The impact of incubation temperatures on broiler performance

To meet consumer demands over the last eight years, poultry is now raised using fewer antibiotics. This shift has led to an increase or variability in seven-day mortality levels in both parent stock and broiler levels.

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This increase in mortality shows typical bacterial infection patterns (see Fig. 1).

These infections are not what is associated at the hatchery with yolk sac infection/omphalitis or visually poorer quality chicks. In fact, chicks appear healthy and active, with a hidden danger underneath, not outwardly visible.

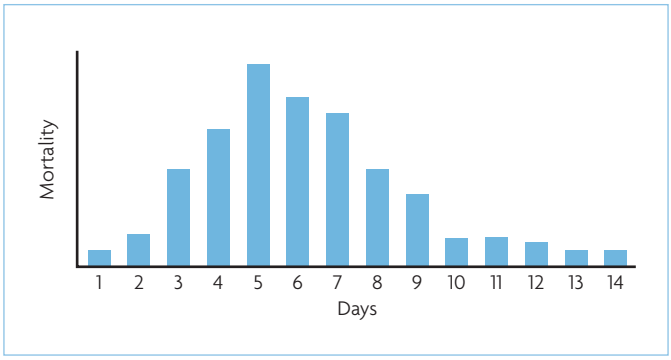


Fig. 1. Daily mortality patterns with a typical bacterial infection (E. coli).

Mortality levels

A great deal of emphasis has been made on incoming egg quality, hatchery sanitation, incubation temperatures and brooding practices in an attempt to reduce the early mortality levels, however, these measures do not often translate into improvements in seven-day mortality levels.

All of these factors are important and should not be compromised to maintain optimum performance.

We have used trials to evaluate the impact of incubation temperatures on broiler performance. The results of these trials show a positive correlation with chick yield percent (chick weight as a percentage of egg weight) in relation to seven-day mortality levels and seven-day body weights (see Figs. 2 and 3).

Historically, the rule of thumb for multistage incubators was chick weight equal to two-thirds of egg weight, or 67%, with a weight loss at 18 days of incubation of 12-14%.

Today with many single-stage machines, it is not uncommon to see a weight loss at transfer of only 9-10% of initial egg weight due to the damper being closed for up to 7-9 days of age.

The closed damper aids the uniformity of temperature in the setter and development of the chorioallantoic membranes with the increase in carbon dioxide (CO_2), but the higher humidity levels result in lower weight loss.

More often than not we do not compensate for this in the hatcher, hence why higher chick yield percentages are seen.

If this were the case, then we would prefer to start opening up the damper in the setter (2-5%) from day one or three rather than day seven or nine to achieve weight loss levels of at least 11% in the first 18 days of incubation.

This period for oxygen supply is essential when certain organ development is critical (heart, lungs, etc). Excessive damper opening in the latter stages of incubation to alleviate high eggshell temperatures or to achieve desired weight loss levels can result in excess ventilation and cause more temperature variations within the incubator.

Low incubation temperatures can result in late-hatching chicks with more residual yolk, higher chick weights and higher chick yield percentage.

High incubation temperatures result in early hatching chicks with less residual yolk and a lower chick yield percentage. The influence of temperature during incubation and hatching times affects the residual yolk percentage in the chick.

Chick yield percentage

Chick yield percentage is a by-product of both temperature and humidity, they go hand in hand.

Excess yolk and higher chick yield levels from later hatching chicks can be due to low incubation temperatures or insufficient moisture loss. The unabsorbed yolk gives more potential for bacterial contamination, especially from stress

Continued on page 9

Fig. 2. Correlation with chick yield percent to seven-day body weights.

