Critical Assessment of Chick Quality Measurements as an Indicator of Posthatch Performance

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ABSTRACT For hatcheries, not only is it important to have a high level of hatchability, but the quality of the chicks provided also has to be good, because broiler farmers are looking for chicks with a high growth potential, resulting in a greater slaughter yield at the end of the rearing period. However, chick quality has proven to be a difficult and subjective matter to define. Therefore, the aim of this study was to investigate the predictive value of different chick quality measurements for BW at slaughter age. Body weight, chick length, shank length, and toe length measurements as well as Tona score determination were performed on 1-d-old chicks and were linked to posthatch performance parameters. Different breeder lines (Cobb and Ross) and breeder ages (39, 42, and 53 wk of age) were used to investigate line and age effects. In addition, variability between people and repeatability in time of these quality measurements were determined. Body weight at 7 d of age appeared to be the best predictor of BW at slaughter age among all the quality measurements performed. Body weight at 1 d of age had the second greatest predictive value, closely followed by the ratio between BW at 1 d of age and chick length squared. Chick length and shank length both had low to no predictive value whatsoever for posthatch performance. The lack of significant correlations between the Tona score and posthatch performance could be explained by the absence of day-old chicks with anomalies (and thus a suboptimal Tona score) because a distinction had already been made, as is done in practice, between top-grade and lower grade chicks.

Key words: chick quality, broiler, posthatch performance

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INTRODUCTION

For hatcheries, not only is it important to have high hatchability, preferably with a narrow hatch window (spread between early and late hatchers), but the quality of the day-old chicks they provide to broiler farmers also has to be good. Broiler farmers are looking for chicks with a high growth potential, resulting in a high slaughter yield at the end of the rearing period.

Chick quality has proven to be a difficult matter to define. It is very much a subjective matter, depending on the judgment of each individual farmer. Over the years, however, different measurement methods, both quantitative and qualitative, for assessing chick quality have been developed. The first quantitative method for describing chick quality is the BW of 1-d-old chicks (Deeming, 2000; Decuypere et al., 2002). The relationship between BW at 1 d of age and slaughter weight, however, is not clear. Powell and Bowman (1964) found a positive relationship, whereas Decuypere (1979), McLoughlin and Gous (1999), Wolanski et al. (2003), and Tona et al. (2004) could find no relationship between these 2 parameters. Tona et al. (2004) did find a positive correlation between BW at 7 to 10 d of age and BW at 42 d of age. A second quantitative measurement method for assessing chick quality is chick length. According to Hill (2001), Wolanski et al. (2003), Meijerhof (2006), and Molenaar et al. (2007), chick length is positively correlated with BW at 42 d of age, with an average correlation coefficient throughout these studies of 0.33. Moreover, Wolanski et al. (2006) concluded that chick length plus shank length of day-old chicks is a better predictor of growth performance than BW at 1 d of age. However, as Deeming (2005) pointed out, substantial scientific evidence of the predictive value and objectivity of chick length as a predictor of growth potential has yet to be provided.

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In addition to quantitative methods for assessing chick quality, qualitative measurements have been developed (Raghavan, 1999; Deeming, 2000; Boerjan, 2002; Decuypere et al., 2002; Tona et al., 2003; Decuypere and Bruggeman, 2007). Boerjan (2002) and Tona et al. (2003) each developed a scoring system based on several qualitative parameters (such as appearance, activity, and quality of the navel area), the Pasgar score and the Tona score, respectively, to transfer these qualitative parameters into a quantitative score. The Tona score can be described as a trapped scoring system with a total score between 0 and 100 based on a wide range of parameters, each with a hedonic score. The score divides the chicks into groups of different qualities, with those scoring 100 being free of any abnormalities and being of the best quality (Tona et al., 2003).

