Day-old Chick Quality: Relationship to Hatching Egg Quality, Adequate Incubation Practice and Prediction of Broiler Performance

K. Tona\textsuperscript{a}, V. Bruggeman\textsuperscript{a}, O. Onagbesan\textsuperscript{b*}, F. Bamelisa, M. Gbeassor\textsuperscript{b}, K. Mertens\textsuperscript{a} and E. Decuyper\textsuperscript{a}

\textsuperscript{a}Laboratory for Physiology and Immunology of Domestic Animals, Department of Animal Production, Faculty of Agricultural and Applied Biological Sciences, Catholic University of Leuven, Belgium; \textsuperscript{b}Université de Lomé, Faculté des Sciences, Lomé, Togo

ABSTRACT

The weight and quality of the broiler chicks that emerges from the egg depend on several factors, which may include the broiler breeder age, egg storage conditions before incubation, and the incubation conditions. Several studies have determined the effect of some of these influencing factors on broiler chick hatching weight with little attention to post-hatch broiler performance. Chick physical quality had received little attention but recently, it has become apparent that the quality of broiler chicks may be linked to the history of the hatching eggs as well as the potential post-hatch performance of the broiler to slaughter age. It has therefore become important to develop universally accepted methods for measuring chick quality. Previous methods for evaluating chick quality relied heavily on hatching weight. Recently, methods for determining and quantifying chick quality based on physical appearance were reported. Physical parameters for determining chick quality were defined and scored according to the level of anomaly in the parameters. Also, the potential influence of these parameters on post-hatch performance was reported. This paper reviews the different methods available for measuring chick quality. The different methods are discussed in the context of the parameters for determining chick quality and the factors that may affect it. These include pre-incubation and incubation factors such as age of breeders, egg storage temperature, relative humidity, and turning requirements. All these factors have implications on chick embryo physiology and development and consequently on the quality of the hatched chick. The potential application of chick quality measurement for predicting performance to slaughter is also discussed.

Keywords: chick quality, chick weight, egg quality, pre-incubation factors, incubation factors, growth potential

1. INTRODUCTION

Until recently, day-old chick quality had received little attention, as there has been no universally established method for its measurement. Day-old chicks are the end product of the hatchery industry but they form important starting material for the broiler farmers because they need chicks with good feed conversion efficiency and low mortality. For economic reason, the major objective of a hatchery is to obtain a high hatchability (large numbers of marketable chicks) while the farmers need chicks of high growth performance. In hatchery management, hatching success and chick quality have often been erroneously linked to each other, leading to the idea that if hatchability can be maximised, automatically chick quality will also be optimal. Day-old chick quality at take off seems to be an all or none question (marketable or non-marketable chicks). It is assumed that on average, 8% of hatched chicks are not marketable (Tona et al., 2004b). Chick quality, as at now, however depends on the judgement of each individual. The parameters used for quality selection are neither well defined nor standardised. So, workers within and between hatcheries judge the

\textsuperscript{*}To whom correspondence should be addressed: Laboratory for Physiology and Immunology of Domestic Animals, Department of Animal Production, Kasteelpark Arenberg 30, 3001 Leuven, Belgium.
E-mail: okanlawon.onagbesan@agr.kuleuven.ac.be
quality of day-old chicks differently. Assessment is mostly subjective and often based on chick appearance. However, Decuyper and Michels (1992) and Borzemska et al. (1998) reported that good hatchability does not necessarily positively correlate with high percentage of chick of good quality, and that maximal hatchability is not the best indicator for the highest post-hatch viability and growth. Therefore, devising qualitative and quantitative methods for measuring day-old chick quality has become an important issue in poultry production.

