Microbiology sampling plans

FOOD QUALITY AND SAFETY - Prof. Angel Angelov, Assoc. Prof. Velitchka Gotcheva

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Microbiological sampling plans

- Define the probability of detecting microorganisms in a lot
- None can ensure the absence of a particular microorganism
- Should be economically feasible

- Sampling for microbiological analysis
  - sampling plan → quality of batch → release safe food

Types of microbiological sampling plans

- Variables plans
  - Non-grouped quantitative analytical results
  - Require distributional assumptions to be made (preliminary knowledge about the product)
- Attributes plans (two- and three-class plans)
  - Qualitative analytical results (presence/absence) or quantitative results that have been grouped (e.g. <10 cfu/g, 10 to 100 cfu/g, >100 cfu/g)
  - No preliminary idea about MO distribution

Sampling plans contain the components of microbiological criteria.

Choice of a microbiological sampling plan

Choice depends on

- The relative degree of risk for the quality of food or the health of the consumer on the basis of the information regarding the product microorganisms
- The expected number of destroyed, survivors or multiplied organisms during the technological operations to manufacture a food product

The two-class plan

- Samples into one of two classes: accept or reject
- Based on presence or absence of an organism or the numbers present
- Sampling plan is defined by:
  - **n** – the number of sample units to be tested (chosen independently and randomly from the lot)
  - **m** – the count above which the sample is considered defective; if acceptance or rejection is based on presence or absence, then m=0
  - **c** - the maximum number of allowable positives or samples with counts above **m**

The two-class plan

Example: Criteria for cooked frozen crab meat:

- *Staphylococcus aureus* n=5 c=0 m = 10^3/g

If all 5 samples contain 10^3 cfu/g or less, the batch is accepted.

If **1** sample has more than 10^3 cfu/g, the batch is rejected.

- *Salmonella spp.* n=10 c=0 m=0

10 samples of 25 g are tested. If any of the samples is positive, the batch is rejected.

The two-class plan

Generally used for pathogens – three categories:

- Pathogens presenting a severe hazard
  - highly potent toxins with high mortality (*Cl. botulinum*) or
  - organisms causing infection with high mortality, low infective dose and which may spread (*Salmonella typhi*)
- Pathogens presenting a moderate hazard
  - with potentially extensive spread (*Salmonella*) (m=0)
  - with limited spread (not necessarily a hazards)
- Two-class plans may be used for indicators as well (*E. coli* as indicator for water supplies or shellfish)

The three-class plan

- Product divided into three classes based on the numbers of organisms present
  - **0 to m**
  - **m** to **M**
  - **above M**

M – the count above which the lot is unacceptable

m – the count which separates good quality from marginally acceptable quality

c – the number of samples with acceptable counts

The three-class plan

Example: Aerobic plate count for pre-cooked breaded shrimp

n=5 c=2 m = 5 x 10^5/g M = 10^7/g

Sample	Count, cfu/g	Conclusion
1	6.3 x 10^6	Two samples fall between m and M. All other samples are below m. As c=2, the batch is accepted.
2	4.8 x 10^5	
3	2.1 x 10^5	
4	5.9 x 10^5	
5	3.6 x 10^5	

The three-class plan

Generally used for

- Organisms associated with general contamination and spoilage – no hazard to consumer (aerobic plate counts)
- Indicators – no direct hazard to consumer, but significant numbers may indicate general process hygiene, post-process re-contamination or temperature abuse (Enterobacteriaceae – problems with general hygiene, *E. coli* – faecal contamination)
- Pathogens representing a moderate hazard with limited or no spread (*Staphylococcus aureus*)

The three-class plan

- **m** – defined by the level of contamination that can be attained by good manufacturing practice
- **M** – numbers giving rise to detectable spoilage, unacceptably short storage life or a potential hazard

Aerobic count in pre-cooked breaded shrimps

n=3 c=2 m=5x10^5 M=10^7

Batch	Sample	Count cfu/g	Conclusion
1	1	4.0 x 10^4	MO count in all samples is below m. The batch is accepted.
	2	3.2 x 10^5	
	3	4.2 x 10^5	
2	1	6.3 x 10^6	MO count in two samples is between m и M. In 1 sample it is below m. Because c=2, the batch is accepted.
	2	2.1 x 10^5	
	3	5.9 x 10^5	
3	1	3.2 x 10^5	MO count in 1 sample is above M. The batch is rejected.
	2	7.8 x 10^7	
	3	4.8 x 10^5	