Chick quality can be influenced in many different ways, as reviewed by Tona et al. (2005) and Decuypere and Bruggeman (2007). Preincubation factors such as egg storage duration, breeder age, and breeder line influence embryonic development and also 1-d-old chick characteristics (Mirosh and Becker, 1974; Deeming, 1996; Christensen et al., 2001; Peebles et al., 2001; Tona et al., 2003). Breeder age also influences the weight of the egg, the weight of the hatchling (Crittenden and Bohren, 1961; Smith and Bohren, 1975; Bohren, 1978; Pearson et al., 1996; Tona et al., 2004), the length of the chick (Hill, 2001), and the incidence of subnormal quality (Tona et al., 2001; Boerjan, 2002; Tona et al., 2004).

The objective of this study was to investigate the value of different methods regarding chick quality for predicting the growth potential of broiler chickens, defined as BW at slaughter age. Different measuring methods for determining chick quality were used to assess the quality of day-old chicks and were linked to posthatch performance parameters. Different breeder lines and breeder ages were used to investigate line and age effects. Because the objectivity of chick quality assessment methods is sometimes questionable, the variability among people and the repeatability in time of these observations were also determined.

MATERIALS AND METHODS

This experiment was approved by the Ethical Commission for Experimental Use of Animals of the Katholieke Universiteit Leuven.

Experiments 1 and 2

Incubation. A total of 300 chicks, originating from 2 separate industrial incubation trials in which 57,600 eggs were incubated, were used for these experiments. All eggs used for these incubations were stored for up to 3 to 7 d before incubation. All eggs were incubated in a sealed, airtight incubator for the first 10 d of incubation, allowing a natural increase of CO_2 in the incubator up to 1% (Airstreamer, Petersime, Zulte, Belgium). With the OvoScan system (Petersime, Zulte, Belgium), the incubator temperature was adjusted continuously in response to the actual eggshell temperature to achieve a constant desired eggshell temperature of 37.8°C.

Eggs were turned once every hour at an angle of 90° from the beginning of incubation until embryonic d 18. At d 18 of incubation, the eggs were weighed and candled, and those with evidence of a living embryo were transferred from the turning trays to hatching baskets.

In the first trial, 150 chicks from a Ross breeder line at 53 wk of age were used, whereas in the second trial, 75 chicks from a Ross breeder line at 39 wk of age and 75 chicks from a Cobb breeder line at 42 wk of age were used.

Chick Quality Measurements. All day-old chicks were collected and numbered individually after the entire batch of chicks was hatched, and chicks were subjected to several quality measuring methods. Body weight, chick length, shank plus toe length, and toe length were determined.

To determine chick length, the chick was laid on its ventral side, with the neck and right leg extended to their maximum length. Chick length was defined as the length from the tip of the beak to the implantation of the nail on the third toe. To measure shank plus toe length, the tibiotarsus was placed perpendicular to the tarsometatarsus. Shank plus toe length was the length from the top of the tarsometatarsus to the implantation of the nail on the third toe. To measure the toe length, the tarsometatarsus was placed perpendicular to the third toe. Toe length was measured from the beginning of the third toe to the implantation of the nail on the third toe. Shank length could then be calculated by subtraction.

Based on the body mass index used in human medical health care, the ratio between day-old BW and day-old chick length squared was calculated. After weight and length measurements were taken, all day-old chicks were scored with a Tona score as described in Tona et al. (2003).

To avoid subjectivity during measurements, all measurements were performed blind, meaning that the measurement of each parameter was done for all chicks, taken in random order from the entire batch of chicks, before the next parameter was measured.

After these quality measurements, 50 chicks (trial 1: Ross breeder line at 53 wk of age) and 30 chicks (trial 2: 15 chicks of the Cobb breeder line at 42 wk of age and 15 chicks of the Ross breeder line at 39 wk of age) were randomly chosen and killed by decapitation. The remaining yolk was isolated and weighed to determine yolk free BW. Yolk free BW (**YFBW**) was then calculated by subtraction.

