HACCP in Water Reuse
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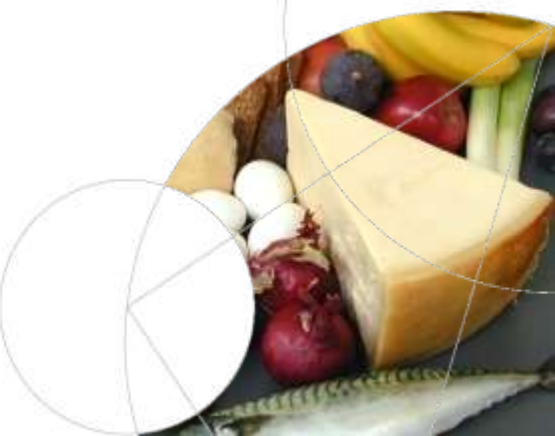


HACCP- Hazard Analysis Critical Control Point

Food Safety Assurance system moving control from end product testing to proces control

Preventive, pro-active, measurements based

Neccessary pre-requisites:

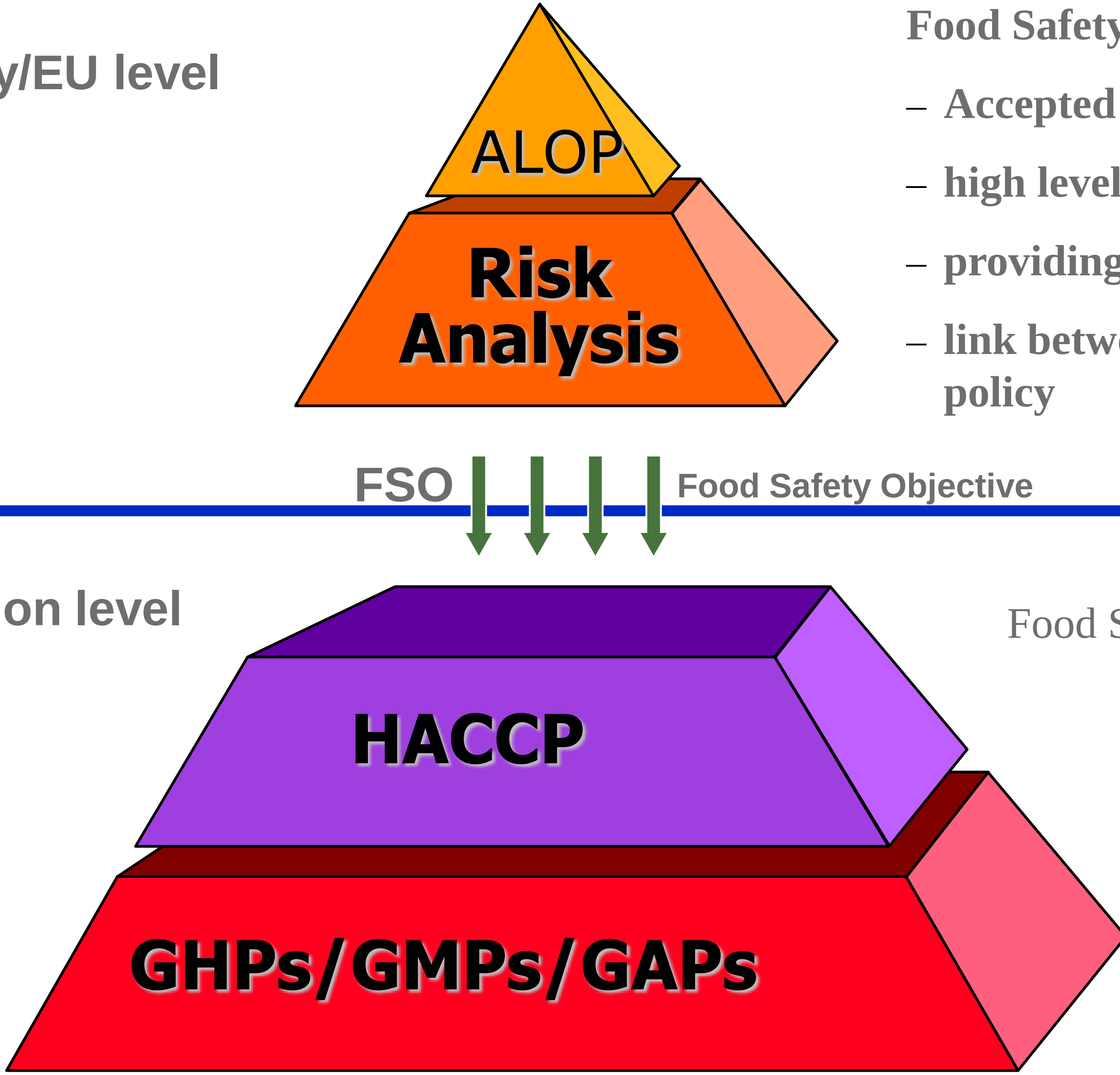
Good Hygiene Practise to ensure proper factory lay-out, equipment design, avoidance of contamination, waste management, cleaning and desinfection programs, personal hygiene, training programs, pest management, recall and traceability systems, supplier control, labelling etc.

