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

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

^aLaboratory for Physiology and Immunology of Domestic Animals, Department of Animal Production, Faculty of Agricultural and Applied Biological Sciences, Catholic University of Leuven, Belgium; ^bUniversité 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 perfor-

mance. 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

*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, Decuypere and Michels (1992) and Borzemska *et al.* (1998) reported that good hatchability does not necessary 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: $[(\text{final body weight in gram}) \times (100\% - \text{mortality})] / [(10 \times \text{period in days}) \times (\text{feed conversion})]$ 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 Lilburn, 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 broiler 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; Decuypere *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; Decuypere *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 (Decuypere, 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 *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.

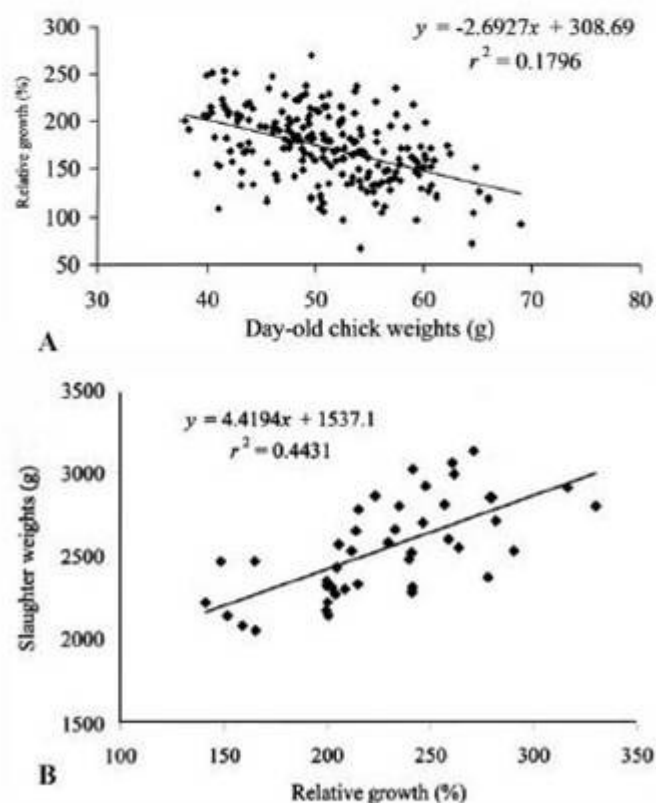


Fig. 1 Relationships (A) between day-old chick weights and relative growth (RG) and (B) between RG and slaughter weights of chicks hatched from eggs of 35 weeks-old breeders. Data from Tona *et al.* (2003b).

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)

Qualitative aspects	Incidence of each parameter (%)	Correlations between qualitative aspects						
		Activity	Down and appearance	Retracted yolk	Eyes	Leg	Navel	Membrane
Activity	36.86							
Down and appearance	23.56	NS						
Retracted yolk	32.93	<0.001 (0.32)	NS					
Eyes	8.76	<0.001 (0.45)	0.013 (0.22)	NS				
Legs	2.11	–	NS	NS	NS			
Navel	63.44	NS	<0.001 (0.41)	0.012 (0.23)	NS	NS		
Remaining membrane	32.93	NS	0.004 (0.28)	NS	NS	NS	<0.001 (0.42)	
Remaining yolk	19.03	NS	NS	NS	0.025 (0.21)	NS	NS	0.002 (0.26)

tions 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).

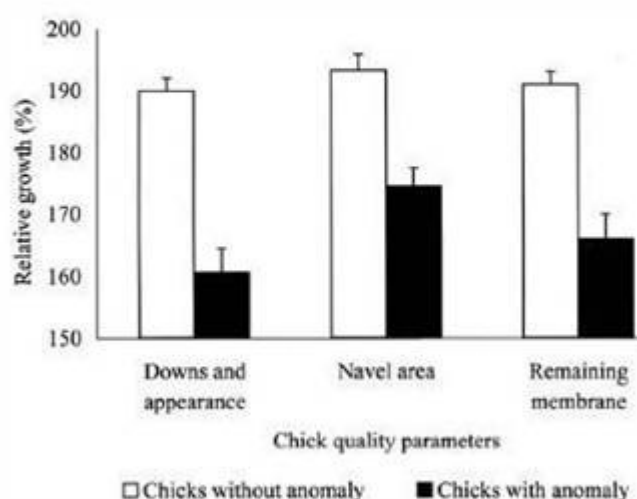


Fig. 2 Relative growth up to 7 days of chicks with anomaly or without anomaly according to some chick quality parameters. From Tona *et al.* (2004b).