Interperson Variability and Repeatability in Time Measurements. A total of 20 one-day-old chicks from each trial were randomly chosen to determine the variability in length measurements and Tona scores between people (interperson variability). The chick length and Tona score of these chicks were then determined by different people independently. In addition, to determine the repeatability of these quality measurements in time, the same chicks were measured and scored by the same person twice, with 6 h between the 2 measurements.

Rearing Procedure. After all chick quality measurements were performed, the chicks were housed in environmentally controlled rooms, where the temperature was set at 35°C at d 1 of age. Temperature scheme, lighting schedule, and feed were given according to the broiler company guidelines. From d 1 to 10, the chicks received a broiler starter diet containing 3,043 kcal of ME/kg and 22.2% CP. From d 10 to 21, they were fed a grower diet containing 3,126 kcal of ME/kg and 20.4% CP. From d 21 onward, a finisher diet containing 3,184 kcal of ME/kg and 19.4% CP was provided. At d 5 of age, the chicks were given an individual wing band.

Measurements During the Rearing Period. Body weight of the individual chickens was measured weekly. With these data, relative growth was calculated:

$$\text{Relative growth}\left(\%\right) = \frac{\text{BW week X} - \text{BW week }(\text{X}-1)}{\text{BW week }(\text{X}-1)} \times 100.$$

Experiment 3

Before the beginning of the incubation, 600 Cobb broiler breeder eggs (breeder age: 42 wk; average egg weight: 64.65 ± 0.15 g) were individually numbered and weighed. During the first 10 d of incubation, they were set in a forced-air incubator (Pasreform, Zeddam, the Netherlands) adapted for CO_2 incubation. This incubator was made airtight, allowing the CO_2 level to gradually increase up to 1.5% at embryonic d 10. From embryonic d 11 onward, the CO_2 incubation was stopped and all eggs were incubated under standard incubation conditions with a dry bulb temperature of 37.6°C and a wet bulb temperature of 29.0°C. Throughout the incubation until embryonic d 18, the eggs were turned once every hour at an angle of 90°. On d 18 of incubation, the eggs were weighed and candled, and those with evidence of a living embryo were transferred from the turning trays to hatching baskets.

Between 464 and 507 h of incubation, hatching eggs were checked individually every 2 h for hatching. Hatched chicks were collected and given an individual number. Four hours after their individual hatch, the chick lengths of several chicks that had hatched between 475 and 483 h of incubation were measured. At a fixed point the day after these chicks had hatched, all of them were measured again, implying that the time interval between the first and second measurement was different between chicks because of their different individual hatch times.

Data and Statistical Analysis

Data were processed with the statistical software package SAS, version 9.1 (SAS Institute Inc., Cary, NC). Correlations were determined by using a CORR procedure. When data were normally distributed, Pearson correlations were used; otherwise, Spearman correlations were used. Effects of breeder age and breeder line were analyzed by 1-way ANOVA for BW and chick length at 1 d of age. To determine the effect of breeder age and line on the Tona score, a nonparametric 1-way ANOVA procedure was used. Interperson variability, repeatability in time of measurements and chick length, measured at different times after hatch, were analyzed by using a paired *t*-test. A 5% degree of significance was used. Body weight and chick length at d 1 and egg weight before incubation are expressed as mean ± SEM. Tona score at d 1 is expressed as median ± interquartile range.

RESULTS

Correlations Among Day-Old Chick Quality Measurements

The correlation between day-old chick weight and day-old chick length was significant and relatively high (r = 0.49) for the chicks from the Ross line at 53 wk of age (Table 1). However, this significant correlation between day-old chick weight and day-old chick length was not found for chicks of the Ross line at 39 wk (r = 0.22) or for the chicks of the Cobb line at 42 wk (r = −0.018). Throughout all the data, the correlations between day-old chick length and shank length and between day-old chick length and toe length were positive and significantly different from zero. The correlations between chick length and toe length were greater than those between chick length and shank length. No correlations between Tona score and chick weight or length at 1 d of age were found in these experiments.