Knowledge of hazards, sources, processes, and end use

Safety culture and integrity

Management of Food Safety Risks

Country/EU level



Food Safety Control:

- **Accepted Level of Protection**
- **high level, generic**
- **providing guidance/targets**
- **link between operation and policy**

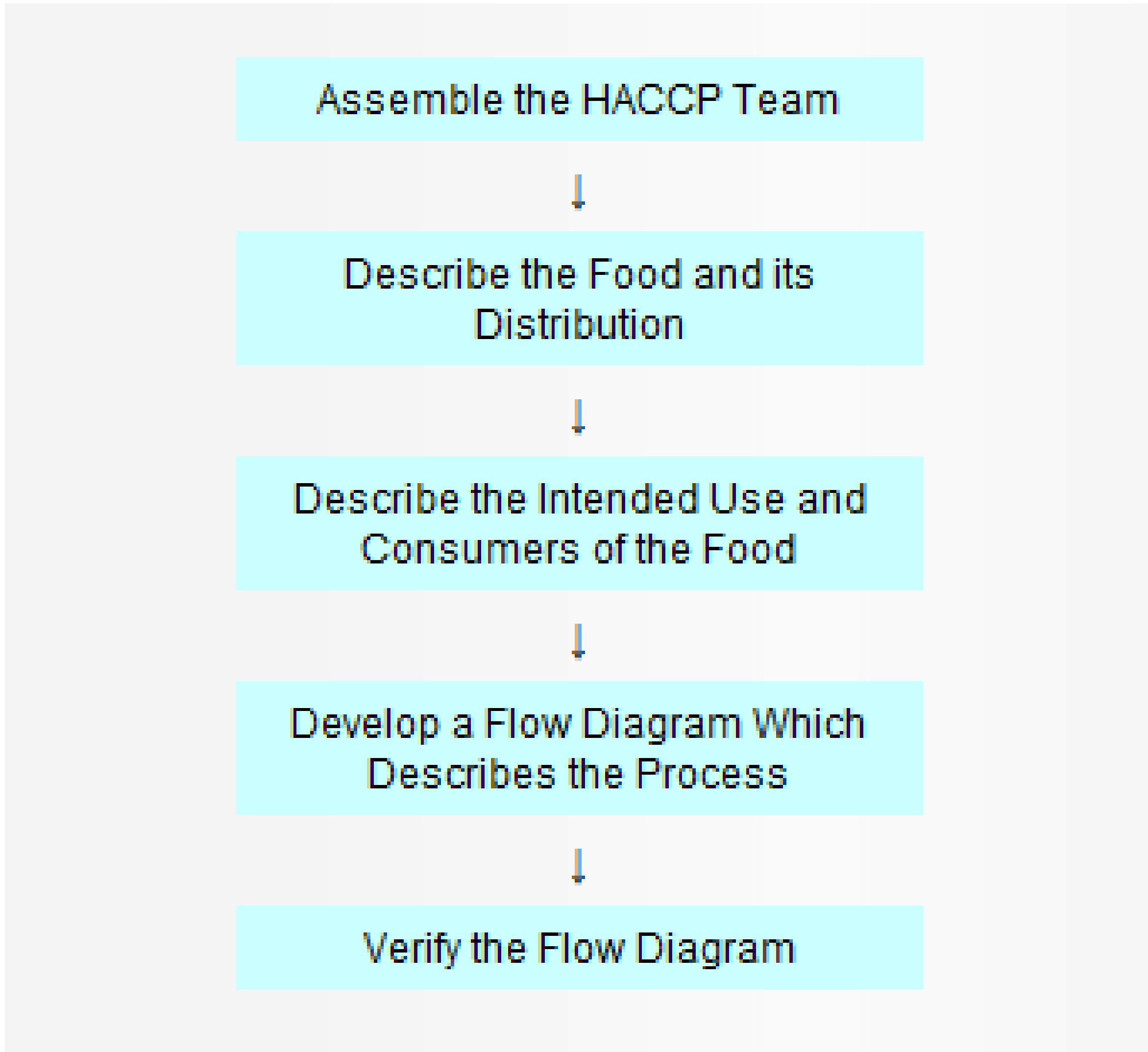
Operation level

Food Safety Management:

Local and specific management at supply chain level

Courtesy of Leon Gorris

Preliminary to HACCP



HACCP is a systematic approach to the identification, evaluation, and control of food safety hazards based on the following seven principles:

1: Conduct a hazard analysis.

