The importance of hygiene and disinfection

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Hygiene and disinfection are partially overlapping concepts. Hygiene is mainly related to cleanliness, to the management of dirt, but also in its microbiological sense.

'Sanitation' means to improve the hygienic circumstances.

Terminal disinfection is strictly about eliminating possible pathogen micro-organisms by reducing them as close to zero as possible (or by a maximum log).

Both are actions aimed at removing possible causes of contamination that can affect your chick quality. Let us call the cleaning part 'macro' and the disinfection part 'micro'.

Visible to the naked eye

The 'macro' part is the bulky part, that is mainly visible for the human eye. On the organic side, we can see the litter, the excrement, the contents of broken eggs, the fluff and meconium of day old chicks and we know they contain micro organisms.

On the inorganic side, we see the lime scale build up, caused by calcium (or other mineral) deposits of hard water. We know they equally shelter micro organisms.

So, we can see if the organic and inorganic dirt has been removed and assume a lot of micro-organisms have gone with it. This is the cleaning part.

The question is: how many pathogens remain after the dirt has been removed? (A rule of thumb in the hygiene industry is that a good cleaning job should remove at least 80, preferably 85% of the micro-organisms. So we consider 'sanitation' as a good cleaning job, not as a good disinfection job!).

Good cleaning essential

A good cleaning job will determine 85% of the microbiological result. The disinfection will contribute for only 15%. A bad cleaning job means that dirt (organic or inorganic) will still harbour micro-organisms that the disinfectant can not reach.

The micro part is the abstract part. It is the fight against an 'invisible enemy'. We need to visualise this enemy through electronic microscopes or incubate them to become visible colony forming units (cfus).

The HACCP standard for disinfection is to reduce the micro-organisms with 99.99% or log 4. (Sterile is 100% reduction and is required in certain surgery circumstances, for example).

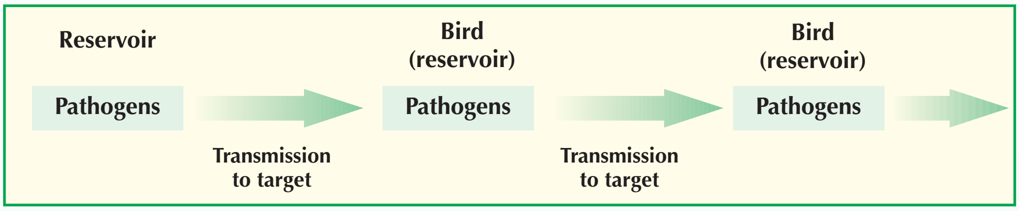

Fig. 1. The chain of infection.

A good hygiene programme will also include operational or managerial measures to prevent contamination or to secure the health (and the life) of your livestock, be it breeders, hatching eggs or broiler chicks. Securing the life (or the 'bios' in Greek) is what biosecurity stands for.

Protecting the population

Biosecurity is often defined as 'measures designed to protect a population from transmissible infectious agents'. Biosecurity has three components:

- Isolation (for example all in- all out).
- Traffic control.
- Sanitation (or cleaning and disinfection).

The goal is to break the chain of infection.

This chain is composed of pathogens that need a reservoir or source (people, other birds, rodents, insects or any organic material acting as life support for those microbes, say 'dirt') and that can get transmitted to (other) birds (the 'target'), again becoming a source for further transmission, etc.

The best way to avoid infection is obviously to have the environment (the incubator, the truck, the barn) free of disease causing organisms. This can only be achieved by thorough cleaning and disinfection (eliminating the original reservoir or source).

HACCP requires a 99.99% or log 4 reduction of those micro-organisms (sterile is 100%). Two weeks downtime or sanitary stop should be allowed to stop the development of the 0.001% germs that may have survived the cleaning and disinfection cycle in the barn. Bacteria can double by cell splitting every 20 minutes, so one bacteria can reproduce in less than a day to a number far greater than the number of people on earth!

This downtime is not possible in the hatchery, so more stringent measures will be needed there. There is a matrix of different sources of contamination – vertical, horizontal, internal (within the house) and external (from outside vectors such as people and their vehicles).

Vertical transmission means that the infection has been transmitted by the parent stock through the hatching egg. Hence the importance of starting with a healthy breeder flock as a first premise for biosecurity. The breeder's health status should be maintained, so they should be protected from horizontal contamination, both internally and externally, which is basically the same principle as in the case of broilers (farm hygiene) that follows. In this article, we will focus on cleaning and disinfection as such, not on the constitutional (geographic location) structural (design and easy to clean material choice), and operational (managerial) biosecurity.