High broiler weight at low feed costs at slaughter age is the main goal of the farmer. In fact, Buyse (1991) defined production score as: \[ \text{production score} = \frac{\text{final body weight in grams} \times (100\% - \text{mortality})}{(10 \times \text{period in days}) \times \text{(feed conversion)}} \] and argued that the best production score should be at least 320. Factors that influence broiler flock performance, such as genetic factors, sex of broiler, nutritional and environmental conditions are well documented (Cabel and Waldroup, 1991; Cornejo et al., 1991; Acamovic, 2001; Applegate and Lliburn, 2002; Borges et al., 2003). In addition, several commercial strains or lines have been developed to improve broiler performance under special conditions and to achieve specific goals depending on the markets (e.g. breast meat or meat quality). On the other hand, the first days of a chick’s life are very crucial, and they need full attention and maximum care from the farmer. However, between and within genotypes, differences between broiler flock performances may depend on the quality of day-old chicks. Our own recent studies have shown that several factors including breeder age, egg storage, incubation environment and management, can influence the quality of day-old chicks. Several studies including those from our laboratory have reported the effects that the quality of the chick may have on the early growth performance of broilers and growth to slaughter weight. Thus, the day-old chick quality provides some important information about the quality of the hatching eggs, the adequacy of the incubation method and can predict the potential growth performance of the broiler to slaughter age.

This paper reviews the different methods for assessing day-old chick quality and the factors that may influence chick quality. It will focus on pre-incubation and incubation factors that affect chick quality such as hatching egg storage, age of breeder breeders and incubation conditions. It will also touch on the relationship between embryo physiology and chick quality, and the relationship between chick quality and broiler performance. Finally, suggestions for improvement of chick quality as a spin-off from these influencing factors will be discussed.

2. ASSESSMENT OF CHICK QUALITY

In general, a day-old chick of good quality can be defined as a chick of high performance potential. Chick hatching weight, and recently chick length, has been differently used as quantitative measurements of chick quality (Hill, 2001; Deeming, 2000; Boerjan, 2002; Decuyper et al., 2002; Tona et al., 2003a). Little attention has been paid to practising an integrated qualitative assessment of day-old chicks by using all physical parameters although only one or two are used as the main method for sorting day-old chicks in commercial hatcheries. This method includes one or two day-old chick physical parameters especially its alertness and appearance. There is little information about day-old chick qualitative aspects in literature. Even when day-old chick qualitative aspects are evoked, they have not been converted into quantitative score and their effects on post-hatch performance have not been investigated until recently (Tona et al., 2003a, 2005). Irrespective of the method used to assess chick quality, the duration between hatch and first food access for predicting future performance has been widely documented but unknown is the fact that this may also be related to the quality of the hatched chick. In the following paragraphs, the different parameters used to assess chick quality are discussed.

2.1 Quantitative measurement of chick quality

The most widely used parameter for day-old chick quality assessment is its body weight (Raghavan, 1999; Deeming, 2000; Boerjan, 2002; Decuyper et al., 2002). Reports are conflicting about the relationship between day-old chick weight and broiler performance (Powell and Bowman, 1964; Tindell and Morris, 1964; Gardiner, 1973; Bray, 1983; Vieira and Moran, 1999; Tona et al., 2003a). However, there is agreement that 7–10 days-old chick weights onwards may be related to slaughter performance (Decuyper, 1979; McLoughlin and Gous, 1999 and Tona et al., 2004b). Deeming (2000) assumed that during the first 7 days, quality may be lost depending on several factors. Based on these conflicting reports, devising a quantitative method for measuring chick quality, by
using hatching weight and 7 days-old weight, may provide a method for predicting performance to slaughter. Hence, Tona et al. (2003a) used growth potential measured as relative growth (RG) up to 7 days of age, defined as percentage of weight gain up to 7 days in relation to day-old weight, as an \textit{a posteriori} quantitative assessment of chick quality. Independently to other factors, the RG can be considered as a parameter for predicting performance and for confirming the chick’s quality because this may be an expression of intrinsic factors (see Figure 1).

Hill (2001) reported a relationship between the day-old chick length uniformity and age of breeders or incubation conditions. Indeed, this author demonstrated that increasing age of breeders leads to an increase of chick length and that single stage incubation system improves uniformity of day-old chick lengths. Until now, the relationship between chick length and post-hatch growth has not been investigated.