Correlations Among Day-Old Chick Quality Measurements, YFBW, and Yolk Weight

The correlations between yolk weight and day-old chick weight (Table 2) were significant and high for all the breeder lines and ages. In contrast, the correlations with chick length were quite low. Only in the Ross lines was the correlation between YFBW and day-old chick length significantly different from zero.

Correlations Among Day-Old Chick Quality Measurements and Posthatch Performance

The correlation between day-old chick weight and BW at d 7 appeared to be significant only for the Ross lines at 53 and 39 wk of age, but no significant correlation was found for the Cobb line (r = 0.25; Table 3). For all breeder lines and ages, day-old chick weight

Table 1. Correlations among day-old chick quality parameters

Parameter	Chick length	Shank length	Toe length	Tona score	BW:chick length^2
BW					
Ross, 53 wk	0.49*	0.19	0.05	0.041	
Ross, 39 wk	0.22	0.30*	0.23	−0.09	
Cobb, 42 wk	−0.018	0.22	0.035	−0.34	
Chick length					
Ross, 53 wk		0.33*	0.40*	−0.041	
Ross, 39 wk		0.34*	0.68*	0.09	
Cobb, 42 wk		0.33*	0.65*	0.21	
Shank length					
Ross, 53 wk			0.16	−0.24*	−0.011
Ross, 39 wk			−0.1	−0.08	−0.03
Cobb, 42 wk			−0.08	0.0015	0.007
Toe length					
Ross, 53 wk				−0.09	−0.22
Ross, 39 wk				0.12	−0.11
Cobb, 42 wk				0.12	−0.36*
Tona score					
Ross, 53 wk					0.07
Ross, 39 wk					−0.17
Cobb, 42 wk					−0.43*

*Correlations significantly different from 0 ($P \leq 0.05$).

was significantly and negatively correlated with relative growth in wk 1, with the exception of the Ross line at 39 wk of age.

From d 14 onward, positive significant correlations were found between BW at 1 d of age and weekly measured BW. Positive and significant correlations of approximately 0.30 were found between day-old chick weight and BW at d 42 for all breeder ages and lines.

Day-old chick length was significantly correlated with BW at d 7 for all breeder lines and ages. Thereafter, the correlation stayed significant for some lines and ages but decreased with age. In addition, no significant correlation between day-old chick length and BW at d 42 was found for any breeder line or age. The correlation between day-old chick length and relative growth (**RG**) at wk 1 was significantly different from zero only for the Cobb line at 42 wk of age. For all breeder ages and lines, correlations between the Tona score and posthatch performance parameters were nonexistent.

Almost no significant correlations were found between shank and toe length and posthatch performance parameters (BW at d 7, RG at wk 1, and BW at d 42). The correlations between the ratio of BW and chick length squared and BW at d 7 were significant for the Ross lines but not for the Cobb line, whereas those with RG at wk 1 were negative and significant. The correlation between the ratio of BW and chick length squared and BW at d 42 was significantly different from zero for the Ross line at 53 wk of age. In general, the correlations of ratio of BW and chick length squared with BW at d 7 and 42 were lower than those with BW at d 1.

Table 4 shows the correlations between BW at d 7 and 42 and RG at wk 1. The correlations between BW at d 7 and 42 were significant and greater than the correlations between day-old chick weight and BW at d 42 for all breeder lines and ages. In contrast, the correlations between RG at wk 1 and BW at d 42 were significant only for the Ross line at 53 wk of age and the Cobb line at 42 wk of age.

Table 2. Correlations between BW and chick length at 1 d of age and yolk free BW (YFBW) and yolk weight at 1 d of age

Parameter	YFBW	Yolk weight
BW		
Ross, 53 wk		0.80*
Ross, 39 wk		0.73*
Cobb, 42 wk		0.80*
Chick length		
Ross, 53 wk	0.38*	−0.03
Ross, 39 wk	0.57*	−0.12
Cobb, 42 wk	0.33	0.51

*Correlations significantly different from 0 ($P \leq 0.05$).

