Interrelationships between chick quality parameters and the effect of individual parameter on broiler relative growth to 7 days of age

Beziehungen zwischen Parametern der Kükenqualität und Auswirkungen einzelner Parameter auf das relative Wachstum bis zum 7. Lebenstag

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Introduction

Chick quality is defined according to the judgement of different people. However, in general, a chick of good quality can be defined as a chick of high performance potential. This can involve external qualitative aspects or intrinsic factors. Though, day-old chick intrinsic factors cannot be judged visually, its qualitative aspects can be observed de visu. Also, chick qualitative aspects may be the only way to select chicks at hatch due to the large numbers of day-old chicks produced in the hatcheries. Day-old weight of broiler chicks is not correlated to the broiler weight at slaughter age but 7 days old weights are (Decuyper et al. 1997; Tona et al. 2003), therefore this weight can be considered as a parameter for predicting performance and for confirming day-old quality (Deeming 1995; Tona et al. 2003) as this may be an expression of intrinsic factors. Chick quality aspects involve several parameters such as abnormalities of the navel and its surroundings, legs and toes, eyes, down and appearance, beak and chick reflex (Raghavan 1999; Deeming 1995; Boerjan 2002; Decuyper et al. 2002). Day-old chick can suffer from abnormal conditions of one or a combination of these parameters. We recently developed a method for assessing chick quality by scoring these parameters depending on the presence or absence of any number of these abnormal conditions and their severity (Tona et al. 2003). These parameters are affected by increasing age of breeders, increasing egg storage duration (Tona et al. 2003) or deviating incubation temperatures (Boerjan 2002). Overall chick quality may determine broiler chick juvenile growth up to 7 days or slaughter weight (Decuyper et al. 2002; Tona et al. 2003). However, the individual frequency and effects on production performance of each parameter has not been well analyzed. Any information about the incidence of every anomaly may indicate how important it is. We hypothesize also that there may be associations between quality parameters. Therefore, this study aims to investigate the importance of each quality parameter and their distribution in the different quality groups of day-old chicks and to analyze any association between components. The result may be important for refining the scoring system for assessing chick quality. The effects of each parameter on juvenile growth will also be studied with the aim that some may be used as alternative methods for screening chick quality and to take this into account in pre-incubation and incubation management in order to improve broiler performance.

Materials and Methods

A total of 10800 Cobb broiler breeder eggs were used for this study. The experiment consisted of 9 replications of 150 eggs per experiment and the experiment was repeated 8 times. Eggs consisted of those collected from breeders of different ages and stored for up to 7 days. Eggs were incubated for 21 days in a forced draft incubator (PasReform, Zeddam, The Netherlands) under similar conditions as described previously (Tona et al. 2003).

At hatch, all chicks were marked, weighed individually and examined macroscopically to record physical quality scores. These included activity, downs and appearance, size and consistency of retracted yolk, eye conditions, leg conformation, colouration of the navel area, remaining yolk and remaining membrane. Scoring was done as previously reported (Tona et al. 2003). Briefly, these characteristics were scored according to their importance. The level of the score for each parameter was related to its importance in the survival of the chick and the severity of any anomaly it may carry. This was expressed as a hedonic score. The quality score for a chick was defined as the sum of the scores quoted for all characteristics (Table 1).

The overall number of chicks that fell into the different score levels for each parameter was then calculated. The total quality score for each chick was also calculated in order to sort them into two major groups of 1) chicks of high total score (designated as good quality chicks) and 2) chicks of low score (designated as chicks of low quality). The two groups were within each replication and were reared in separate pens. All chicks were reared until 7 days of age to determine their performance. Chicks were kept on floor pens at 30-32°C and a photoperiod of 23hr light : 1hr dark. Chicks were fed on standard broiler starter diet containing 3100 kcal metabolizable energy and 22% crude protein. Water was provided ad libitum. At the end of 7 days, all chicks were weighed and the relative growth to 7 days (RG) was calculated. Chick weights and RG were then sorted according to their quality score for each parameter at hatch in order to analyse performance relative to initial score.
Statistical analysis

