H4



Enterohemorrhagic *Escherichia coli*

- Hemorrhagic colitis
- Hemolytic uremic syndrome (acute renal failure in children)

This disease outbreak is caused by a different virotype of *E. coli* but:

- Exhibit the same symptoms as EHEC
- Affect all age groups, not just children

What did we learn?

Persistence

That pathogenic *E. coli* strain survived for ≥ 2 years in the dry seeds

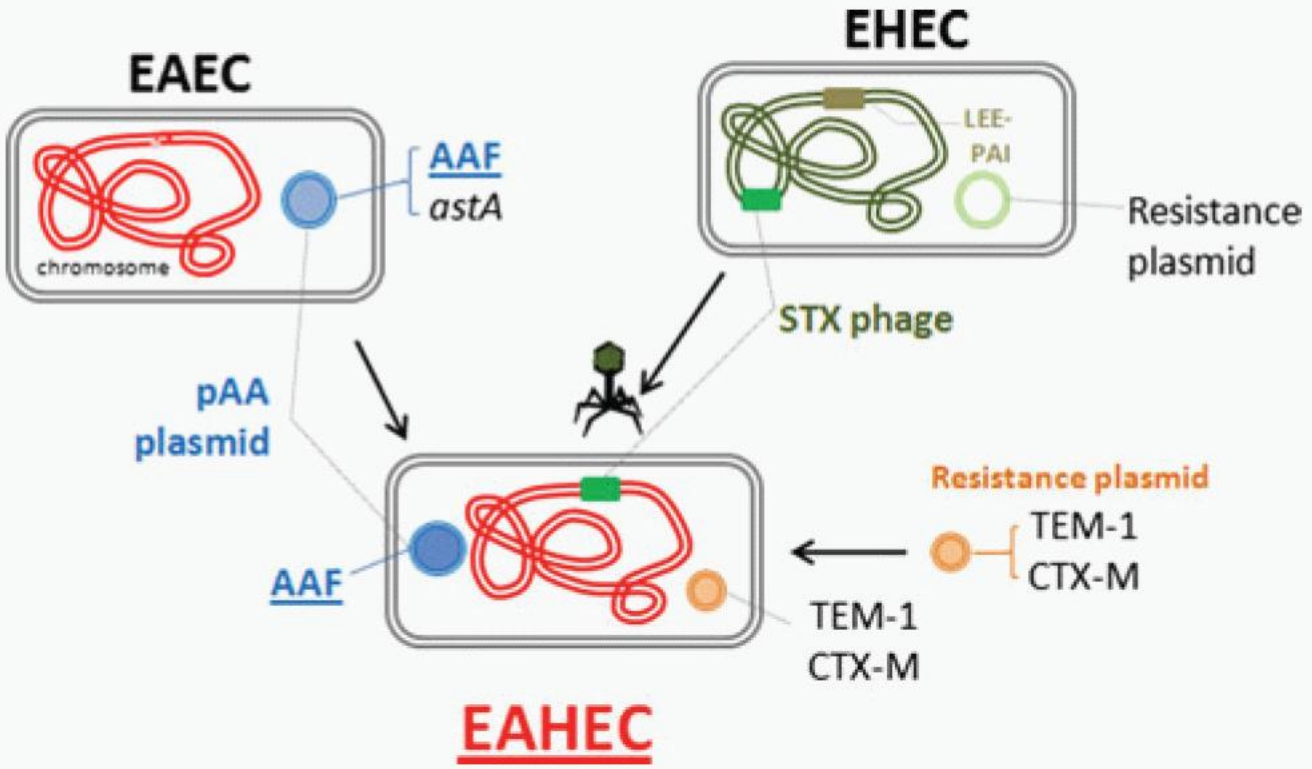
Microbiological analysis

- Tracking the source was unsuccessful initially
- Outcome: Costly to Spain ($200M/week), Egypt, Germany, and other European countries