Chick Length and Time of Measurement After Hatch

Table 5 clearly shows that chicks grew on average 10 to 11 mm over a period of 22 to 30 h after hatch. Significant differences in chick length were found, with chick length at 22 to 30 h after hatch being significantly greater than at 4 h after hatch.

Effect of Breeder Age and Breeder Line on Chick Quality Parameters

Body weight at d 1 of age was significantly lower for the chicks of Ross breeders compared with those of Cobb breeders of a similar age (39 and 42 wk, respectively; Table 6). In addition, there was a significant effect of age on chick weight. Chicks originating from the younger breeders (39 wk of age) were significantly lighter than those originating from the older breeders (53 wk of age). For the quality score, differences between breeder lines and breeder ages were also found. The chicks from the Ross line had scores that were 6

Table 3. Correlations between day-old chick quality measurements and posthatch performance

Parameter	BW	Chick length	Tona score	Shank length	Toe length	BW:chick length
Relative growth, wk 1						
Ross, 53 wk	−0.27*	−0.052	−0.1	0.064	0.12	−0.28*
Ross, 39 wk	−0.16	0.25	−0.09	0.035	0.14	−0.32*
Cobb, 42 wk	−0.31*	0.35*	0.21	−0.06	0.27	−0.46*
BW, d 7						
Ross, 53 wk	0.42*	0.29*	−0.072	0.19	0.15	0.28*
Ross, 39 wk	0.45*	0.36*	−0.2	0.23	0.25	0.23*
Cobb, 42 wk	0.25	0.34*	0.04	0.039	0.27	−0.009
BW, d 14						
Ross, 53 wk	0.40*	0.24*	0.0065	0.16	0.12	0.28*
Ross, 39 wk	0.39*	0.5*	−0.14	0.35*	0.27	0.11
Cobb, 42 wk	0.37*	0.27	−0.18	0.17	0.16	0.13
BW, d 21						
Ross, 53 wk	0.30*	0.084	0.087	0.09	0.043	0.28*
Ross, 39 wk	0.43*	0.38*	−0.14	0.33*	0.17	0.22
Cobb, 42 wk	0.38*	0.09	−0.25	0.16	0.097	0.15
BW, d 28						
Ross, 53 wk	0.24*	0.057	0.092	0.013	0.029	0.23*
Ross, 39 wk	0.38*	0.33*	−0.11	0.31*	0.13	0.19
Cobb, 42 wk	0.36*	0.09	−0.26	0.1	0.13	0.14
BW, d 35						
Ross, 53 wk	0.24*	0.060	0.098	0.012	0.021	0.22*
Ross, 39 wk	0.35*	0.32*	−0.087	0.33*	0.18	0.17
Cobb, 42 wk	0.30*	0.38*	−0.15	0.08	0.18	0.013
BW, d 42						
Ross, 53 wk	0.25*	0.05	0.084	0.021	0.0023	0.25*
Ross, 39 wk	0.33*	0.22	−0.06	0.23	0.17	0.19
Cobb, 42 wk	0.35*	0.23	−0.17	0.05	0.08	0.14

*Correlations significantly different from 0 ($P \leq 0.05$)

points greater than those of chicks from the Cobb line, whereas the chicks from younger breeders had greater quality scores than the chicks from older breeders. No effect of breeder age or breeder line was found on chick length at 1 d of age.

Variability in Day-Old Chick Quality Measurements Between People and Repeatability of Day-Old Chick Quality Measurements in Time

In the first trial, the average difference in measurements of the length of the same chick made by 2 different people was 4 mm, with a minimum difference of 0 mm and a maximum difference of 9 mm (Table 7 A). This difference in chick length measured by 2 different persons was significant. In the second trial, no significant difference was found for the measurement of chick length by different people. The average difference was reduced to 2 mm and the maximum difference to 4 mm compared with the first trial.