Plan stringency

Decisions should take into account

- Potential temperature abuse during storage, distribution and retailing
- Possible abuse by the consumer
- The target consumer
- Whether consumer will normally cook the food, type of cooking
- How much food is expected to be consumed

Choice of a sampling plan

- Purpose of control - acceptance or rejection, quality assessment, determination of uniformity
- Nature of the lot - size, dividing into sub-lots
- Nature of test material - uniformity, size of units, price
- Nature of analytical procedures - destructive or non-destructive, duration and price of analysis

Sample analysis

- Collection of samples
- Transportation
- Sample preparation
- Analysis

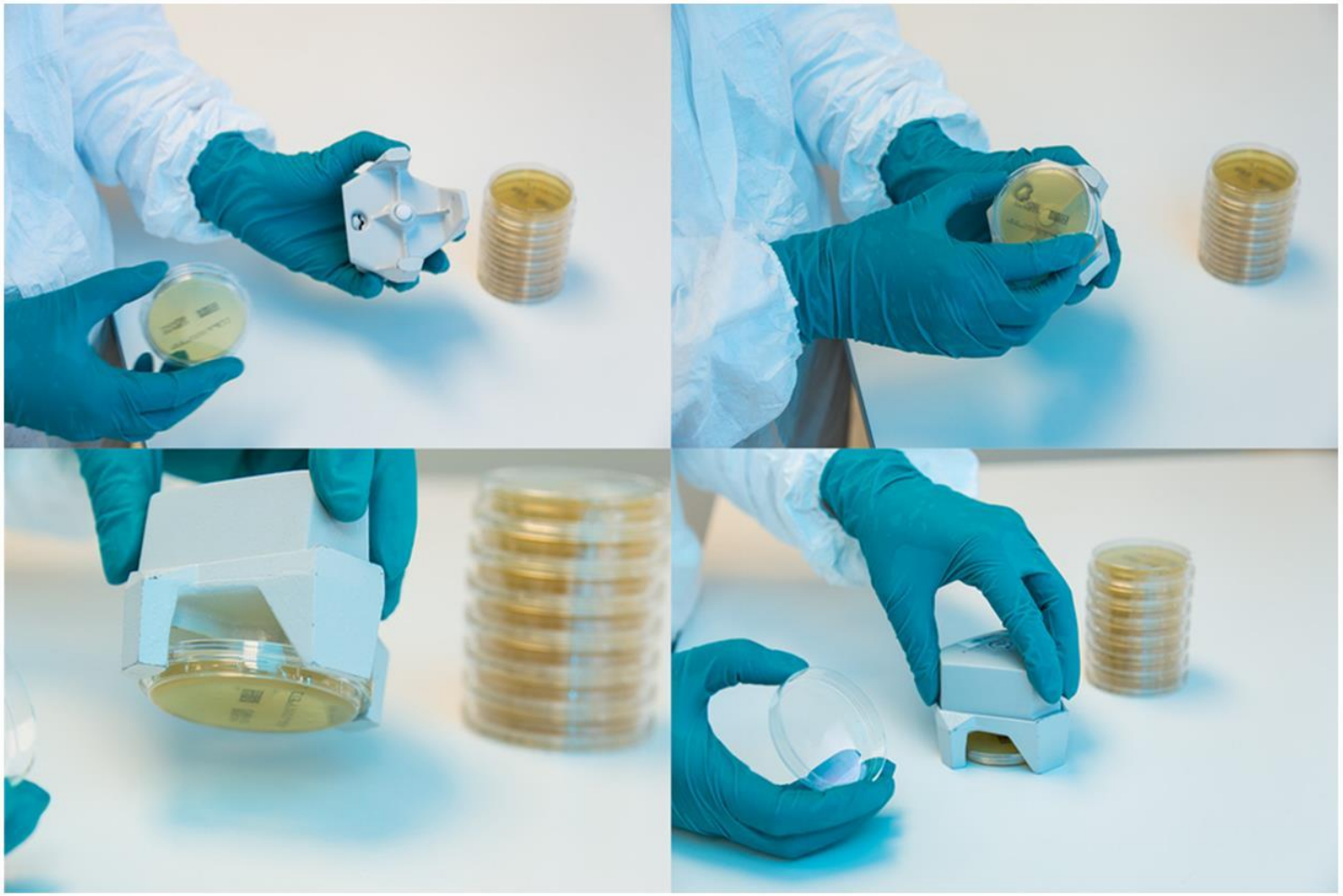
Sample analysis

- Liquid samples

- Samples from solid products

- Samples from surfaces

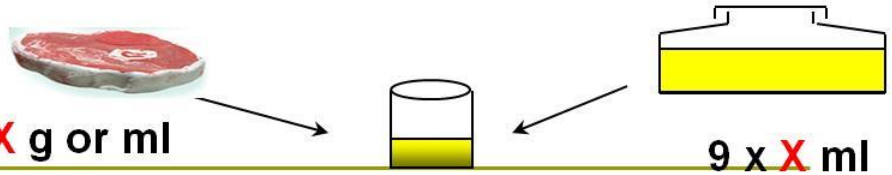
Sample analysis

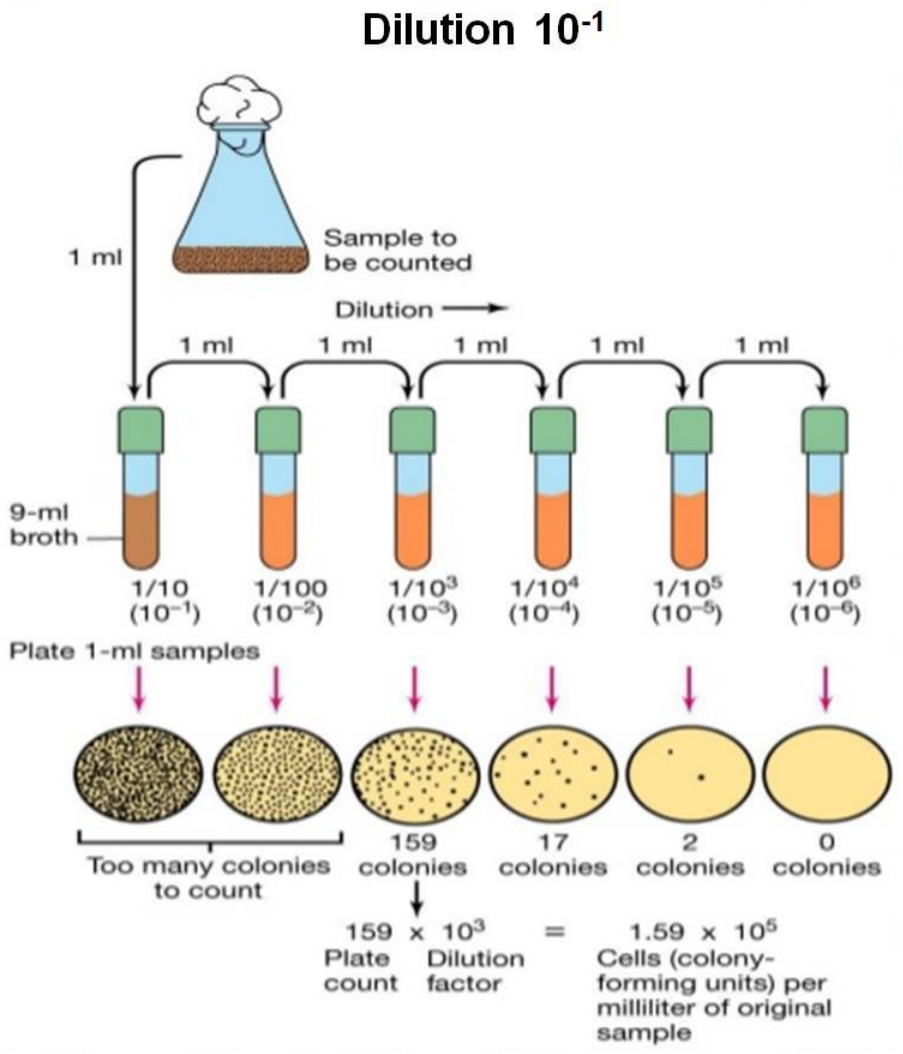


Sample analysis

- Liquid samples – possible dilution, filtration
- Powder samples - dilution
- Samples from solid products – homogenization (blender, Stomacher)
- Choice of dilution solution
  - 0.1% peptone water (pH=6.8-7.0), phosphate buffer or Ringer solution; combination of от 0.1% peptone and 0.75% NaCl (ISO 6887:1983)
  - solutions for osmophilic and halophilic microorganisms

Sample analysis





Sample analysis

- ISO 7218: Microbiology of food and animal feeding stuffs - General requirements and guidance for microbiological examinations
- ISO 6887-1/2/3/4/5/6: Microbiology of food and animal feed - Preparation of test samples, initial suspension and decimal dilutions for microbiological examination
- B.A.M. (Bacteriological Analytical Manual) – FDA's laboratory procedures for microbiological analyses of foods and cosmetics (previous editions by Association of Official Analytical Chemists)