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 moulting of older breeders leading to an improvement in chick quality (Tona *et al.*, 2002).

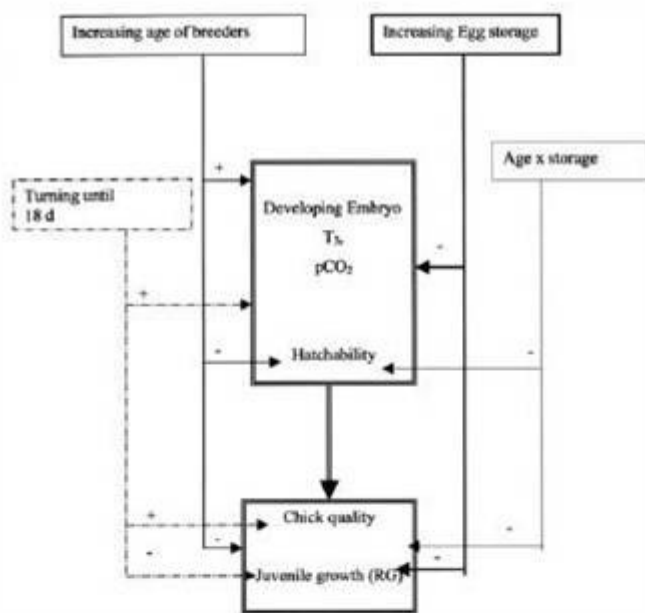


Fig. 3 Scheme showing positive (+) or adverse (-) effects of increasing age of breeders, increasing egg storage duration and turning until 18 days on incubating eggs, embryonic developmental parameters and production parameters. From Tona (2003).

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; Fassenko, 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). Intermittent low temperature (33.5°C) treatment during the last days of incubation affected post-hatch growth (Decuyper, 1979; Nvota *et al.*, 1980; Kühn *et al.*, 1982; Decuyper, 1984; Minne and Decuyper, 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, Bruzual *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 food 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 (Zehava *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 immunoglobuline 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 hatching time 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 hatchers 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; Decuyper *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.

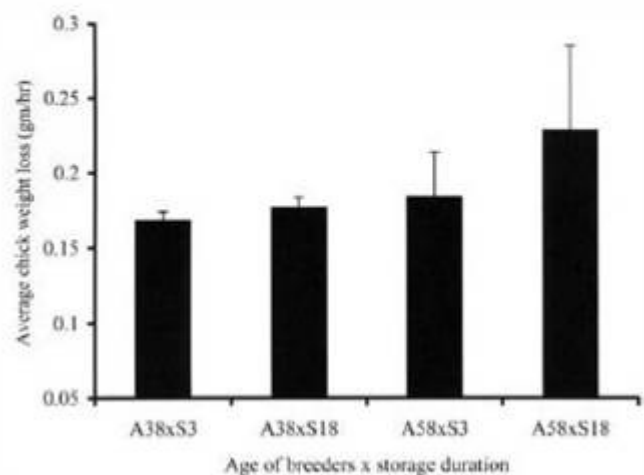


Fig. 4 Relative chick weight loss during holding time according to the age (A38 or A58 weeks) × storage treatments (53 or 18 days) and food treatments. From Tona (unpublished).

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)

Age of breeders (weeks)	Egg storage duration (days)	Chick quality score	Relative growth (%)	
			Delayed access	Immediate access
38	3	91.38 ± 4.65a	200.87 ± 6.83a	216.65 ± 8.20a
	18	87.81 ± 14.81ab	164.35 ± 12.19b	190.15 ± 9.99b*
58	3	83.44 ± 14.46ab	174.33 ± 8.02b	186.84 ± 8.79b
	18	77.37 ± 11.93b	159.85 ± 11.52b	179.00 ± 13.72b*