In the first trial, no significant differences were found between measurements of chick length by the same person at different times (Table 7 B). The average difference between time-divided measurements was less than 2 mm, the minimum difference was 0 mm, and the maximum difference was between 2 and 4 mm. In the second trial, a difference in time measurements was found for chick length, with an average difference of 2 mm and a maximum difference of 4 mm.

Table 7 shows the variability between people and repeatability in time of Tona score measurements. The determination of Tona scores in both trials was not significantly different between different people and also was not significantly different in time.

Table 8 shows the incidence of a lower than maximum score for each Tona score parameter for all chicks evaluated during the first and second trial. In both trials, and also overall, the following parameters rarely had a score lower than the maximum score: activity, down and appearance, retracted yolk, eyes, legs, and remaining yolk. This was in contrast to the parameters concerning the evaluation of the navel area (navel area and remaining membrane), which had an occurrence of more than 50%.

DISCUSSION

In recent years, chick quality has become a research topic of increasing interest, with the aim of finding a clear and objective definition and quantification of chick quality to be able to hatch and detect chicks with good growth potential at 1 d of age. Many different methods for measuring or quantifying chick quality

Table 4. Correlations between BW d 7, BW d 42, and relative growth (RG) at wk 1

Parameter	BW, d 7	RG, wk 1
BW, d 42		
Ross, 53 wk	0.37*	0.22*
Ross, 39 wk	0.38*	0.16
Cobb, 42 wk	0.54*	0.34*

*Correlations significantly different from 0 ($P \leq 0.05$).

Table 5. Chick length (mm) measured at two different times after hatch

Hatch time (h)	Hatchlings (n)	Egg weight (g) before incubation	Time after hatch (h) of chick length measurement	Chick length (mm)
475	15	65.57 ± 0.72	4	177 ± 1[b]
			30	186 ± 2[a]
477	35	63.31 ± 0.62	4	175 ± 1[b]
			28	185 ± 1[a]
479	34	64.51 ± 0.59	4	174 ± 1[b]
			26	185 ± 1[a]
481	20	63.92 ± 0.68	4	179 ± 1[b]
			24	189 ± 1[a]
483	19	64.75 ± 0.77	4	173 ± 1[b]
			22	186 ± 1[a]

[a,b]Within each hatch time, different letters indicate a significant difference ($P \leq 0{,}0001$) in chick length.

are used, such as measuring BW and chick length and determining the Tona score or Pasgar score of 1-d-old chicks. Researchers have claimed that these methods can each (partially) predict the growth potential of the chick when it is only 1 d old. However, evidence of a linear relationship between these day-old chick quality methods and posthatch performance is not convincing or is even lacking.

The correlation between BW at d 1 and chick length at d 1 was not consistent between lines and ages in our experiments and is comparable to the correlation found by Wolanski et al. (2006) between hatch length and BW at hatch. Although the overall correlation was significantly different from zero, only 9% of the variability in BW was explained by chick length. These correlations suggest that long chicks are not necessarily heavy. As Deeming (2005) explained previously, the weight loss of the eggs and dehydration at hatch could play an important role in this phenomenon. In contrast to the findings of Wolanski et al. (2006), the linear relationship between chick length and shank length at d 1 was not as high, although it was significantly different from zero. However, we found a greater correlation between chick length and toe length at d 1. When measuring BW at hatch, no distinction was made between the actual BW and the weight of the residual yolk; therefore, a biased conclusion about embryo development could be made. We found a small but significant correlation of 0.34 between chick length and YFBW in our results and no correlation whatsoever between chick length and residual yolk weight.

