# focus on RESEARCH

Focus on Research sponsored by the Incubation and Fertility Research Group (IFRG)

## Effects of thermal manipulation of broiler embryos from 7 to 16 days of incubation on later life thermotolerance

An experiment was conducted to investigate five different thermal manipulation (TM) protocols utilising eggshell temperature (EST). Group 1 was set at 37.5°C and 60% relative humidity (RH) from day 1 to 19 of incubation. Treatments in groups 2 to 5 covered days 7 to 16 of incubation, employing different EST and 65% RH (group 2: 39.5°C/6h/day; group 3: 39.5°C/12h/day; group 4: 40.5°C/6h/day; and group 5: 40.5°C/12h/day). A total of 4,300 eggs were distributed across five different setters with a capacity of 860 eggs each.

After hatching, 540 male Ross chicks (108 per treatment) were reared with six pens of 18 chicks each. Until 21 days of age, room temperature followed the Ross guidelines, whereafter, all groups were subjected to heat stress (8h/32°C) from day 21 to 28 post-hatch. Performance and cloacal temperature were evaluated at 28 days of age. Chicks from group 2 (39.5°C/6h/day) had lower cloacal temperature during heat stress (P<0.05; 41.0°C) compared to the other groups: 42.9 41.5, 41.5, and 41.1˚C for groups 1, 3, 4, and 5, respectively. Body weight gain (BWG) at 28 days of age was lower for group 5 (1,425g), and this group also had the worst feed conversion ratio (FCR) (1.47; P<0.05), whereas there was no difference among the other groups (1,574 g and 1.33 respectively on average). Feed intake was not affected (P>0.05).

Group 1 chicks had a higher mortality rate (10.7%) between days 21 and 28 (immediately after the onset of heat stress) compared to other groups (P<0.05). Based on cloacal temperature and mortality rate, it can be concluded that the best TM protocol was 39.5oC EST between days 7 and 16 for 6 hours per day.

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### Impact of Incubation Temperature on Meat Quality in Broilers

The broiler industry plays a key role in supplying protein sources for people as having advantages over red meats in terms of the easily digestible protein source, greater protein/fat ratio, lower cost, shorter production duration, and lower carbon fingerprint.

During the last 60 years, the selection program of breeding companies has focused on growth rate, feed efficiency, and breast meat yield to meet consumer demand for chicken meat. This increase in growth rate and breast yield is associated with muscle development and meat quality in commercial chickens. Chicken skeletal muscle development occurs between the beginning of embryonic development and early post-hatch.

While the number of muscle fibres is fixed during embryogenesis, postnatal skeletal muscle growth depends mainly on muscle fibre volume. In recent years, muscle development in embryos has gained attention. In chicken embryos, environmental factors in the incubator such as temperature, humidity, ventilation, turning, and lighting determine embryonic development. Within these factors incubation temperature, which is between 37.5 and 37.8°C in modern today's incubators, is the most important factor that optimises hatchability. However, during the natural nest, embryos face daily fluctuating temperatures. Incubation temperatures higher or lower than optimum may have long-lasting effects on post-hatch growth performance, behaviour, and locomotor activity.

Previous studies have shown that higher cyclic incubation temperatures affect muscle growth during embryogenesis, increasing muscle relative weight and promoting fibre development. This effect may be mediated by IGF-I gene expression and muscle marker genes (myogenin, MyoD, Pax7) without significant change in breast meat pH, lightness, redness, and drip loss. However, different durations, timing, and temperatures appear to have different effects on muscle growth and meat quality, and its effect on muscle myopathies varies across many studies and the information is conflicting.

Further results showed that the response of skeletal muscles to changes in the incubation temperature would differ between species, egg- and meat-type chickens, and commercial strains. Critically, understanding the impact of incubation temperature on muscle development and meat quality can enable the development of new approaches to poultry production.