2: Determine the critical control points (CCPs).

3: Establish critical limits.

4: Establish monitoring procedures.

5: Establish corrective actions.

6: Establish verification procedures.

7: Establish record-keeping and documentation procedures

Questions for HACCP team: RO treated milk water

Hazards:

- Source whey (Raw milk? Pasteurised milk? Repasteurized? Ultrafiltrated? Concentrated?)
- Microbiological or chemical contamination potential during transfer

CCPs

- reverse osmosis (treatment efficiency?, potential variations?)
- Distribution and storage (levels and types found in permeate? Growth/time/temperature? Biofilm build-up?), Use (direct, indirect, technical?)

Monitoring options (type?, sensitivity?, correlation with contaminants? Real-time?)

Critical limits

corrective actions incl. alternative use with non-compliance

Data documentation/Record keeping

Monitoring: Case study on peeled shrimps

Quality data for water recovered from peeling before and

Parameter[a]	Unit	Influent	Effluent			Removal [log]
			Average	Guideline value	Measurements	
Escherichia coli	CFU in 100 ml	5	< 1	< 1	5 (0)[b]	0.7
Enterococci	CFU in 100 ml	120	< 1	< 1	5 (1)	2.1
Coliform bacteria	CFU in 100 ml	> 240	< 1	< 1	5 (0)	2.4
Aerobe viable counts	CFU ml^{-1}	10^5-10^6	< 1	< 200	5 (1)	5.8
Aerobe viable counts	CFU ml^{-1}	10^5	< 1	< 20	5 (1)	4.4
Hardness, total	°dH	13.6	0.26	< 5	5 (0)	1.7
Conductivity	mS m^{-1}	169	11.5	-[c]	5 (-[d])	1.2
pH	pH unit	8.35	6.3	6.5-8.5	On-line	-
Temperature	°C	10.2	15.6	AP[e]	36 (0)	-
Dry solids	mg l^{-1}	2,287	178	< 1,500	4 (0)	1.1
NVOC	mg C l^{-1}	220	4.1	< 4	2 (0)	1.7
BOD_5	mg O_2 l^{-1}	1,630	5.4	AP	3 (0)	2.5
COD	mg O_2 l^{-1}	1,867	13	AP	5 (0)	2.2
Total N	mg N l^{-1}	197	7.0	AP	5 (0)	1.4
Total P	mg P l^{-1}	10	0.03	< 0.15	3 (0)	2.5
Ammonium	mg NH_4 l^{-1}	0.14	0.80	< 0.5	5 (3)	-0.8
Nitrite	mg NO_2 l^{-1}	0.19	0.02	< 0.1	5 (0)	1.0
Nitrate	mg NO_3 l^{-1}	< 0.5	2.6	< 50	3 (0)	-0.7
Iron	mg Fe l^{-1}	0.05	< 0.01	< 0.2	3 (0)	0.7
Manganese	mg Mn l^{-1}	< 0.01	< 0.01	< 0.05	3 (0)	0.0
Chloride	mg Cl l^{-1}	274	19.9	< 250	5 (0)	1.1
Calcium	mg Ca l^{-1}	62.6	0.23	< 200	3 (0)	2.4
Magnesium	mg Mg l^{-1}	16.2	0.09	< 50	3 (0)	2.3
Sodium	mg Na l^{-1}	176	17.6	< 175	5 (0)	1.0
Potassium	mg K l^{-1}	32.4	2.44	< 10	2 (0)	1.1
Sulphate	mg SO_4 l^{-1}	49	< 0.50	< 250	3 (0)	2.0

[a] The parameters were determined according to EU recommendations (Directive 98/83/EC, 1998); [b] Five analysed samples and numbers in parenthesis are those exceeding the guideline value; [c] The water should be as little aggressive as possible; [d] All measurements were below 28 mS m^{-1}; [e] AP: As low as possible

Reverse Osmosis

APC removal:

7 log CFU ml^{-1}

Treated water

DWQ

⇑ TAP water

Casani, Leth & Knøchel 2005

Monitoring: Case study (Casani et al. 2005)

Comparison of rapid methods for evaluation of the hygienic quality of treated water recovered from peeling in a shrimp processing factory