Wolanski et al. (2006) found an even greater correlation of 0.60 between chick length and YFBW and a negative correlation of −0.28 between chick length and residual yolk weight. Chicks with better yolk utilization could have developed more body mass during the incubation period and therefore could be longer (Meijerhof, 2006). Chick length and shank length at 1 d of age are said to be better tools for predicting chick growth potential than BW at 1 d of age (Hill, 2001; Wolanski et al., 2006). In addition, Molenaar et al. (2007) concluded that chick length at hatch has a predictive value for slaughter weight (r = 0.36) and breast meat yield (r = 0.25), at least for male broilers, but not for female broilers. Wolanski et al. (2006) reported greater correlations between chick length and shank length at 1 d of age and BW at d 14 than between chick weight at d 1 and BW at d 14, suggesting that length measurements provide a more accurate measure of growth potential than chick weight at 1 d of age. None of these findings was confirmed in this study. Correlations between chick and shank length at 1 d of age and BW at d 14 were not stronger than those between BW at d 1 and BW at d 14. In addition, the predictive value of the length measurements performed appeared to be even lower than that of BW at 1 d of age, and correlations between shank and toe length and posthatch performance (BW at d 7, RG at wk 1, BW at d 42) were very low. Although chick length was significantly correlated with BW at d 7, this correlation decreased with age, with no differences thereafter. Our results concur with the doubts of Deeming (2005) about the usefulness of chick length as a meaningful indicator of chick quality. An additional reason strengthening this doubt is the observation that chicks can grow as much as 1 cm in less than 24 h and can also lose weight in this period. Because the hatch window or the spread between early and late hatchers is approximately 24 to 36 h, this means that if chick length is measured at the end of the entire hatch, the early hatchers have already had the opportunity to grow in length compared with the late hatchers. This leads to an overestimation of chick length of the early hatchers. This finding shows that one must be cautious in interpreting data on chick

Table 6. Effect of breeder line and breeder age on BW d 1, chick length d 1, and Tona score

Item	BW, d 1	Chick length, d 1	Tona score
Effect of breeder line			
Ross, 39 wk	43[b]	19.9	96[a]
Cobb, 42 wk	45.9[a]	20.0	90[b]
Effect of breeder age			
39 wk, Ross	43[b]	19.9	96[a]
53 wk, Ross	47.4[a]	19.9	90[b]

[a,b]Different letters indicate a significant difference ($P \leq 0.05$) between breeder lines or breeder ages.

Table 7. Interperson variability in day-old chick quality measurements for the first and second trial; repeatability in time of day-old chick quality measurements for the first and second trial; and interperson variability and repeatability in time of Tona score determination

Parameter	First trial	Second trial
Interperson variability		
Δ in chick length (mm)		
|Average Δ|	4	2
|Min Δ|	0	0
|Max Δ|	8	4
P-value	0.0002	0.79
Repeatability of measurements		
Δ in chick length (mm)		
|Average Δ|	1.6	2
|Min Δ|	0	0
|Max Δ|	3	4
P-value	0.54	0.0031
Tona score		
Interperson variability	10/20[1]	14/20
P-value	0.33	0.97
Repeatability in time	11/20	17/20
P-value	0.40	0.18

[1]This score shows the number of chicks that had the same score given by different persons at different times.

length measurements in relation to other 1-d-old chick parameters and to posthatch growth. The rationale for using the ratio between chick weight and chick length squared at d 1 was to find a better predictor of posthatch performance. Although this ratio did have correlations with posthatch performance similar to chick weight at d 1, these correlations were never greater; therefore, these parameters are not a better predictor of growth potential.

The correlation of the overall Tona score with RG up to 7 d of age, as found by Tona et al. (2003, 2005), appears to be valid and relevant only if a significant number of chicks are of submaximal quality; if not, differences in growth potential (on a genetic or epigenetic basis) will prevail over the effect of the chick quality score on growth. Because the chicks used in these experiments came from an industrial incubation, a distinction between first-grade and lower grade chicks had already been made. Therefore, great abnormalities, such as spread legs and non-uptake of the yolk sac, were no longer found among these chicks. This likely explains the lack of correlation between the Tona score and posthatch performance in these experiments. With correlations of 0.37 or greater, BW at d 7 of age appeared to be the best predictor of growth potential among all the quality measurements performed, which is in agreement with the observations of Tona et al. (2004).

