Predictability of Egg Content in Hen's Eggs by Means of Cross Sectional Image Analysis

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ABSTRACT

The present study was designed to determine the in vivo predictability of egg content in hen's eggs by means of computer tomography (CT). The experiment was carried out with altogether 120 eggs, which were originated from a 36 weeks old TETRA-H parent stock. During the CT measurements eggs were placed in egg holders (10 eggs) thus two eggs were scanned simultaneously. Following scanning parameters were set in: 110 kV – 40 mAs, spiral mode, pitch 1, FoV 110 mm. In all cases eggs were scanned using overlapping 3 mm slice thickness on a Siemens Somatom Emotion 6 multislice CT scanner. On the CT images obtained the volume of the albumen, yolk and shell was determined by a self-developed egg-separation and segmentation software. After the CT measurements eggs were broken and their yolk, albumen and shell weight were measured. Between the CT predicted volumes and the measured weights Pearson correlations were calculated. The highest correlation (r=0.90) was found between the CT predicted albumen volume and the measured albumen weight. In the case of the yolk and shell the correlation coefficients were 0.793 and 0.713, respectively. Based on these results it was concluded that the accuracy of prediction seems to be precise enough in the case of the albumen, but its improvement is necessary in the case of the yolk and shell. Possible ways for improving the accuracy of prediction could be the use of another algorithm in the egg-segmentation software and the optimization of settings of the CT examination.

Keywords: Computer tomography, egg composition, hen, image analysis, Hungary

1. INTRODUCTION

In poultry breeding, it is an old question, whether the size or the composition of the eggs has greater effect on the viability of the offspring. In former studies it was already observed that the mass of the eggs and also that of the egg yolk increases parallel with the age of layers (Applegate *et al*., 1998; Hartmann *et al*., 2000; Silversides and Scott, 2001; Oloyo, 2003). Experiments that followed up the development of embryos and the birds hatched have clearly demonstrated that in eggs laid by young layers the development of embryos is slower than in those laid by older ones (Applegate, 2002). It was supposed that this is partially due to the higher egg yolk ratio of eggs from older birds, which enables a more substantial incorporation of nutrients into the organism of the developing embryo.

Over a long period of time, elucidation of the correlations between the composition of hatching eggs and the development of the birds hatched was hampered by the lack of instruments

T. Donkó, M. Emri, G. Opposits, G. Milisits, Z. Sütő, A. Orbán, I. Repa. "Predictability of Egg Content in Hen's Eggs by Means of Cross Sectional Image Analysis". CIGR Workshop on Image Analysis in Agriculture, 26-27. August 2010, Budapest.

that would have been capable of determining the composition of eggs without opening them. An attempt for determining the chemical composition of intact eggs was made by Williams *et al*. (1997), using the so-called TOBEC (Total Body Electrical Conductivity) method in their study. In this experiment it was demonstrated that there are significant correlations between the so-called E values measured by the TOBEC method (the electrical conductivity of the eggs) and the water content of the eggs as well as the dry matter content of the albumen in all the four species studied (chicken, duck, guinea fowl and quail).

Relying on the results of Williams *et al*. (1997), studies on this field have recently been started at the Kaposvár University as well. In the framework of a three-year programme (2005–2007) it has been demonstrated that eggs with markedly different composition can be distinguished and assorted efficiently by means of the TOBEC method. At the same time, the research results have confirmed that eggs with different composition – i.e., having dissimilar yolk/albumen ratios – have significantly deviating hatchability, and that the birds hatching from these eggs have significantly different body composition at the time of hatching and significantly different growth rate during rearing and finishing (Milisits *et al*., 2008a, 2008b). On the basis of all these findings, therefore, it seemed to be expedient and justifiable to continue this research in order to determine the correlations between egg composition, hatchability and the development of the birds hatched in a more accurate manner. Namely, the biggest disadvantage of the above-mentioned TOBEC method is that, because of the only moderate correlation found between the electrical conductivity and the composition of eggs, it is not suitable for demonstrating minor changes in egg composition, and is reliable only for distinguishing eggs with extremely divergent composition (Milisits *et al*., 2007). The aim of the present study was to examine, whether computer tomography (CT) is suitable for the more accurate *in vivo* prediction of egg composition.

2. MATERIAL AND METHODS

The experiment was carried out with altogether 120 eggs, which were originated from a 36 weeks old TETRA-H parent stock. The CT examination of these eggs was performed at the Institute of Diagnostic Imaging and Radiation Oncology of the Kaposvár University.