5. RELATIONSHIP BETWEEN EMBRYO PHYSIOLOGICAL PARAMETERS AND CHICK QUALITY

During embryonic life, physiological parameters such as O_2 and CO_2 exchanges (Visschedijk, 1968; Vleck *et al.*, 1979; Tazawa, 1980; Tullett, 1990; Gefen and Ar, 2001; Fasenko *et al.*, 2002; Menna and Mortola, 2002), heat production and metabolism (Decuyper *et al.*, 1979; Geers *et al.*, 1983; Fasenko *et al.*, 2002; Janke *et al.*, 2002), and hormonal balance, especially of T_3 , T_4 , T_3/T_4 ratio and corticosterone (Karnofsky *et al.*, 1951; Wise and Fry, 1973; Kalliecharan and Hall, 1976; Decuyper *et al.*, 1979; Muambi *et al.*, 1981; Ockleford *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 liveability 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 T_3 , pCO_2 or T_3/T_4 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); Proudfoot *et al.* (1982) and Hearn (1986), 1 g 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, Vieira and Moran (1999) reported a negative correlation between the same parameters. Decuyper (1979), McLoughlin 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)

Developmental stages	Egg storage duration	Physiological parameters			Production parameters	
		T_3	Ratio T_3/T_4	pCO_2	Quality score	RG
Internal pipping	3 days	3.98 ± 0.19	0.74 ± 0.08	47.35 ± 1.40	–	–
	18 days	3.07 ± 0.20	0.59 ± 0.05	42.20 ± 1.02	–	–
Hatching	3 days	3.57 ± 0.08	0.92 ± 0.05	–	96.59 ± 0.43	184.97 ± 2.63
	18 days	3.95 ± 0.10	0.76 ± 0.05	–	92.04 ± 0.96	168.96 ± 3.31

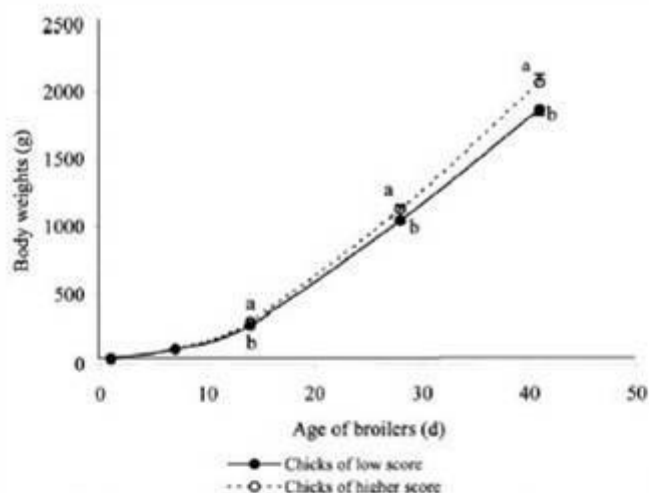


Fig. 5 Broiler growth according to day-old chick quality. From Tona (2003).

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 information 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

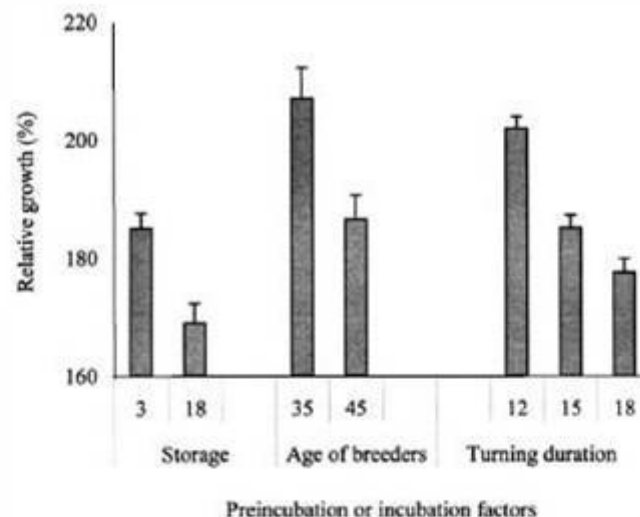


Fig. 6 Effects of pre-incubation factors (age of breeders and egg storage duration) and incubation factors (egg turning duration) on relative growth (RG) up to 7 days for chick of high quality at the time of hatch. From Tona *et al.* (2003a, 2003c, 2004).

other unknown factors are involved in growth performance. 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 characteristics 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 parameters, 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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