In this study, we also questioned the interperson variability and repeatability in time of these measurements, and it appeared that the strength applied to stretch the chick when measuring chick length was dependent on the person. This was illustrated in our trial test 1, in which one person always pulled harder, and therefore had a longer length for the same chick, than the other person. In trial 2, however, the difference between the measurements of different people was reduced to an average of 2 mm and a maximum of 4 mm. We could therefore conclude that although the strength needed to stretch the chick will always be different between people, it can be adjusted to a standard strength between people. The repeatability of chick length measurements in time was smaller than the interperson variability, although the value of these measurements can be questioned, because there was a period of 6 h between the 2 time measurements and, as mentioned previously, chicks can grow as much as 1 cm in length in less than 24 h. In both trials, no significant differences in determining the Tona score were found between people and in time. Different scores were caused mainly by a different evaluation of the navel area. Abnormality of activity, down and appearance, eyes, legs, and retracting yolk were almost nonexistent (respectively, 0, 1.6, 0.7, 0 and 0.3%). Abnormality of the remaining yolk had a slightly greater occurrence (7%) but was not as high as abnormality of the navel area and the remaining membranes, which both had an occurrence of more than 50%. These results suggest that the parameters concerning the navel area may have a greater weight in determining the Tona score. This confirms the conclusions of Tona et al. (2005) that the parameters included in the assessment of chick quality and scoring may need to be revised.

Chick quality can be influenced in many different ways, as stated by Tona et al. (2003) and Decuypere and Bruggeman (2007). The preincubation factors of

Table 8. Incidence of abnormalities among chicks scored with Tona score

	Occurrence of abnormalities (%)		
Tona score parameter	First trial	Second trial	Overall
Activity	0 (0/150)	0 (0/150)	0 (0/300)
Down and appearance	0 (0/150)	3 (5/150)	2 (5/300)
Retracted yolk	1 (2/150)	0 (0/150)	0.7 (2/300)
Eyes	0 (0/150)	0 (0/150)	0 (0/300)
Legs	0 (0/150)	0 (0/150	0 (0/300)
Navel area	32 (79/150)	58 (87/150)	55 (166/300)
Remaining membrane	59 (89/150)	61 (92/150)	60 (181/300)
Remaining yolk	4 (6/150)	10 (15/150)	7 (21/300)

breeder line and breeder age were variable in these experiments. The fact that older breeder lines lay heavier eggs and therefore produce heavier chicks was demonstrated well in these experiments. Not only breeder age, but also breeder line had an influence on the weight of the day-old chicks. Concerning these observations, it is necessary to mention that the egg size, and concomitantly the weight of day-old chicks, is dependent on the breeder age and line. According to Hill (2001), chick length increases with age of the breeder line. However, in our study, chick length was not influenced by either the breeder line or breeder age. Our results on chick scores confirm the results of Tona et al. (2001), Boerjan (2002), and Tona et al. (2004) showing that the incidence of subnormal quality increases with breeder age. Although significant differences were observed between the 2 different lines (Ross and Cobb) for both day-old BW and Tona score, the influence of breeder line and breeder age on correlations between day-old chick quality and posthatch performance were minimal in these experiments.

In conclusion, under practical conditions, BW at 7 d of age appeared to be the best predictor of BW at d 42 among all the quality measurements performed. Body weight at 1 d of age had the second greatest predictive value, closely followed by the ratio between BW at 1 d of age and chick length squared. Chick length and shank length both had low to no predictive value whatsoever for posthatch performance. The lack of a significant correlation between the Tona score and posthatch performance could be explained by the absence of day-old chicks with anomalies (and thus a suboptimal Tona score) because a distinction had already been made, as done in practice, between first-grade and lower grade chicks.

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