2.2 Assessment of qualitative aspects

In hatchery management, day-old chick quality is based on the all or none principle that involves physical aspects of the hatchling and/or presence of sources of contamination. The broiler farmers pay more attention to day-old chicks reflex at the time of their placement at the farm. Research on chick quality, in the past, gave very little importance to the physical quality aspects of day-old chicks. Although researchers are convinced that these physical aspects of day-old chicks that are used to sort chicks in hatcheries can be related to performance, there is a hesitation to investigate this assessment of chick quality because it seems to be subjective. However, it is generally agreed that a day-old chick of good quality must be clean, dry and free from dirt and contamination, with clear and bright eyes, free from deformities, with completely sealed and clean navel, and no yolk sac or dried membrane should protrude from the navel area. The body should be firm to touch, without any sign of stress such as respiratory distress. It should be alert and interested in its environment, responding to sound, normal conformation of legs, no hock, no swelling, no skin lesions, have a well formed beak, not soft but straight toes (Funk and Irwin, 1955; Raghavan, 1999; Deeming, 2000; Boerjan, 2002; Decuyper et al., 2002; Tona et al., 2003a). However, the individual or collective influences of the parameters remain unknown until recently.

Based on these qualitative parameters, Boerjan (2002) used the Pasgar score of a scale from 0 to 10 and Tona et al. (2003a) a trapped scoring system with a total score between 0 and 100 based on a wide range of parameters each with a hedonic score. This provides a method for converting those qualitative parameters into a quantitative score. The scores dichotomised chicks into groups of different qualities; those with a score of 100 being free from any abnormalities and of highest quality. Further investigations by Tona (2003) and Tona et al. (2005) established the correlations between several of the qualitative parameters that have been included in determining the scores for chick quality. This suggests that the parameters may evoke correlated response effects. Interestingly, most parameters are highly correlated with the conditions of the navel area, amount of retracted yolk and chick activity indicating that scores from these parameters alone may be sufficient for sorting day-old chicks into quality groups (Table 1). These authors showed that the incidence of day-old chicks with subnormal condi-
Table 1 Interrelationships between quality parameter and their significant levels and r values between brackets and the incidence in subnormal conditions for each parameter. Data from Tona et al. (2005)

<table>
<thead>
<tr>
<th>Qualitative aspects</th>
<th>Incidence of each parameter (%)</th>
<th>Activity</th>
<th>Down and appearance</th>
<th>Retracted yolk</th>
<th>Eyes</th>
<th>Leg</th>
<th>Navel</th>
<th>Membrane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity</td>
<td>36.36</td>
<td>NS</td>
<td>&lt;0.001</td>
<td>NS</td>
<td>0.013</td>
<td>NS</td>
<td>NS</td>
<td>0.602</td>
</tr>
<tr>
<td>Down and appearance</td>
<td>23.56</td>
<td>NS</td>
<td>&lt;0.001</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>(0.26)</td>
</tr>
<tr>
<td>Retracted yolk</td>
<td>32.93</td>
<td>NS</td>
<td>0.045</td>
<td>NS</td>
<td>0.013</td>
<td>NS</td>
<td>NS</td>
<td>(0.22)</td>
</tr>
<tr>
<td>Eyes</td>
<td>8.76</td>
<td>NS</td>
<td>0.034</td>
<td>&lt;0.001</td>
<td>0.013</td>
<td>NS</td>
<td>NS</td>
<td>(0.22)</td>
</tr>
<tr>
<td>Legs</td>
<td>2.11</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>(0.21)</td>
</tr>
<tr>
<td>Navel</td>
<td>63.44</td>
<td>NS</td>
<td>NS</td>
<td>&lt;0.001</td>
<td>0.013</td>
<td>NS</td>
<td>NS</td>
<td>(0.26)</td>
</tr>
<tr>
<td>Remaining membrane</td>
<td>32.93</td>
<td>NS</td>
<td>0.034</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>(0.23)</td>
</tr>
<tr>
<td>Remaining yolk</td>
<td>19.03</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>0.025</td>
<td>NS</td>
<td>NS</td>
<td>(0.42)</td>
</tr>
</tbody>
</table>

Sections in the navel area was the highest indicating that this may be a parameter of significant importance in the growth of the chicks. Also, other subnormal conditions that contributed highly to the number of chicks with subnormal conditions included the amount of retracted yolk, remaining membrane, activity, downs and appearance. Using the scores from these parameters for determining chick quality proved to be a more reliable measure for predicting broiler performance (Figure 2).