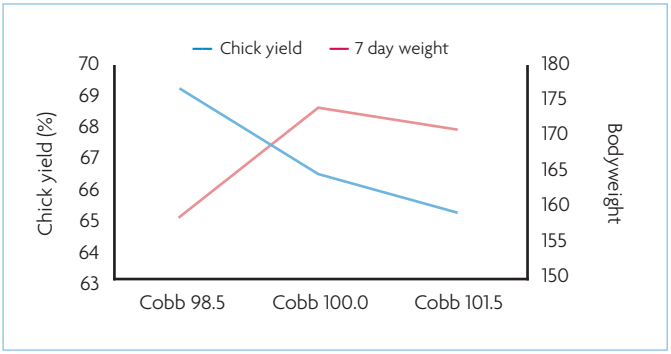
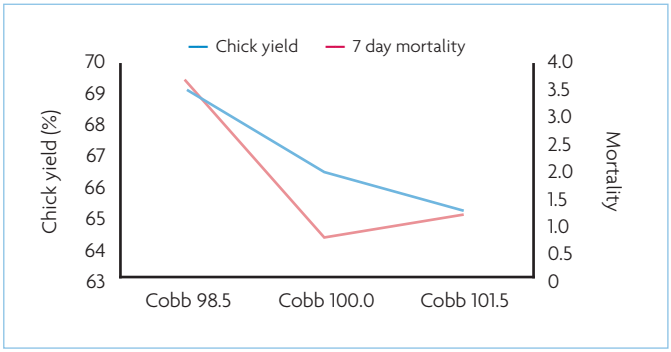


Fig. 3. Correlation with chick yield percent to seven-day mortality levels.



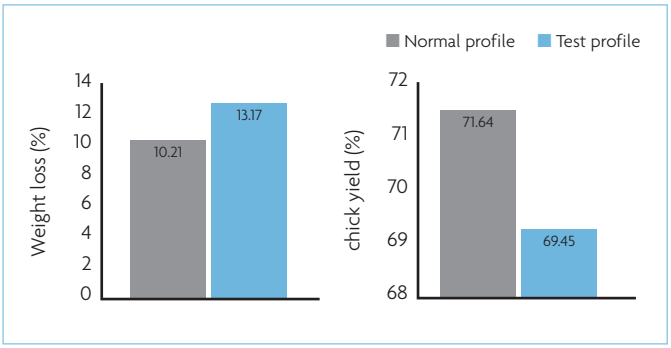


Fig. 4. Weight loss up to 18 days of incubation and chick yield percentage.

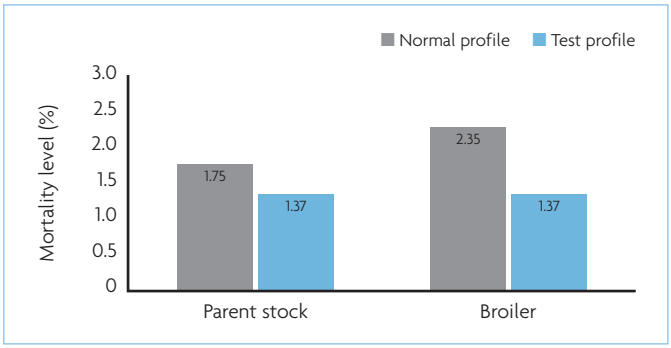


Fig. 5. Seven-day mortality levels at parent stock and broiler levels.

Continued from page 7
levels. If exposed to more bacteria, then the multiplication enhanced from feeding and drinking can lead to the higher mortality levels

With single-stage incubation using CO_2 control, weight loss can be reduced due to minimal ventilation in the first half of incubation in the setter. This can result in very high humidity levels, to the extent that moisture is visibly seen in the setter and running out of the machine under the door.

The risk of these high humidity levels can lead to any bacterial loading on the eggshell, which can penetrate the eggshell and, subsequently, the albumen.

Even though bacteria are present, the chick can still hatch. But any stress factor, such as overheating or cold draughts at hatch, chick processing, transport or at the farm, can expose secondary infections like E. coli or septicaemia.

At the farm, chicks have access to feed and water, hence the bacterial loading increases to the extent where the chick dies around days 2-5. We are in no way criticising single-stage incubation, but we must be aware of the effects of trying to achieve high CO_2 levels and damper closing in the early stages of incubation.

I have seen this occur throughout the production cycle from pedigree level to broiler level. We strongly believe that achieving desired levels of chick yield percentage can reflect seven-day mortality levels along with stress-free environments.

Figs. 4 and 5 show the results of trials conducted with a 'normal incubation profile' with the damper opening at seven days of age, compared to the 'test profile' with the damper opening earlier at two days of age.