Table 1. CFU reductions at North Carolina State University test farms.

House status	CFU/sq. in.	Reduction from previous step (%)
Dirty	3,000,000	
Blown down (air)	2,900,000	3.4
Air out	2,000,000	31
Washed with water	500,000	75
Washed with detergent	100,000	80
Disinfected	<1,000	>99

So, is cleaning and disinfection important?

Research at the Institute of Poultry Research in Holland has shown that the better the 'hygiene score', the better the 'production figure' is.

Cleaning first!

It is impossible to disinfect dirt. Dirt harbours micro-organisms, so you may disinfect the outside layer of the dirt, but not kill the bugs inside it.

Cleaning is the removal of dirt. A study at N. Carolina State University (Table 1) stresses the importance of using detergents (and disinfectants afterwards).

So, what do those detergents do, to make the surfaces cleaner?

Their characteristics include:

- Wetting: decreases surface tension.
- Dispersing: splits up dirt particles.
- Emulsifying: splits and suspends oil and fat.
- Suspending: floats and carries away dirt particles.
- Sequestering: dissolves salts.

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This is the 'chemical' action of detergents. The action will also be determined by the pH.

If the dirt is organic (fat, proteins) then an alkaline (pH >8) detergent will be needed. If the dirt is inorganic (lime scale from calcium or any other mineral deposit), an acid (pH <6) detergent will be needed.

In total, there are four factors of cleaning:

- Chemical energy: pH and concentration. (Alkaline detergents remove proteins and fat; acid detergents remove mineral deposits like scale).
- Thermal energy (fat starts to dissolve as from 35°C or 95°F.)
- Physical energy (for example a high pressure washer).
- Contact time. This will enable the chemical energy to do its job. Moreover, it is the only factor that does not cost any energy, it is free of charge!

If you increase one factor, you can save on the others. Since contact time is free of charge, this is the one we should maximise, in order to save water consumption, labour and energy, as shown in Fig. 3.

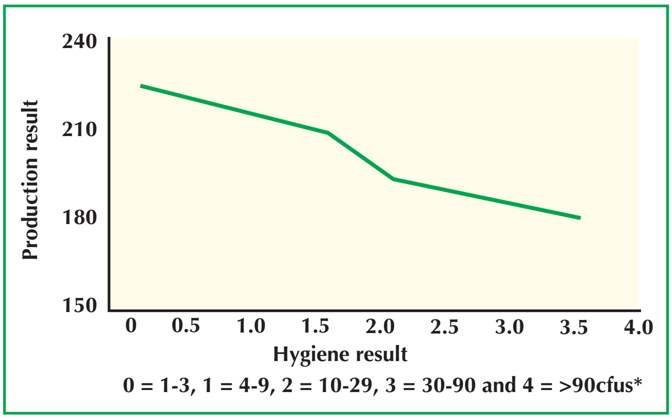

Fig. 2. Correlation between hygiene and production result. The production result is the EPF (European Production Figure). Calculated as follows: ((Growth (kg) x survival rate) / FCR) x 100). *Dutch IKB standard.

Product A (100 gr/L, dilution @ 2%) costs €10/L
Product B (200 gr/L, dilution @ 1%) costs €20/L

Diluted price prod. A : €10 x 0.02 = €0.2/L dilution
Diluted price prod. B : €20 x 0.01 = €0.2/L dilution

Table 2. The real cost of a disinfectant.

Disinfection

The goal of disinfection is to reduce the number of pathogens, ideally with log 4 (99.99%).

Therefore, the disinfectant should comply with a number of characteristics.

First of all, it should be compatible with the detergent, foam or gel cleaner. This means that if your cleaning agent contains cationic surfactants, your disinfectant should not contain anionics. (Phenols and especially their derivates like cresolics are known not to be compatible with non-ionic surfactants and cationics like quaternary ammonia).

Well formulated disinfectants should comply with a number of characteristics, such as composition, opportunity, safety and tested (COST).

Composition

- How many different active ingredients compose the product, so that it assures a maximum synergy?
- Does the product contain buffering agents (surfactants, wetting agents, sequestering agents) so it does work in contact with organic matter, in hard water, in cold water, in all pH and assures a minimum two year shelf life?
- The one million € question: how many grams/L (oz/gal) or % active ingredients does the product have? And, is it expressed in terms of 100% ingredients (for example glutaraldehyde is sold in 50%? This amount should be halved to express the total number of g/litre glutaraldehyde); or in other words how much water is there in the drum? This concentration will determine the dilution.