3. FACTORS INFLUENCING CHICK QUALITY

3.1 Pre-incubation factors

Pre-incubation factors may determine hatching egg characteristics that may affect chick quality and their performance. All the factors that can affect egg characteristics, within line, strain or flock are determined mainly by the age of the breeders and the egg storage conditions (Williams, 1992; Tona et al., 2002, 2004b). The effects of these factors on hatching success, chick quality and RG are schematically shown in Figure 3.

Mirosh and Becker (1974); Muambi et al. (1980); Deeming (1996); Christensen et al. (2001); Peebles et al. (2001) and Tona et al. (2003b) have demonstrated that egg storage and age of broiler breeders influenced embryonic development and therefore day-old chick characteristics. Incubating egg weight and therefore day-old chick weight at hatch depends on the age of the breeder (Crittenden and Bohren, 1961; Smith and Bohren, 1975 and Bohren, 1978; Pearson et al., 1996; Tona et al., 2004b). Similarly, Hill (2001) reported an increase in chick length with increasing age of the breeder. Also, increasing age of breeders leads to an increase of the incidence of chick of subnormal quality (Tona et al., 2001; Boerjan, 2002; Tona et al., 2004b). This effect of age was reversed by the molting of older breeders leading to an improvement in chick quality (Tona et al., 2002).
This effect of moulting was essentially through an improvement of egg quality. With regard to storage condition, there is greater occurrence of poor quality chicks from eggs stored for longer duration than from eggs stored for shorter duration (Boerjan, 2002; Fasenko, 2002; Tona et al., 2003a) and this was further exacerbated by storage of eggs of older age of breeders (Tona et al., 2004b).

3.2 Incubation factors

The conditions commonly used in commercial incubators for all eggs whatever their characteristics, are temperature, relative humidity, egg turning requirements and ventilation (Ancel and Visschedijk, 1993). It is well known that the optimum temperature for incubating chicken embryo is between 37.5 and 38°C. Incubation temperature is important not only for hatchability but also for post-hatch growth (Romanoff, 1935 and Romanoff, 1936). Intermitent low temperature (33.5°C) treatment during the last days of incubation affected post-hatch growth (Decuypere, 1979; Yvota et al., 1980; Kühn et al., 1982; Decuypere, 1984; Minne and Decuypere, 1984). By contrast, periodic heat treatment during the first 10 days or the last 10 days of incubation (39°C) improved feed efficiency but did not affect body weight (Abd El Azim, 1991). Boerjan (2002), using Pasgar score as a quantitative tool for chick quality measurement, reported an improvement in quality score (9.1 vs 8.6) when hatching eggs from hens of 45 weeks of age were incubated at higher temperature (0.2°F from day 10–12 and 1°F at day 18 of incubation) compared to standard incubation temperature.

The optimum RH during incubation is 50 to 60%, which allows eggs to lose ideally 11 to 13% of their initial mass up to the beginning of pipping (Taylor, 1999; Tona et al., 2001; Bamelis, 2003). Too high RH prevents hatching because not enough water is lost and when the RH is too low, dehydration occurs (Taylor, 1999). However, Brunaal et al. (2000) and Bamelis (unpublished) showed that incubation RH of 43 to 65% had no significant effects on broiler chick qualitative aspects, day-old chick weight or its post-hatch growth.