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### Mild Pre-Hatching Temperature Stimulation Improved Post-Hatching Performance in Male and Female Cobb500 Broiler Chickens

The aim of this study was to investigate the effect of mild pre-hatching temperature stimulation (MTS) of Cobb500 eggs on hatching results as well as on growth performance and organ development on day 7 post-hatching. 355 eggs were incubated under standard incubation conditions (37.3°C, 55% relative humidity) until transfer on day 17 where living embryos were randomly divided in two

# The effect of a '24-day incubation principle' on broiler performance

Recently HatchTech introduced SetCare on the market. This setter comprises the gradual warming of chicken eggs during six days from storage- to incubation temperature at high RH and CO2 levels and a total incubation duration of 24 days. In-company studies with SetCare found longer chicks at hatch compared to conventionally incubated chicks.

A positive correlation between hatchling length and post hatch performance of broilers has been shown. It was therefore hypothesised that SetCare advances broiler performance. Besides incubation, broiler performance is affected by the moment of first feed and water access: directly after hatch (referred to as 'early feeding') or delayed till arrival in the broiler house. Early feeding seems to be optimal, but effects can depend on chick quality. It can be hypothesised that the improved chick quality realised through SetCare amplifies the positive effects of early feeding on broiler performance. To study this, long stored eggs from a 34 wk Ross308 parent flock were incubated in a 2x2 factorial design in different setter systems (SetCare vs conventional) and hatcher systems (HatchCare vs conventional hatcher with delayed feeding).

At hatch, chicks (N=576) of both sexes were equally divided over 32 floor pens. Broilers and feed were bulk weighed weekly per pen and ADFI, ADG, and FCR were calculated. Mortality was observed daily to determine survival probability. No setter x hatcher interaction was found, except for survivability (P=0.02). SetCare × HatchCare had 6.3% higher survivability probability compared to conventional × HatchCare. SetCare resulted in higher BW at all ages (P<0.02) as well as higher ADFI and ADG (P<0.03) and lower FCR (P=0.03) over the total growth period compared to conventional setter.

HatchCare resulted in a higher BW at all ages (P<0.01) and tended to increase ADG and ADFI (P<0.08) over the total growth period compared to conventional hatcher (P<0.01), whereas FCR was not different (P=0.26). In experimental conditions, both SetCare and HatchCare seem to benefit broiler performance over conventional systems, but their combination does not have a clear added positive effect and a field study is proposed to verify results in commercial practice.

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groups: control (C: standard incubation conditions, n=156) and MTS (+1°C for 2 h per day, on days 17-20, n=156). After hatching, chickens were sorted by sex (feather sexing). Chick quality (Pasgar©Score) and body weight (BW) as well as in 20 birds (10 female/10 male) of each group yolk sac to BW ratio (YBW ratio) were analysed. In a subsequent growing trial of 7 days, growth performance was measured, and bursa and heart samples were collected and weighed. MTS improved hatching rate (MTS: 90.4%; C:87.2%).

As usual, sex ratio of the hatched chicks was characterised by slightly more hatched females and similar in both groups (MTS females: 54.6%, MTS males: 45.4; C females: 55.1, C males: 44.9). MTS did not significantly change chick weight, chick quality and YBW ratio at hatch. YBW ratio was lower than 10% in both groups (MTS: 8.5%; C: 6.9%) but, MTS chickens of both sexes had numerically higher YBW ratio than control chicks. No statistically significant sex differences were found within the groups.

During the first seven days post-hatching mortality was zero in all groups. MTS chickens had a statistically significant higher BW (MTS, BW 144.8g ± 19.2; C, BW 137.8g ± 17.0, p = 0.01) and body weight gain (BWG) when compared to control chickens and showed a tendency towards improved feed conversion (FC; MTS: 0.98 ± 0.04kg/kg, C: 1.03 ± 0.03 kg/kg) and feed intake (FI; MTS: 15.53 ± 0.5g/broiler/d, C: 15.99 ± 0.2g/broiler/d). There was no significant influence of sex of the birds on all parameters within the groups. But, numerically MTS female chickens showed the highest BW and BWG within the MTS group. No statistically significant differences were found for the relative bursa and heart weights between the groups.

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## How to Warm Eggs from Storage to Incubation Temperature?