A new pathogen seems to be evolving

- Deadly to adults
- Looks like a hybrid between two dangerous groups: EHEC and EAEC

Proposed scheme of the origin of the new *E.coli* pathotype



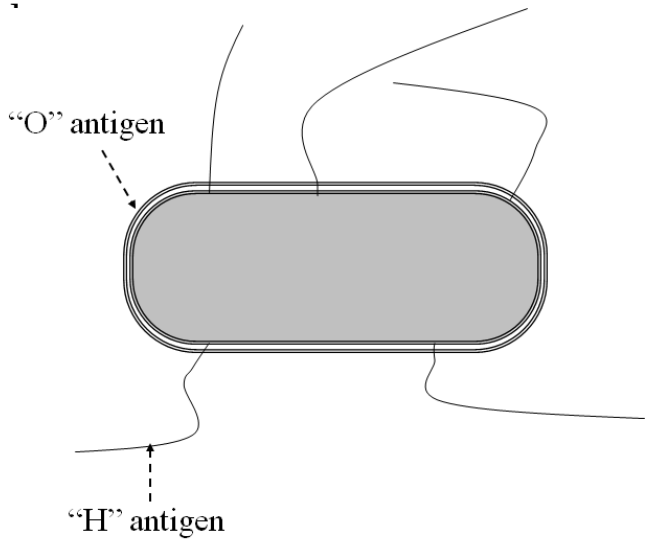
(Brzuszkiewicz, E et al, Arch. Microbiol., Doi 10.1007, June 2011)

For Pathogen Identification and Tracking: What to search for?

E. coli

Enterohemorrhagic *Escherichia coli* O104:H4 XXXXX

Virotype:	Species	Serotype	Strain
Communicates information about disease and sequelae	Communicates genotypic and phenotypic similarity at species lev	Information about somatic and flagellar antigens	Name of a specific culture originating from a single isolate



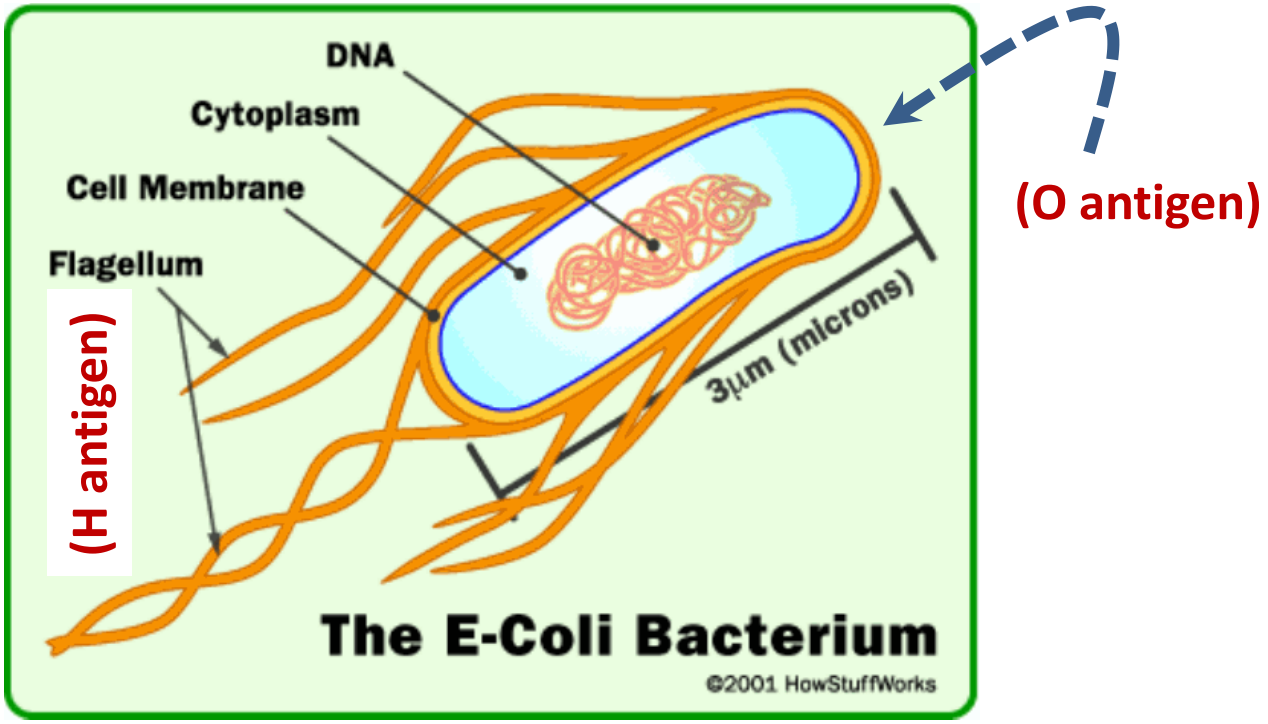
What can be done?