Turning involves several parameters such as frequency, axis of setting and turning, turning angle, planes of rotation and stage of incubation requiring turning (Wilson, 1991). Egg turning has been reported to reduce malpositions (Robertson, 1961), to prevent abnormal adhesion of the embryo or embryonic membranes to the shell membrane (New, 1957) and to encourage the complete and timely closure of chorio-allantois at the small end of the egg (Deeming, 1989). These reports suggest that egg turning requirements can affect the quality of day-old chicks. Deeming (2000) reported that insufficient turning during incubation leads to a delay of hatching and adversely affects day-old chick qualitative aspects. It was also shown that transferring eggs from turning trays to hatching basket before day 18 of incubation depressed chick quality and this is more pronounced in chicks from eggs of older breeders (Tona et al., 2001). Paradoxically, egg turning until day 18 of incubation depresses RG up to 7 day while it improves chick qualitative aspects (see Figure 3) (Tona et al., 2003c). However, turning eggs until day 12 and transferring to hatcher baskets at day 18 improved RG and chick quality was comparable to turning until day 18 of incubation.

Recently, Hill (2001) reported that single stage incubation system leads to higher chick length at hatch compared to multi-stage incubation system. The author also showed that hatchery management influences chick length at hatch.
4. DELAY IN FEED ACCESS, CHICK QUALITY AND BROILER PERFORMANCE

A delay in feed access leads to alterations in the morphology of the microvilli and physiological changes such as villus volume and crypt depth in the small intestine during holding time (Zelhava et al., 1998). These defects have been hypothesised to contribute to the lower performance of broilers (Pinchasov and Noy, 1993; Turner et al., 1999). In addition, the holding or transportation conditions (e.g. density or environmental conditions) before placement at broiler farm influence post-hatch growth (Freeman, 1984; Van der Hel and Henken, 1990). As chicks are precocial, they will forage for feed almost immediately after hatch and begin to grow, whereas holding them without feed results in a decreased body weight, and a decrease in overall production performance of the broiler (Noy and Sklan, 1999). During the holding time, the retracted yolk provides immediate post-hatch energy (Romanoff, 1960) or assumes the maintenance (Anthony et al., 1989) during the period between hatching and access to food or during the first days of the chick (Noy et al., 1996; Noy and Sklan, 1999). Even though their metabolism is lower, a delay in the maturation of enzymatic systems controlling metabolism, e.g. deiodination system and activation of the T3-pathway (Darras et al., 1996) and immunoglobulin G (IgG) uptake provided by the yolk (Dibner, 1999) in the first day after hatch may be retarded.

However, all chicks do not hatch at the same time and this factor is often omitted. There is a hatching window of 24–36 hours spreading of late versus early hatching which can influence the homogeneity of day-old chicks. Investigating the effects of incubation duration on post-hatch growth, Lourens (2001), using Ross eggs, reported that chicks that hatched around an estimated average hatching time gained 26 or 88 g compared to the chicks, which hatched late or early respectively. Using Cobb eggs, Tona et al. (2003a) reported a negative correlation between RG and hatch timing for chicks from eggs stored for long duration (18 days) but found no effect of hatching time on RG in chicks from eggs stored for short duration (3 days). The weakness of late hatcher is also reflected in their lower triiodothyronine (T3) levels (Iqbal, 1989). Therefore, the duration of hatching window should be considered together with the holding time and transportation duration for delay in feed access estimation.

Under practical conditions, many birds have access to feed only 36–48 hours after hatching of the batch and during this time, body weight decreases speedily (Noy and Sklan, 1999; Pinchasov and Noy, 1993). Several authors reported an inverse relationship between the duration of holding time (e.g. holding time at the hatchery and the transportation duration) after hatch and chick subsequent growth (Pinchasov and Noy, 1993; Hackl and Katela, 1997; Xin and Lee, 1997; Noy and Sklan, 1999; Dibner, 1999; Decuypere et al., 2001). Recently, we found that chick weight loss during the holding time was only slightly higher in chicks from eggs of older breeders or those stored for long duration, more often of lower quality (Figure 4; Tona, unpublished). This observation suggests that day-old chicks of subnormal quality may not lose more weight than those of higher quality during holding time. With regard to post-hatch growth, it was shown that delay in food access caused a greater depression of the RG in chicks from eggs that have been stored for long duration (the greater % of which are of sub-optimal quality) than those that have been stored for shorter duration (the greater % of which are of high quality). (Table 2: Tona, unpublished). Since increasing age of breeders × storage duration adversely affect chick quality (Tona et al., 2004b it can be hypothesised that the worse the quality of day-old chick, the more the post-hatch growth is depressed.