Chicken hatching eggs contain an embryo blastoderm already at moment of lay. In commercial practice, these eggs are stored ≤18°C to preserve their quality until incubation. Once incubation starts, they have to be warmed to 37.8°C eggshell temperature (EST), meaning that the embryo blastoderm undergoes a temperature transition of approximately 20°C. Embryos are poikilotherm and therefore blastoderm development is affected by the rate and duration of this temperature transition. It has been shown that the rate and duration for the transition from storage to 29.4°C EST are of minor importance as long as condensation will be prevented.

But from 29.4°C EST onwards, a linear increase during 17 hours to 37.8°C EST lowered early embryo mortality compared to shorter prewarming durations. Until now, durations >17 hours for this specific temperature transition have never been studied.

All eggs were linearly warmed in 5 hours from storage temperature to 29.4°C EST whereafter the duration of linearly prewarming them from 29.4°C to 37.8°C EST was increased from 17 hours to 8 days stepwise in 18 consecutive experiments using a total of 146,880 eggs.

For each experiment, eggs originated either from broiler (Ross308) or layer (Dekalbwhite) parent flocks of various ages (26-58 wk) and were stored 0 to 23 days prior to incubation. Early embryo mortality and hatchability of set eggs were observed. Results indicated that a duration of 6 days was the most optimal duration of prewarming eggs from 29.4°C to 37.8°C

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## Incubator Temperature versus Eggshell Temperature During Artificial Hatching of Ostrich Eggs

Problems may arise if incubators do not have sufficient heating, cooling and air exchange for the larger ostrich eggs set. Incubator temperature settings are used during incubation, but due to the size of the developing ostrich embryo, it is vital to investigate eggshell temperature (EST).

The differences between incubator temperature and EST during incubation of ostrich eggs were investigated on the Oudtshoorn Research farm, South Africa, during the 2000 and 2021 breeding seasons. The set temperature for the incubators was 36.4°C. Heat sensors were placed at different locations in the incubators to monitor heat distribution throughout and at the same locations, sensors were placed on the nearest eggs to be able to determine the effect of incubator temperatures on eggshell temperature (EST). The data collected over the incubation period of 42 days, included temperature readings from 71 incubator probes (6334 readings/probe) and between 2878 and 6334 readings from 186 probes attached to eggs for EST.

During the setter phase (≤ 36 days of incubation) significant differences were found between the different sectors in the incubators, ranging from 34.7±0.01°C in the middle sector of the incubator to 35.7±0.01°C at the top sector of the incubator. EST was significantly higher than incubator temperature for each of the corresponding sectors, but the biggest difference was at the middle section of the incubator where the mean EST was 36.0±0.01°C, while the mean incubator temperature was 34.7±0.01°C. There was no significant difference between the overall mean incubator temperature and mean EST up till day 37 of incubation. Between days 37 and 38 of incubation a sharp increase in EST (from 36.4±0.3°C to 37.4±1.1°C) occurred and, while incubator temperature also increased during this period (from 35.2±2.4°C to 35.7±0.3°C), it was significantly lower than of EST. Up to 35 days of incubation, the EST did not differ for eggs that were either infertile, early embryonic (EED) and late embryonic deaths (LED), or produced a live chick.

These results showed that the placement of controller sensors is very important, because depending on the fan placement, heat distribution differs within incubators. The effect of the rapid increase in EST during the hatcher phase (≥ 36 days of incubation) on incubator temperature needs to be investigated further in order to improve management of hatcher temperature during this critical stage of incubation.

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EST. Early embryo mortality was reduced and hatchability was increased between 1.2 to 21.8% in 14 out of 18 experiments (P≤0.04).

In conclusion, early embryo mortality is affected by the rate and duration with which eggs are warmed prior to incubation. Very gradual preincubation warming of eggs during 6 days from storage to incubation temperature can be considered as a strategy to enhance hatchability as it reduces the relatively high early embryo mortality that is found during artificial incubation. However, the downside of this strategy is that it prolongs the total incubation duration (start of prewarming until pull) by approximately 3 days compared to the standard practice of ≤0.5 day prewarming.

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