Better science in identifying and tracking pathogens

Serotyping doesn't correlate with pathogenicity

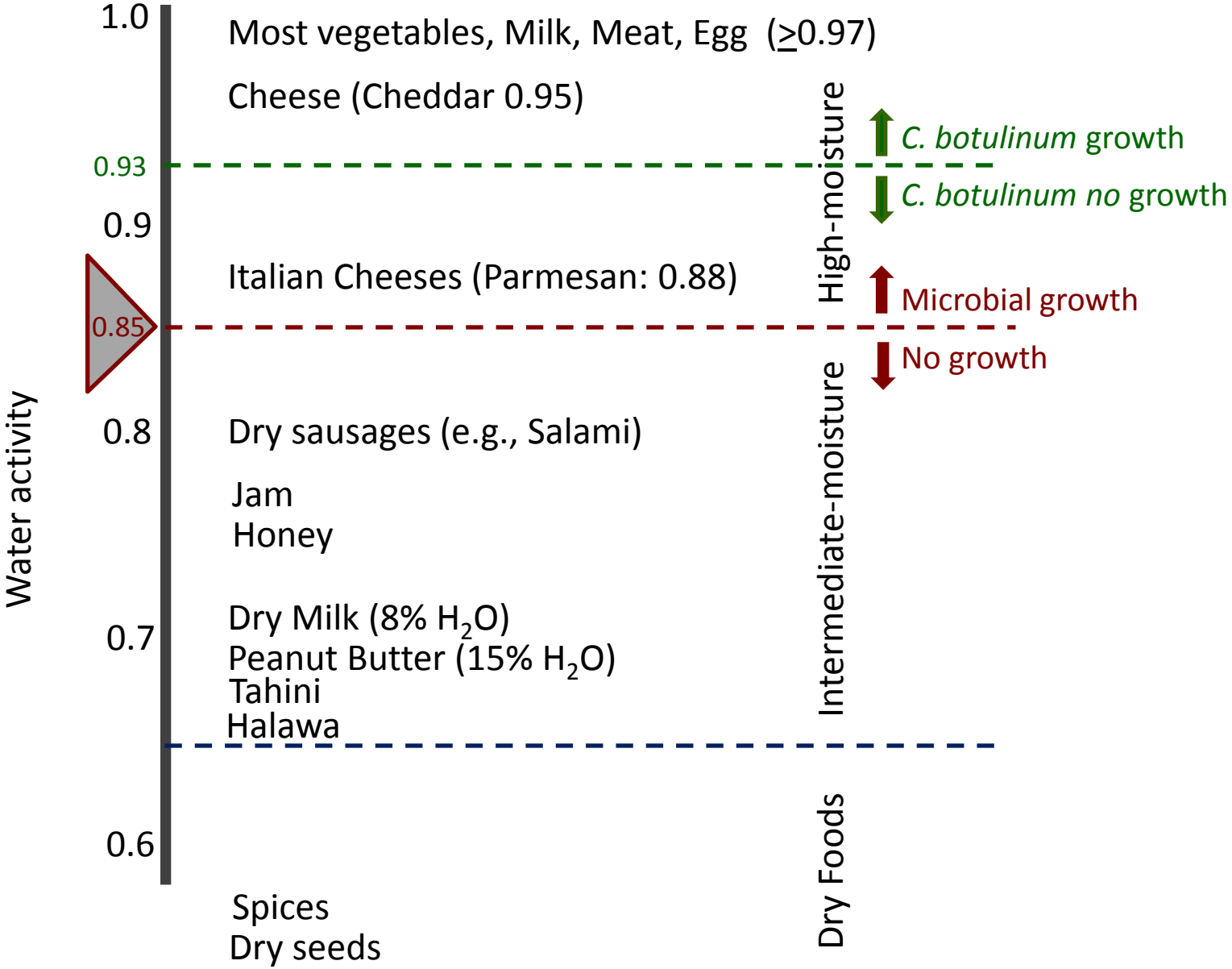
Current finger-printing techniques have shortcomings