Opportunity

Does the product have the full spectrum: bactericide, fungicide, virucide and sporicide? (Beware of -stats, like bacteristats. They stop their development, but do not reduce their number!)

Is it also versatile to be sprayed, foamed and fogged without adding any additives, ready to use?

Safety

- For people (for example not containing carcinogenic substances like formaldehyde).
- For animals.
- For equipment (not being corrosive on galvanised feeder lines and fans, or aluminium drinker supports).
- For the environment (being biodegradable and therefore not containing heavy metals such as tin, silver).

Tested

Has it been tested by international standards such as the new ENE (European Norms-Normes Européennes) and the AOAC (Association of American Chemists, that work with 5% organic load and in 400ppm hard water) rather than only national standards (such as DEFRA, DVG, Afnor) that will be replaced by the ENE?

This acronym (COST) is more relevant than the perceived cost – the price per litre (per gallon).

The real cost is the cost in dilution, determined by the concentration and the synergy. An example is shown in Table 2.

Hatching egg hygiene

With the exception of cases involving transovarian infection, the hatching egg (or 'pregnant egg') is free of micro-organisms when it leaves the oviduct. This presumes a clean cloaca, that is not affected by diarrhoea, since wet droppings will contaminate the shell.

Then it may face many challenges. If the egg is laid in the nest (floor eggs and eggs laid on slats are 'dirty' by definition), a dirty nest or litter will immediately contaminate the egg, as will dirty egg belts in the case of mechanical or automatic nests.

Thus, eggs laid in nests or transported on belts contaminated with droppings, broken eggs or wet shavings may be as contaminated as floor eggs are, or even more!

Next, non-sanitised hands may put them on contaminated flats, trays or cartons. The egg storage room in the breeder farms also stores many micro-organisms as does the truck that brings them to the hatchery. Once there, they may again be contaminated.

Moreover, a 'rough ride' to the hatchery can cause cracks in the shell that allow for an easier bacteria penetration and affect hatchability. Needless to say that the vehicle transporting the eggs should be clean and disinfected.

In addition to all that, other biological vectors such as insects, rodents or wild birds can contam-

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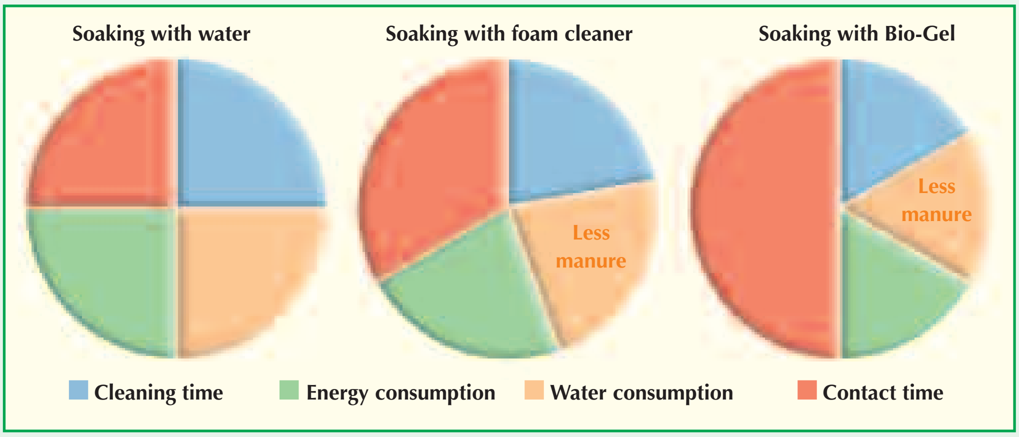
Fig. 3. The sinner circles with increasing contact time.



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inate the eggs should they be in contact with them.

Last but not least, wide temperature changes can make the eggs sweat, which allows rapid multiplication and easier access of micro-organisms to the highly nutritious egg content.

So, there is room for hygiene measures at each of the above 'critical control' points. In addition, frequent egg collection will help reduce contamination (and 'spontaneous incubation' in hot climates).

As a summary, the precious hatching eggs are at risk from:

- External contamination of the shell and through pores and hairline cracks.
- Vertical transmission (from infected flocks).
- Internal contamination (of yolk and albumen).
- External vectors such as hands, trays, vermin and transport equipment.