Data were processed with the statistical software package SAS version 6.121 to investigate the effect of the different parameters studied. The correlation between quality parameters and the percentages of chicks of good quality were subjected to logistic regression analysis. For each parameter, as well as for day-old chick quality, the scores were considered as binomial in distribution in the chicks of high or low quality scores. Then, a general linear model was also used to analyze the effect of the dichotomized chick quality on RG. The model was as follows:

\[ Y_{ij} = \mu + \alpha_i + \epsilon_{ij}; \]

Where, \( Y_{ij} \) = studied parameter \( i \) with \( \mu \) = overall mean \( \alpha_i \) = main effect of parameter \( i \) and \( \epsilon_{ij} \) = random error term from chick \( j \) within parameter \( i \).

Results

Relationship between chick total quality score and relative growth (RG)

Overall, RG up to 7d was 176.97% ± 2.37 or 200.84% ± 3.26 respectively for d-old chicks of lower quality and chicks of higher quality. Figure 1 shows that there was significant but low positive linear relationship between chick score and RG (\( P < 0.05; r = 0.33 \)). The large scatter indicates that other factors affected RG.

Distribution of chicks among quality parameters

Table 2 shows the distribution of day-old chicks among the parameters used for assessing chick quality. The data is presented as incidence of a parameter in the overall total number of chicks examined and also as incidence within chicks considered as low quality chicks. Data show that a significant number of chicks among the low quality group had low score for the condition of the navel area. Similarly,
chicks with low score due to the amount of retracted yolk, remaining membrane, activity and downs and appearance were high in this group. The relative incidence of these scores as a function of the totality of chicks remained the same and were significantly high. Consistently, the incidence of low score due to leg conformation, remaining yolk and eyes was very low.

Correlations between quality parameters

In Table 3, the correlations between the different parameters were analysed using the data on distribution of scores in chicks. The data show strong correlation between some parameters and none at all between others. There was a strong association between parameters that contribute to high incidence of low scores in chicks. The condition of the navel area was strongly correlated to down and appearance, and remaining membrane. The amount of retracted yolk was also strongly correlated to navel area. So also was remaining membrane to residual yolk. The activity of the chicks was also correlated to the amount of retracted yolk. These correlations suggest that a low score in a parameter may be followed by a similar low score in an associated parameter(s).

Effect of individual quality parameter on juvenile growth rate (RG) of chicks

Table 4 shows the body weights of chicks at day-old and their RG to 7 days analysed as a function of each qualitative parameter. Chicks with high score for down and appearance, navel area condition and remaining membrane were significantly heavier at day-old compared with those with low scores in these parameters. Day-old weights were similar for chicks with either low or high scores for activity, retracted yolk, eye conditions, leg conformation and residual yolk. The data on RG to 7 days show significant relationships between some parameters and RG. Except for leg conformation and remaining yolk which had no effect on RG to 7 days, but birds with a low score in other parameters showed significantly lower RG. Low score in the condition of the navel area, remaining membrane and downs and appearance showed the greatest effect on RG.

Discussion

The results of this study give further evidence that chick quality parameters, as previously reported (Tona et al.
Chicks with lower RG and almost certainly results in very low quality chicks. The level of activity may reflect the reflexes of the chicks and therefore suggests the expression of intrinsic factors. We demonstrated in a previous study (TONA et al. 2003), that egg storage and age of the breeder can affect chick quality, but the mechanisms by which these factors or incubation conditions affect the individual quality parameters are yet to be established.