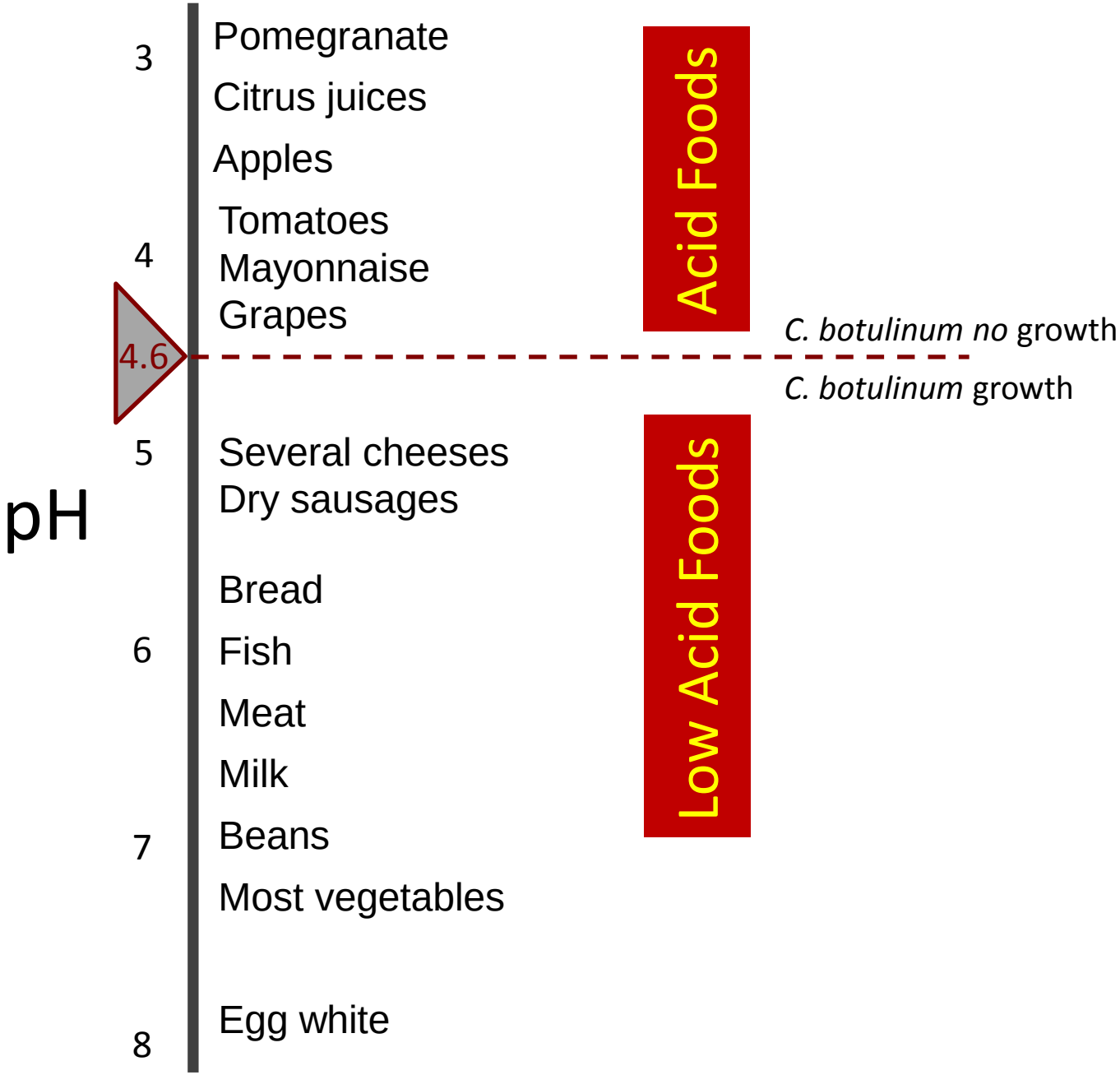
Whole-genome sequencing seems to be the answer