Microbiological environment

Bacteria such as salmonellae, E. coli, pseudomonas and proteus and moulds (such as Aspergillus fumigatus) can contaminate both egg and chick. The micro flora of the shell is dominated by Gram positive bacteria. Gram negative bacteria dominate rotten and tainted eggs.

Nature provides the egg with some natural barriers such as the cuticle, the shell (with 7,000 to 17,000 pores), the two shell membranes, and chemical defences within the albumen.

The cuticle is a physical barrier to micro-organisms, but it can be removed by improper washing products and procedures or by rubbing the egg.

The shell thickness and pore length will determine the resistance of shell penetration. Bacteria will penetrate thin shelled eggs (from older flocks) more easily.

Calcium should be added to the feed of breeder hens, but be sure that enough calcium is absorbed in the metabolic process to ensure a strong shell formation.

Hens with diarrhoea will not absorb sufficient nutrients and calcium, and more will be excreted.

Chemical sanitisers will reduce the microbial population on the shell at the time of application. However, if micro-organisms have already invaded the egg, it is too late; the sanitisers will be ineffective!

Egg washing or not?

An egg can appear clean, but can carry over 100,000 micro-organisms on the shell surface. A test conducted by the Institute of Poultry Research in Beekbergen, Holland, indicated that mechanical egg washing can reduce the counts to 50 per egg.

'Nest clean eggs' are generally accepted as having less than 10 CFU bacteria and <5 fungi per 13cm^2 or two square inches.

Washing only dirty eggs is not the total answer, as clean eggs can be re-contaminated in the setters by bacteria from the unwashed eggs which appear clean.

Dry cleaning hatching eggs, for example with paper, will remove the cuticle that protects them and is therefore not advisable.

The University of Athens, Georgia (USA) reports that "the difference in hatchability between nest clean and dirty eggs was due to higher embryonic mortality following transfer into the hatcher of dirty eggs." So, washing dirty eggs is not a luxury after all!

Temperature control

The biggest problem with egg washing (and disinfection) is that there should be proper temperature and concentration control.

Hatching eggs can be washed with alkaline products (based on potassium hydroxide), to remove mainly fat and protein, which can be either chlorinated or non-chlorinated.

Proper temperature control (42-45°C or 108-113°F) is crucial. The water should be warmer than the egg contents throughout the cleaning cycle. This will result in a positive pressure in the egg, causing the inner membrane to expand against the shell to help prevent anything from entering the egg.

Contact time should be limited to approximately five minutes, in order not to damage the cuticle.

The washing machine should be temperature and concentration controlled (automatically stopping when either are not optimal).

Compatible disinfectants

Disinfection afterwards should be at a slightly higher temperature, to prevent the product from entering the pores (45-47°C or 113-117°F); after rinsing at the same temperature.

Use only disinfectants chemically compatible with the cleaning product. There must be no conflict between the surfactants in the cleaning product (anionic surfactants neutralise cationic).

Use only recommended disinfecting products at the correct concentration or penetration of the cuticle can occur. Ideally, a disinfectant with a residual action should be used, to prevent early re-contamination. This is not the case with formaldehyde fumigation.

As an alternative to form-aldehyde fumigation, the Dutch Research Institute 'Praktijkonderzoek Pluimveehouderij Beekbergen' found CID 2000 in an ultrasonic fogger 'as efficient as formaldehyde', without affecting hatchability.

There are alternatives!

Other hatcheries obtain excellent results by spraying (non formalin based) disinfectant solut- ions on the eggs. So, there are alternatives to formalin fumigation!

Table 3 gives a summary of the major actions to be taken.

A UK study concludes that "Salmonella contamination in a single hatchery can result in salmonella spreading nationwide". A hatchery is indeed a 'funnel', a 'hub' with eggs from many farms, distributing chicks to many more farms. ■

Table 3. Hatching egg hygiene before setting (eggs from a healthy flock).

Nest hygiene	Clean nests and belts, regularly disinfected
Egg collection	With clean hands and flats, regularly disinfected
Egg storage on farm	Cool (around 18°C-65°F) in a clean and disinfected area
Egg transport to hatchery	In a cleaned and disinfected truck, with good (air) suspension
Egg storage in the hatchery	Cool (around 18°C-65°F) in a cleaned and disinfected egg room
Egg handling in general	Carefully, not causing cracks