Fig. 4 Relative chick weight loss during holding time according to the age (A38 or A58 weeks) × storage treatments (53 or 18 days) and food treatments. From Tona (unpublished).
Table 2. Relative growth RG and day-old chick quality scores according to the age of breeders, egg storage duration and delayed or immediate food access. Within column, data sharing no common letter are different and * indicates the difference between RG according to the food access treatments (P < 0.05). Data from Tona (unpublished).

<table>
<thead>
<tr>
<th>Age of breeders (weeks)</th>
<th>Egg storage duration (days)</th>
<th>Chick quality score</th>
<th>Relative growth (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>38</td>
<td>3</td>
<td>91.38 ± 4.65a</td>
<td>200.87 ± 6.83a</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>87.81 ± 14.81ab</td>
<td>164.35 ± 12.19ab</td>
</tr>
<tr>
<td>58</td>
<td>3</td>
<td>83.44 ± 14.46ab</td>
<td>174.33 ± 8.02b</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>77.37 ± 11.93b</td>
<td>159.85 ± 11.52b</td>
</tr>
</tbody>
</table>

5. RELATIONSHIP BETWEEN EMBRYO PHYSIOLOGICAL PARAMETERS AND CHICK QUALITY

During embryonic life, physiological parameters such as O₂ and CO₂ exchanges (Visseh毓jik, 1968; Vlek et al., 1979; Tazawa, 1980; Tullett, 1990; Gelfen and Ar, 2001; Fosenko et al., 2002; Menna and Mortola, 2002), heat production and metabolism (Decuyper et al., 1979; Geers et al., 1983; Fosenko et al., 2002; Janke et al., 2002), and hormonal balance, especially of T₃, T₄, T₃/T₄ ratio and corticosterone (Karmofsky et al., 1951; Wise and Fry, 1973; Kalliecharan and Hall, 1976; Decuyper et al., 1979; Muamba et al., 1981; Ockelford et al., 1983; Hylka et al., 1986; Kuhn et al., 1993; Darras et al., 1996) are of fundamental importance for embryonic development during incubation and their levels may affect the livability of the embryo and therefore chick quality. Specific physiological parameters serve to indicate developmental stages of the embryo. These parameters may have important roles as indicators of metabolic levels, stress levels and hatchability of the embryos. The levels of these parameters may reflect the adequacy of the incubation conditions and the quality of the hatching egg. They may also predict the quality and post hatch performance of the hatched chicks. Until now, very little research has been conducted in this area. Embryos with higher levels of T₃, pCO₂ or T₃/T₄ ratio (Table 3), and heat production (Geers et al., 1983; Tona et al., 2004a) had better hatchability, chick quality and post-hatch chick growth performance depending on breed or line. However, further studies are necessary to clarify which aspects of qualitative parameters are affected by each of these physiological parameters.

6. RELATIONSHIP BETWEEN CHICK QUALITY AND BROILER PERFORMANCE

First investigations studied the relationships between day-old chick weight and post-hatch performance up to slaughter age. Indeed, Powell and Bowman (1964) reported a positive correlation between day-old chick weight and post-hatch growth. According to McNaughton et al. (1978), Froudfoot et al. (1982) and Heam (1986), 1g increase in egg weight results in an increase of 8.3 g and 2.3 g for slaughter weight for younger flocks and older flocks respectively. By contrast, Vicira and Moran (1999) reported a negative correlation between the same parameters. Decuyper (1979), McInerthin and Gous (1999) and Tona et al. (2004b) found no relationship between day-old chick weight and slaughter performance but pointed out that