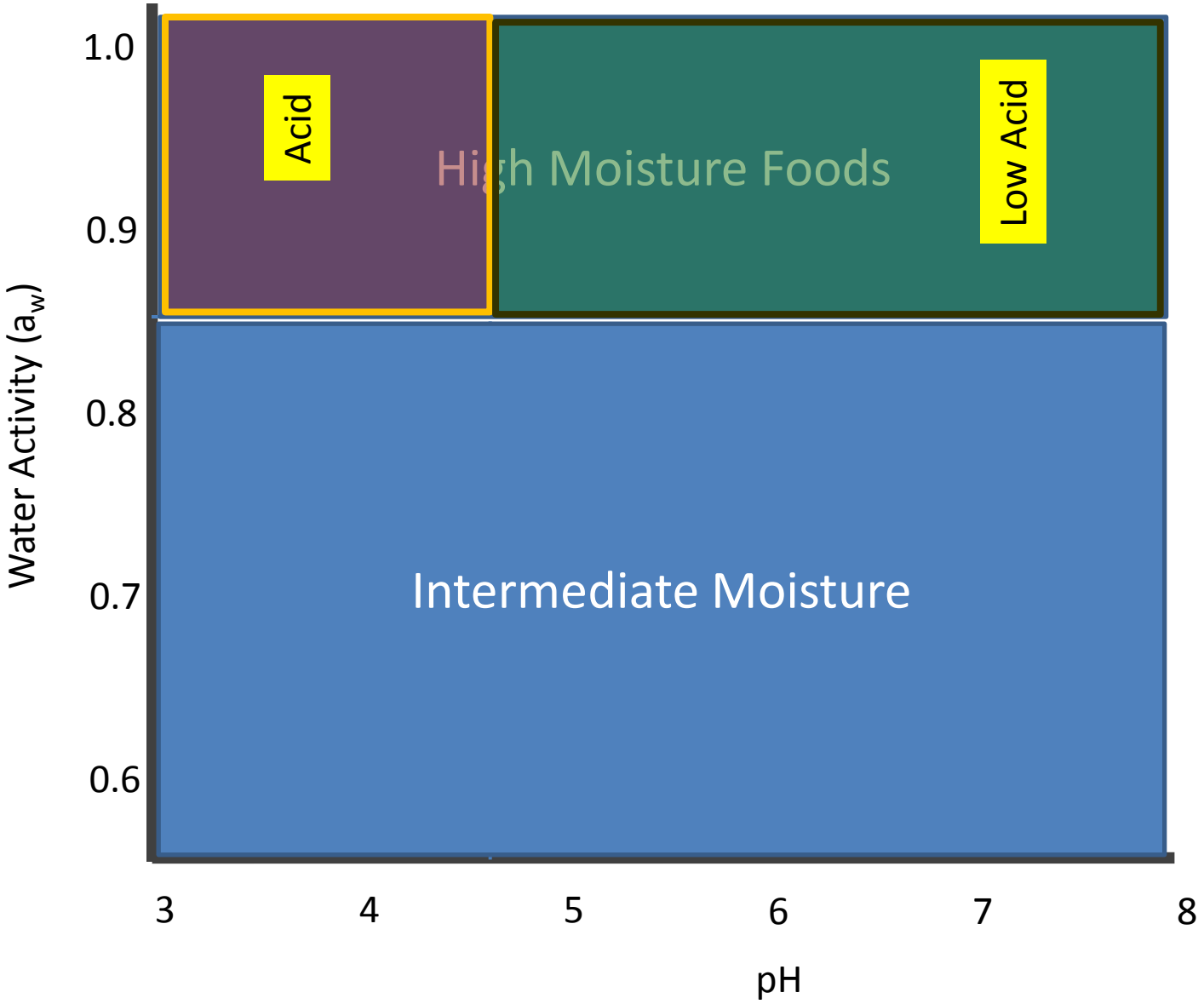