Parameter	ATP	Conductivity	Turbidity	Absorbance	Multichannel fluorescence
Pre-treatment of sample	No[a]	No	No	No	No
Precision	High	Very high	High	High	High
Detection of RO failures [% feed in permeate]	≥ 0.1	≥ 1	≥ 0.1	> 10	≥ 1
Detection limit [CFU ml^{-1}]	≥ 10^3	≥ 10^5	≥ 10^4	> 10^6	Not investigated
Monitoring	On-site	On-site[b]	On-site[b]	Laboratory	On-site[b]
Investment cost [EUR]	4000	400	1,500	2,000[c]	54,000[d]
Operation cost per test[e] [EUR]	3/test	None	None	None	None
Maintenance problems	None	Calibration Fouling	Sample cells[f]	Lamp	Calibration
Advantages	Simplicity	Precision Simplicity	Overcomes feed variations Accepted by regulatory authorities	None	Allows recording and automation
Disadvantages	Interferences[g]	Temperature dependence[h]	Handling of sample cells	Low sensitivity	Requires expertise for development

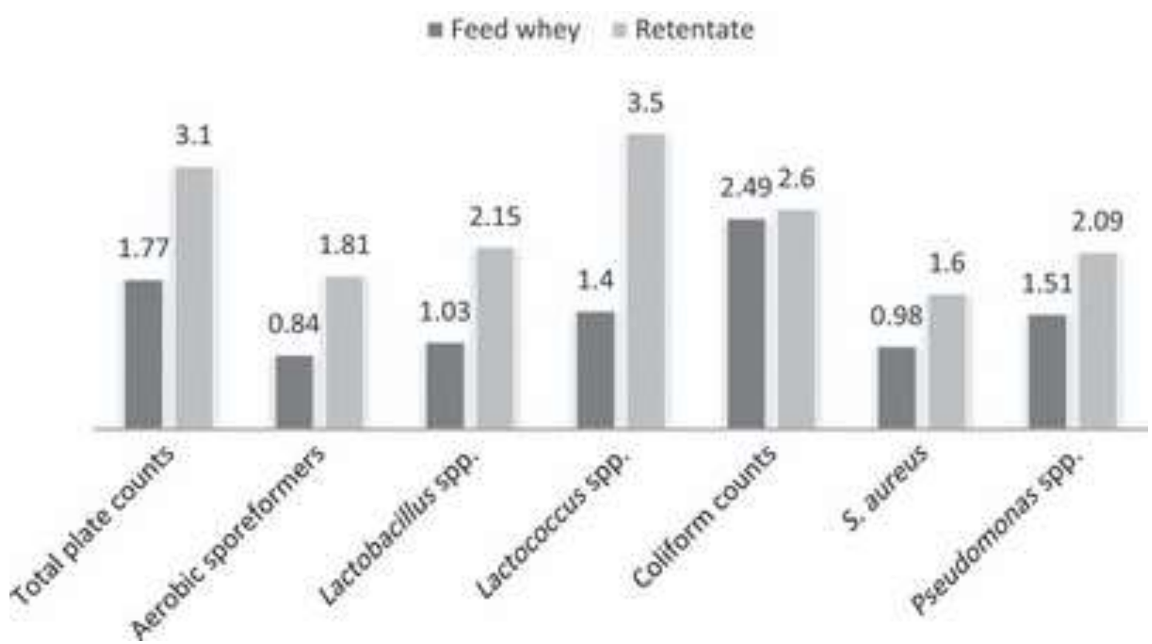
[a] Not done here, but necessary to exclude ATP from somatic cells, [b] Potentially on-line, [c] Approx. 5000 EUR for a new model, [d] Simple dedicated instrument may reduce cost significantly (x 100), [e] Regarding reagents, [f] Must be extremely clean and free from scratches, [g] Non-distinction between bacterial and non-bacterial ATP, [h] Conductivity decreased as sample temperature increased when measuring ten consecutive samples of feed and permeate

Are all microorganisms killed by CIP?

Fluorescence microscopy image: Dead (red) and live (blue) bacterial cells on the surface of 14-mo-old reverse osmosis whey concentration membrane *after CIP*

Journal of Dairy Science, Volume 93, Issue 6, 2010, 2321–2329

The effects of biofilms formed on whey reverse osmosis membranes on the microbial quality of the retentate



Differences in bacterial counts ($\log_{10}$ cfu mL^{-1}) of feed whey and retentate (whey concentrate) because of an increase in their log numbers during a typical 21-h filtration cycle (each value is an average of 10 replicates).

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