Table 3. Effects of egg storage duration on embryo physiological parameters and its reflects on the subsequent production parameters. Data from Tona et al. (2003a,b)

<table>
<thead>
<tr>
<th>Developmental stages</th>
<th>Egg storage duration</th>
<th>Physiological parameters</th>
<th>Production parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>T₃</td>
<td>Ratio T₃/T₄</td>
</tr>
<tr>
<td>Internal pinning</td>
<td>3 days</td>
<td>3.98 ± 0.19</td>
<td>0.74 ± 0.08</td>
</tr>
<tr>
<td></td>
<td>18 days</td>
<td>3.67 ± 0.20</td>
<td>0.59 ± 0.05</td>
</tr>
<tr>
<td>Hatching</td>
<td>3 days</td>
<td>3.57 ± 0.08</td>
<td>0.92 ± 0.05</td>
</tr>
<tr>
<td></td>
<td>18 days</td>
<td>3.95 ± 0.10</td>
<td>0.76 ± 0.05</td>
</tr>
</tbody>
</table>
only the weights of 7 to 10 days old chicks onwards are correlated with slaughter age weights. Also, by mixing
day-old chicks from eggs of breeders of different ages
or storage durations, Tona et al. (2003a) reported a
negative correlation between day-old chick weight and
broiler early performance up to 7 days (see Figure 1).

With regard to chick qualitative aspects, the informa-
tion from broiler farmers suggests that day-old chicks
of sub-optimal quality results in 200 to 300 g lower
slaughter body weight than those of high quality. In
line with this observation, Tona (2003) reported a
positive correlation between day-old chick quality
and RG up to 7 days as well as slaughter performance
(Figure 5) indicating that day-old chick qualitative
aspect is relevant for predicting broiler performance.
Devising an all-encompassing method that takes into
account all the quantitative and qualitative aspects of
the day-old chick for measuring day-old chick quality
may provide a mean for predicting performance to
slaughter. A note of caution in the application of this
method is the influence of some yet unknown intrinsic
factors that may affect chick quality. The effects of
these factors become apparent when chicks of the same
higher quality come from different sources such as
from stored eggs or older breeders. Indeed, when day-
old chicks are of the same quality score, the potential
for growth may still differ depending on whether eggs
were stored, or originated from breeders of different
ages or were incubated under different conditions
(Figure 6). The differences in growth potential
between chicks of the same quality score suggest that
other unknown factors are involved in growth per-
formance. The mechanisms by which these factors affect
performance are still not clear. One can speculate
however that these factors may have modified the
physiology of the embryo through changes in gene
expression or changes to downstream transcription
leading to changes in relevant modulators of genes
involved in growth.

7. CONCLUSION

Day-old chick quality is related to egg characteris-
tics and incubation conditions with both influencing
embryo development especially physiological and
hatching parameters, and the conditions between
hatching and placement at the farm. Although there
are still some unknown factors that can be involved in
chick quality definition, it is clear that quantitative
(weight or length) and qualitative assessment of day-
old chick quality are relevant and related to broiler
performance. Objective definition of chick quality
needs a combination of several factors such as
embryonic and/or day-old chick physiological para-
meters, hatching weight, chick length, and chick
physical aspects. As for qualitative aspects of chick
quality, the incidences of day-old chicks with
subnormal conditions in the navel area and those of
hatchling activity are of significant importance in the
growth of the chicks. Chick quality as well as broiler
performance are greatly depressed by longer storage of incubating eggs and this effect is more pronounced in eggs from older breeder. These effects of storage or age of breeders could not be explained by the proportion of sub-optimal chicks in the flock as these growth performance differences were predominantly present in chicks with maximal quality score. Therefore, there are still other unknown factors that affect later performance. Since pre-incubation factors and incubation conditions can affect embryo physiology in different ways, differential incubation conditions according to the egg characteristics should improve chick quality and thus broiler growth for the well being of the poultry industry.

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