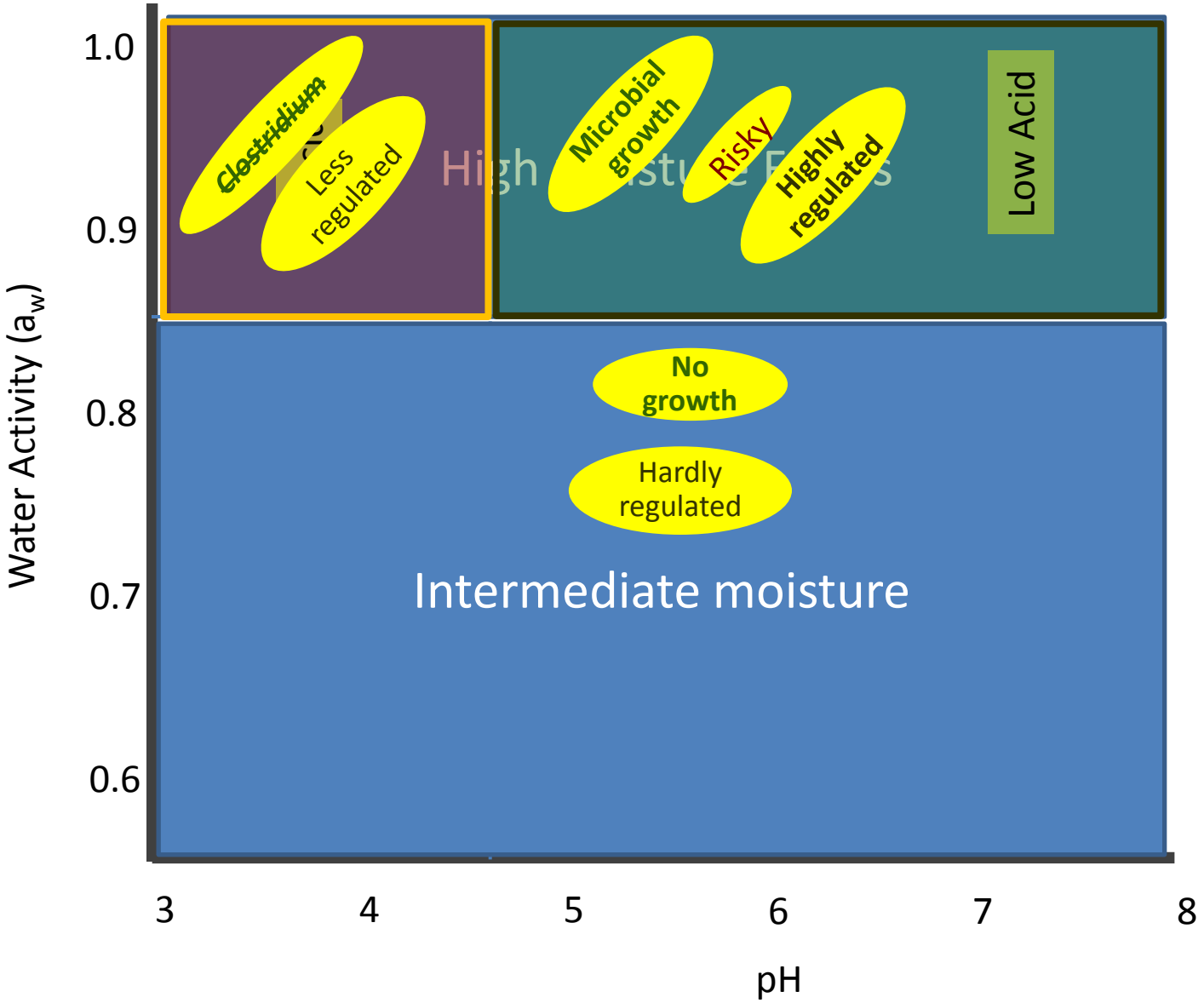
How about survival in the dry state?

