Egg microbiology – the first essential is to understand your enemy

Microbiology is the study of microbes and when we consider it in the context of hatching eggs and hatcheries this usually means those micro-organisms that interact with the egg to cause problems. These are limited to bacteria and fungi. Other microbes, such as viruses and mycoplasma, can pass though the egg to infect the resulting progeny and, for the purposes of this article, these will not be considered.

Let us start by considering just what a bacterium is and what it needs to grow and multiply. This is perhaps best done by considering bacteria as microscopic animals and, if we do this, it is amazing how similar their needs are to our own or, for that matter, those of any animal. In a similar way we can look upon fungi as microscopic plants.

Bacterial need

Bacteria are important to us for two reasons – they can cause problems in the egg or progeny and some bacteria, notably salmonella and campylobacter, can persist in the birds and ultimately potentially cause cases of human food poisoning.

We talk about bacteria being microscopic but what does this mean in reality? In simple terms a chain of bacteria one centimetre long would contain some 10,000 bacteria and one an inch long would contain some 25,000 or so bacteria!

Bacteria require food. Food for bacteria is basically relatively simple molecules, such as sugars and amino acids. In fact bacterial food has been described in the popular press as 'a source of carbon atoms' but this is a bit too simplistic and potentially misleading. However, it is not too far away from being factually correct.

Thus, substances such as faecal material egg contents and blood splashes all provide a bountiful source of nutrients for bacteria.

Bacteria require drink in the form of water. In this context any area of dampness should be regarded as an adequate water supply for thousands, if not millions, of bacteria. Many bacteria require oxygen and these are known as aerobic bacteria, whereas others do not and are known as anaerobic bacteria. Others can survive on reduced oxygen levels and these are known as microaerophilic bacteria.

Bacterial growth is temperature dependent – the warmer it is (up to approximately 40°C) the faster bacteria grow and multiply. All bacteria have an optimum temperature at which growth and multiplication is at its maximum. For disease causing bacteria this is more or less body temperature, whereas for spoilage bacteria it is lower (20-30°C).

In addition, bacteria, like animals, benefit from being able to move into new environments. Some have whip-like appendages known as flagella that can propel them through water films. All can be transferred from place to place on things such as boots, tools, trays and eggshells. Such vehicles are known as fomites.

They also need protection from adversities such as high temperatures, desiccation and chemicals like disinfectants and sanitisers.

Before we even consider controlling micro-organisms by disinfection, let us just review this information and see how we can use it to control bacteria (killing or reducing multiplication rate). Obviously we can starve them or deprive them of water. This is achieved by keeping areas clean and dry at all times. We can deprive them of oxygen – this is what we do to extend meat's shelf-life by processing with vacuum and modified atmosphere packing (MAP). If we can keep things cool (for example, refrigeration of foods) we can depress bacterial growth and multiplication. A good example of this is the management of egg store temperatures.

Remove protection

Keeping areas dry has another benefit – it removes the water film through which flagellated microbes can move. In addition, we can minimise bacterial movement by controlling the movement of fomites on the farm (for example, not transferring brushes between houses) or in the hatchery (for example, not backtracking dirty equipment from chick handling or hatcher areas to setter rooms or egg stores).

If we remove protection from adversities then, for example, disinfection procedures will be more effective. Remembering how small bacteria are we need to remove all cracks and holes as well as materials with porous surfaces as they all have the potential to harbour thousands, even millions, of bacteria.

Potential bacterial havens

Ideally, all surfaces should be hard, impermeable and totally free of cracks and holes (bacterial havens). It is interesting to audit a room in a hatchery – you will be surprised how many potential bacterial havens you will find! All of these need to be filled and sealed off.

However, if you reflect on the above you will appreciate that in eggs we have a perfect environment for bacteria. The egg provides them with a huge source of food and water and then protects them from adversities by enclosing them in a protective shell! Then just to further help the bacteria we place these eggs in an incubator!