The positive correlation between RG and chick quality scores in this study confirms our earlier report that chick quality may be a better tool for predicting the post-hatch growth performance of broilers. This may be a better tool than the hatching weight since the correlation between RG and chick day-old weight has been shown to be negative (-0.42) (TONA et al. 2003). The study also showed a correlation between chick performance and the individual quality parameters. In the comparison between birds of high score and those of low score, day-old broilers with low score due to sub-normal navel condition, down and appearance, and remaining membranes had significantly lower body weights. Their RG to 7 days was also significantly lower. The effect of retracted yolk, activity and eyes were manifested in the RG to 7 days but not at day-old. However, their effect was not as high as those recorded for those of the navel, down and appearance and remaining membrane but suggests that effects may manifest at different periods post-hatch. With the depth of effect seen with low scores on the former, one is tempted to suggest that more emphasis be placed on these parameters in the scoring system for chick quality screening. The effects of the quality parameters on performance (RG) to 7 days are re-

### Table 4. Day-old weights (W0) and relative growth (RG) up to 7 days in relation to each quality parameter

<table>
<thead>
<tr>
<th>Qualitative aspects</th>
<th>Chicks with lower than maximum score in quality aspect</th>
<th>Chicks with maximum score in quality aspect</th>
<th>P value (RG)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>W0</td>
<td>RG</td>
<td>W0</td>
</tr>
<tr>
<td>Activity</td>
<td>45.57 ± 4.44</td>
<td>175.50 ± 6.0</td>
<td>45.76 ± 5.04</td>
</tr>
<tr>
<td>Down and appearance</td>
<td>43.05 ± 3.70</td>
<td>160.52 ± 3.75</td>
<td>46.21 ± 4.93</td>
</tr>
<tr>
<td>Retracted yolk</td>
<td>45.71 ± 3.84</td>
<td>177.30 ± 3.30</td>
<td>45.71 ± 4.92</td>
</tr>
<tr>
<td>Eyes</td>
<td>44.30 ± 3.86</td>
<td>175.82 ± 9.47</td>
<td>45.80 ± 4.94</td>
</tr>
<tr>
<td>Legs</td>
<td>41.79 ± 3.95</td>
<td>190.63 ± 25.32</td>
<td>45.77 ± 4.88</td>
</tr>
<tr>
<td>Navel area</td>
<td>44.41 ± 4.80</td>
<td>174.46 ± 2.95</td>
<td>46.66 ± 4.75</td>
</tr>
<tr>
<td>Remaining Membrane</td>
<td>43.79 ± 4.55</td>
<td>165.92 ± 3.99</td>
<td>46.25 ± 4.86</td>
</tr>
<tr>
<td>Residual Yolk</td>
<td>47.94 ± 4.92</td>
<td>187.32 ± 5.74</td>
<td>45.39 ± 4.81</td>
</tr>
</tbody>
</table>

The letters a,b represent significant difference between RGs within rows and * represents significant difference between W0 also within rows. (P < 0.05).
lated to the significance of each of the parameters in determining chick quality and the performance of the broilers. Although the mechanism by which the quality parameters influence growth potential is not quite known but several explanations can be advanced.

The process from embryo initiation until hatching is complex. During embryogenesis, albumen is absorbed partly into the yolk sac (Romanoff 1960; Deeming 1989). From the 19th day of incubation, the yolk that lies over the embryo's ventral surface, between the legs, is retracted into the abdomen cavity (El-Ibably et al. 1966). The retracted yolk provides immediate post-hatch energy (Romanoff 1960) or assumes its maintenance (Anthony et al. 1989) during the period between hatching and access to food or during the first days of the chick (Nov et al. 1996 and Noy and Sklan 1999). In relation to this importance of the yolk during embryogenesis, any anomaly in the retraction of the yolk may influence the quality of the hatched chick and thus its viability and growth potential. Moreover, the yolk sac membrane is supposed to be a digestive and an absorption organ and also a site for the synthesis of specific proteins. This role of the yolk sac membrane can explain the adverse effect of any remaining membrane around the navel area on RG. Since the navel is, for day-old chick, the barrier between abdominal cavity especially retracted yolk and ambient environment, any anomaly in its closure may jeopardize the integrity of the retracted yolk and thus may influence growth potential. Also, any discoloration of the navel area of day-old chick may be due to an anomaly in abdominal cavity especially in the retracted yolk. Leg conditions may be due to the chicks' posture in the hatcher baskets. Abnormal leg conformation will not allow the chicks to return unto their feet during an activity test and will explain the association of the legs with activity. The aspect of down and appearance of the chick had a large effect on RG and this can be related to the fact that, dirt on the skin surface or wetness of the down can be a source of contamination, which may affect growth. Also, the aspect of down and appearance may reflect hatching process or condition. Although quality parameters affect RG at different levels, their effect at the end of the first level of life is very important since body weight at this age is highly correlated to weight at slaughter. The first week of broiler life is considered as a fluctuation period and the real start of rearing period at broiler farms is supposed to be the end of this period (Deluyfvere 1979; Deeming 1995). Thus, the qualitative aspects of day-old chicks can be partly linked to their viability and performance.