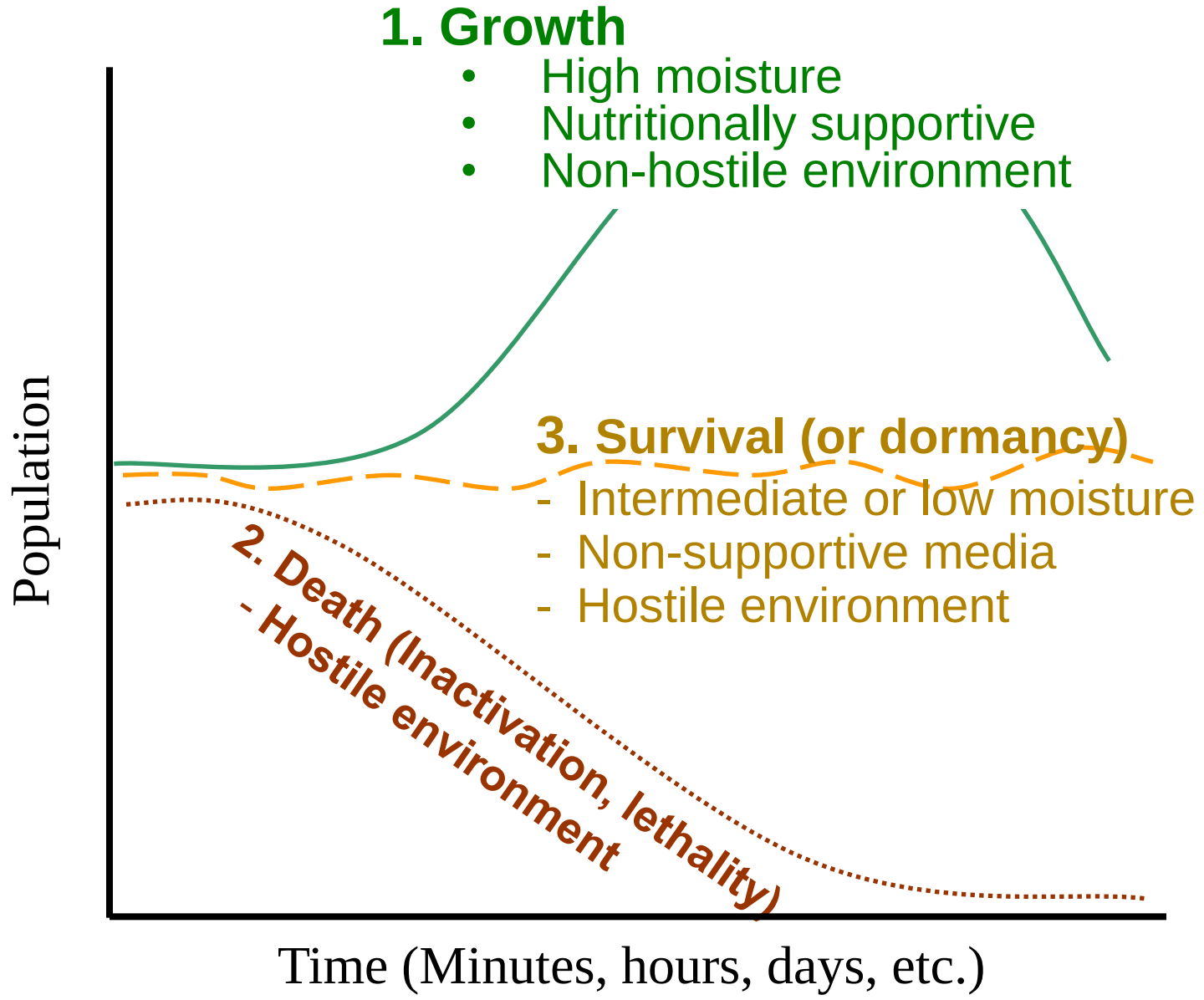
Moisture and pH; importance in food regulations