There was a significant increase in moisture loss at transfer (18 days of incubation) by allowing more air circulation in the incubator during these early stages. Fig. 4 shows the higher weight loss and resulting lower chick yield percent.

The chicks from the trials were delivered to both a parent stock customer and the by-product to a broiler customer on the same day. Both placements saw a relative difference in lower seven-day mortality levels from the incubation profile that opened up the damper earlier, therefore alleviating the high humidity levels.

For most broiler hatcheries, chick placements to broiler farms do not incur a great deal of transport time (within four hours), whereas parent stock and grandparent hatcheries can have a time lag from chick takeoff to customer delivery of 24 hours or more.

Therefore, we appreciate that for these longer deliveries the chicks need to hatch later or be 'fresher' so that they do not dehydrate and suffer high mortality levels.

Our recommendation for broiler hatcheries or placements less than six hours is to try and achieve a chick yield percentage between 66-68%. For long-distance placements, we recommend achieving a chick yield percentage between 68-70%.

These chicks will lose weight during transit, but should still arrive at the farm with the chick yield percentage close to the broiler target of 66-68%. It is common to have a hatch window (hatching time from first chick to hatch day) of 24-30 hours so there will always be a difference in chick weights and chick yield percent, but we monitor this by measuring the average weight of chicks to determine the chick yield.

Which chicks are more likely to affect our seven-day mortality levels?

Low temperatures generally gave higher seven-day mortality levels. Why? Because the chicks hatch later and have more residual yolk present and, if exposed to stress factors such as overheating or cold stress/draughts, they can elevate secondary infections like E. coli to manifest.

Yes, high temperatures can cause chicks to hatch early and increase the risk of stress from overheating and dehydration, but you can normally relate to this if seen in the hatchery.

Table 1 shows work we conducted by monitoring the effects of hatching times to seven-day body weights and mortality levels.

There is a dramatic increase in mortality from the chicks hatched in the last 12 hours before takeoff.

Only 1.3% of the total chicks were hatched in this period but their chick weight reflected a high chick yield percentage and very high seven-day mortality level.

As seen in many of our earlier trials, this correlation still remains relative with earlier hatching chicks achieving better seven-day weights and lower mortality levels, whereas the later hatching chicks achieve the opposite.

Table 1. The impact of hatching times on seven-day weights and mortality levels.

	Chicks (%)	Chick weight	Seven day weight	Seven day ADG	Chick yield (%)	Seven day mortality (%)
36 hour pre pull	19.5	43.7	169.2	17.9	67.9	1.1
24 hour pre pull	64.3	45,4	171.4	18	69.6	1.3
12 hour pre pull	15.0	47.0	164.7	16.8	71.4	2.9
Pull	1.3	46.9	136.0	12.7	73	19.2

Conclusion

In conclusion, here are my top seven recommendations to achieve optimal chick yield:

- For relatively short chick placements, achieve a chick yield between 66-68%.
- For long-distance deliveries, achieve a chick yield between 68-70%.
- Adapt your incubation profiles for a weight loss of 11-13% by 18 days of incubation. Young flocks will have lower weight losses and older flocks will have higher weight losses.
- Avoid excessive humidity levels in the early stages of incubation. Ideally achieve 65% RH as a maximum at the start and 40% RH as a minimum at the end of incubation.
- Avoid stress factors especially in the chick processing areas, chick holding rooms, transport and at the farm. It takes 21 days to nurture the day-old chick and too many times we expose it to adverse conditions and stress within one hour after takeoff. Overheating is common with insufficient ventilation or chicks placed too close together with little air circulation. Cold draughts are another common stress factor with fans in the holding rooms directly blowing onto chicks. Another factor is unloading chicks at the farm with the truck not parked facing the prevailing winds and hence chicks being exposed.
- Cloaca temperatures should be maintained between 40.0-40.6°C at all times in the first day for chicks to maintain their comfort zone. At 41.0°C, chicks will start 'panting' which is another stress factor.
- Record these measurements and see if your adverse seven-day mortality results correlate to when you are outside these parameters. ■