In other words, virtually everything we do to manage the egg in incubation is also greatly favouring bacterial growth and multiplication! Thus, as we can not do much in incubation to control bacteria it is critical that eggs entering the incubators are as clean as possible. We also need to ensure that anything penetrating eggs or chicks that could introduce bacterial infection is as clean as possible. This includes needles on chick and in ovo vaccinators and equipment used for beak tipping, toe clipping and, in the case of turkeys, desnooding.

Another facet to all of this is the integrity of the eggshell. Any micro-crack will be a wide open door for bacterial entry. The embryos in such eggs often die off because of dehydration because the eggshell has been breached and therefore can not control moisture loss from the egg and its contents. These 'dead eggs' can be vast reservoirs of potential bacterial problems in the incubator, especially if they break and release their contents.

Another phenomenon we need to be aware of is that as the breeder laying flock ages the shells on their eggs become thinner and more porous. This is why we see a rise in the number of rotten eggs or rots in the latter stages of a flock's life.

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In the multi-age machines these are often mixed in with eggs from younger flocks, whereas single stage incubation does give us the opportunity to segregate these eggs and set them in a few machines.

Another good practice is to separate dirty/floor eggs and to keep these to one or two machines as these eggs invariably experience elevated numbers of rots and bacterial problems in the chicks they produce. These can then be managed through the system and ultimately have their chicks placed in one flock.

This has the advantage that we know where a potential problem could be and it makes strategic medication a more realistic or feasible option as we are greatly minimising the number of birds that are treated.

The other thing which is important is the original level of bacterial contamination on the egg. So, let us consider where this could have come from and what we can do to manage this.

The first point to consider is that the hen has been very poorly designed in that faeces and eggs come out of the same orifice and this must provide opportunities for bacterial contamination of the eggshell's surface.

The next opportunity for bacterial contamination is immediately after the egg is laid in the nest box. This is because the contents of the egg shrink on cooling and this can 'suck' bacteria/fungi into the egg and its air cell which is formed as the end result of this shrinkage. Interventions here include maintaining clean nest box litter and collecting eggs frequently so as to minimise their time in the nest box environment.

The next thing that the egg comes into contact with is the hand that removes it from the nest box. Hands should be washed and sanitised before egg collection and floor and nest box eggs should be collected separately so that floor eggs do not contaminate the collector's hands. After this the eggs come into contact with the tray the collector puts the eggs on. This can be a real microbiological hazard if the same trays are used day after day and are not cleaned or sanitised. This can be compounded if they are actually stored in the laying house environment prior to being used.

Then a second handling occurs when eggs are sorted and graded on farm. When storing eggs it is important to get the storage conditions correct because if we do not we can induce 'sweating' which wets the eggs' surface and, for reasons previously, discussed this is undesirable.

So, if we look at egg handling closely, there are many opportunities for egg contamination to occur and as managers we must do all we can to eliminate these or, at least, minimise their impact.

Monitoring for bacteria

The final thing we are going to consider in this article is how we can monitor for bacteria and fungi. The first thing we can do is a visual audit and it is a safe conclusion to say that 'where there is dirt there will be microorganisms'.

The next stage is to undertake microbiological testing or 'swabbing'. Bearing in mind what we have just said, we should look upon microbiological testing as a tool to confirm that visibly clean is microbiologically clean and swabs taken of visibly dirty areas can be regarded as swabs wasted.

Obviously, this is not the case if we are taking swabs for the specific purpose of salmonella screening where there is merit in sampling dirty areas. At this stage we need to be perfectly clear about the objective of any swabbing exercise. This should be to find areas that are unacceptable so that by paying attention to these during cleaning and disinfection we can improve our standards. Microbiological testing should not be a case of 'finding good results to keep senior management off our backs!'

Thus, testing should be done by someone who is independent of the cleaning team and somebody who has some idea about what is involved and where to swab.

It is not sensible to have a pre-defined sampling regimen because the cleaning team will become wise to this and the areas to be swabbed will receive preferential treatment!

The key to sampling is one word – random. Random areas tested on random days at random times! ■