Water activity
1.0
0.9
0.8
0.7
0.6
0.93
0.85
Most vegetables, Milk, Meat, Egg (≥0.97)
Cheese (Cheddar 0.95)
Italian Cheeses (Parmesan: 0.88)
Dry sausages (e.g., Salami)
Jam
Honey
Dry Milk (8% H2O)
Peanut Butter (15% H2O)
Tahini
Halawa
Spices
Dry seeds
High-moisture
Intermediate-moisture
Dry Foods
C. botulinum growth
C. botulinum no growth
Microbial growth
No growth


pH
3
4
4.6
5
6
7
8
Pomegranate
Citrus juices
Apples
Tomatoes
Mayonnaise
Grapes
Several cheeses
Dry sausages
Bread
Fish
Meat
Milk
Beans
Most vegetables
Egg white
Acid Foods
Low Acid Foods
C. botulinum no growth
C. botulinum growth


Water Activity (a_w)
1.0
0.9
0.8
0.7
0.6
Acid
High Moisture Foods
Low Acid
Intermediate Moisture
3
4
5
6
7
8
pH


1.0
0.9
0.8
0.7
0.6
Water Activity (a_w)
3
4
5
6
7
8
pH
Clostridium
Less regulated
Microbial growth
Risky
Highly regulated
Low Acid
No growth
Hardly regulated
Intermediate moisture



Behavior of microorganisms in various environments (including food)

	Survival	Growth
• **Infectious microbes** - Enterohemorrhagic *Escherichia coli* - *Salmonella* serovars - *Listeria monocytogenes* - *Yersinia enterocolitica* - etc.	Health hazard	Greater hazard
• **Toxins-producing microorganisms** - *Clostridium botulinum* toxin - *Staphylococcus aureus* toxin - *Bacillus cereus* toxin	No or minimal hazard	Greater hazard

Salmonellosis outbreaks linked to sesame products from middle east (INFOSAN, 2004)

2001: *Salmonella* Typhimurium DT 104 in imported Halawa, in Europe

2003: *Salmonella* Montevideo in imported Ta

Sesame seeds

Tahini

Halva

Are non-spore-forming pathogens adapting to low a_w food?

- Peanut butter
- Spices
- Milk Powder
- Cholate products

Are new dry-resistant strains evolving?

- Selective pressure of low a_w
- Adaptive mutation
- Horizontal gene transfer

Conclusions

- As new pathogens emerge, our detection and tracking methods need to cope.
- Contrary to long-standing convention, attention need to be directed to the safety of low water activity food.
- Middle eastern foods with low a_w have been implicated in a number of high-profile disease outbreaks.
- Solutions are ideal at the preharvest stage (prevention), but post-harvest decontamination should only be used as the last resort.


Questions?