It is concluded that qualitative aspects of day-old chicks are important but some parameters may be more influential in determining the growth potential of the chick to 7 days of age and hence broiler performances at slaughter age. Chick of irreproachable quality can be defined a priori as a chick with high overall quality score at hatch and a fortiiori of high growth speed up to 7 d. In view of the level of the effects and distribution of some of the individual parameters, a revision of the scoring system may be necessary to improve the assessment of chick quality.

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Summary

In a previous report, day-old chick quality was defined to incorporate physical qualitative parameters and that chick quality, as distinct from hatching weight, influenced the relative growth (RG) of the broiler to 7 or 42 d of age. These quality parameters were based on information collected from hatcheries and broiler farms. The scoring system was related to the importance of the parameter to the survival of the chick and severity of the abnormality. The current study evaluated the level of occurrence of abnormality of each parameter in newly hatched day-old chicks as a method of ascertaining their importance in determining the quality of chicks in a flock. The study also determined the interrelationships between parameters to check the possibility of correlated responses and to ascertain the individual effect each parameter may have on RG. This is with a view to reviewing the quality parameters included in the assessment of chick quality and the scoring system. A total of 10800 eggs from Cobb broiler breeders were incubated and all the chicks hatched were weighed individually and scored for quality parameters. The chicks were reared until 7 d of age and weighed again. The data collected were analyzed to determine the number of chicks with or without abnormality in each of the parameters and any correlations between them. Body weights were used to calculate RG. The results show a low but positive correlation (0.33) between RG and quality score. The major cause of lower than maximum quality score was attributable to abnormality of the navel area. Activity, remaining membrane, retracted yolk, down and appearance, also ranked high but lower than navel abnormality. Abnormality of the legs, eyes and residual yolk were very low suggesting that they may not be of great importance. The data also revealed significant correlations between quality parameters, especially those abnormalities with high occurrence suggesting that the occurrence of one may always be associated with the other. The individual effect of qualitative parameters was reflected in day-old weights and RG. Again, those abnormalities with high occurrence and correlation caused significant lowering of RG. Leg abnormality or residual yolk had no effects. It is concluded, in view of these result, that parameters included in the assessment of chick quality and scoring may need to be revised.

Key words

Broilers, chick quality, correlations, relative growth

Zusammenfassung

Beziehungen zwischen Parametern der Kükenqualität und Auswirkungen einzelner Parameter auf das relative Wachstum bis zum 7. Lebenstag

In einer früheren Veröffentlichung wurde bereits die Kükenqualität anhand von physikalischen Qualitätskriterien definiert. Es wurde gezeigt, dass die Kükenqualität neben dem Schlupfgewicht das relative Wachstum (RG) der Broiler zwischen dem 7. und 42. Lebensst. beeinflusst. Die Qualitätskriterien wurden aus Informationen von den Brüteteien und Mastbetrieben abgeleitet. Das verwendete Skalierungssystem trug der Bedeutung der Parameter im Hinblick auf das Überleben der Küken und auf das Ausmaß der Abweichung Rechnung. In der vorliegenden Untersuchung wurde geprüft, inwieweit die Häufigkeit der Abweichungen bei den einzelnen Qualitätskriterien beim


Stichworte

Broiler, Kükenqualität, Korrelation, Wachstum

References

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