Before the CT measurements all of the eggs were weighted and positioned for the scanning in standing/upright position thereafter. During the CT measurements eggs were placed in egg holders (10 eggs), thus two eggs were scanned simultaneously. Scanning parameters 110 kV and 40 mAs were set in. In all cases eggs were scanned using overlapping 3 mm slice thickness on a Siemens Somatom Emotion 6 multislice CT scanner.

The images obtained were analysed by a new self-developed egg-separation and segmentation software.

After the CT measurements, all of the eggs were broken and their yolk, albumen and shell were separated. Between the CT predicted volumes and the measured weights Pearson correlations were calculated. For the determination of the correlation coefficients the SPSS statistical software package (SPSS for Windows, 1999) was used.

3. RESULTS

The calculated correlation coefficients were lower than the expected values, but they were better than values originated by using TOBEC method. It is likely, that further modification of the

aquisition parameters and testing of other segmentation and separation algorithms could increase the correlation coefficient of the egg yolk size estimation.
A previous study reported that based on the X-ray density values of the pixels (picture elements) the correlation coefficients were very low between the measured yolk weight and the estimated yolk volume, while the manual scan evaluation were more precise, but it resulted in a quite intricate method (Milisits et al., 2009). The root of the problem was that there were some pixels with characteristic of albumen on the yolk area and inversely as well. The precise volume of yolk and albumen could be evaluated by modelling the manual evaluation process. In compliance with these results and taking into consideration the numerous eggs, it was necessary to develop a semiautomatic scan analysis to replace the manual scan evaluation. In the first step, the developed software separated the measurements, accordingly to the individual eggs.
The second step of the process was the segmentation which is based on finding the border between shell and albumen and albumen and yolk. The first step of the volumetric evaluation was the determination of the strongest correlation between predicted and measured egg yolk content depending on the applied threshold values for separating the different egg components. As a result of this evaluation it was found that the use of the value 97 resulted in the most accurate separation of albumen and yolk, i.e. in the highest correlation between the predicted and measured yolk content of the eggs (Figure 1).

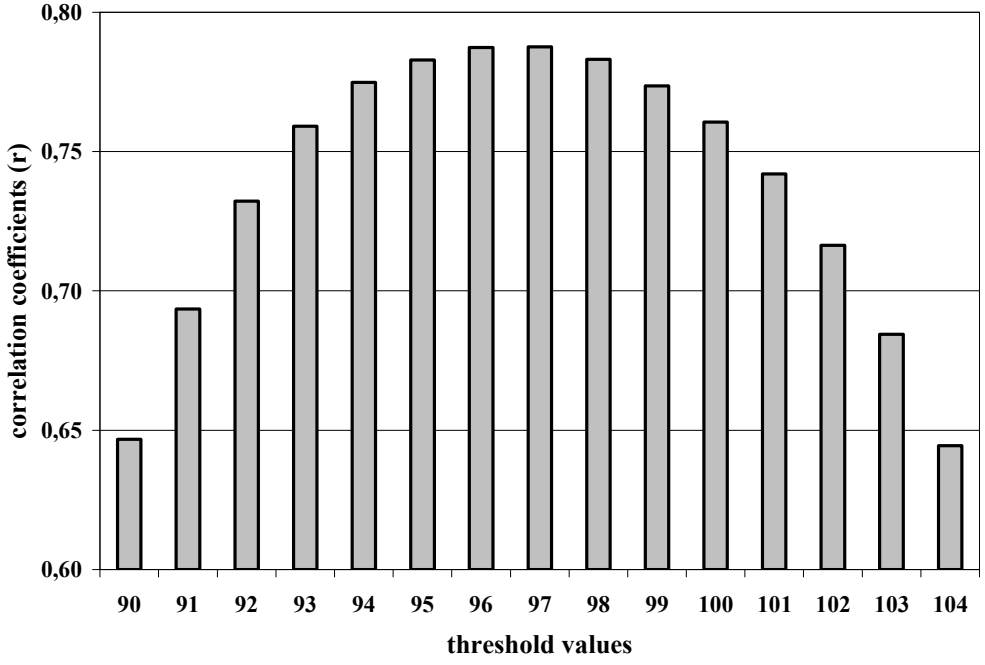

Figure 1. Correlations between CT predicted and weighed egg yolk content of hen's eggs using different threshold values in the image evaluation

Based on the results the highest correlation (r=0.90) was found between the CT predicted albumen volume and the measured albumen weight. In the case of the yolk and shell the correlation coefficients were 0.793 and 0.713, respectively.

4. CONCLUSION

The applied *in vivo* CT evaluation method seems to be more suitable in comparison with the TOBEC examination. Based on these results it was concluded that further development of this method is needed for increasing the correlations obtained. Potentially the egg-segmentation software may be tested using modified algorythms; further optimization of the parameters of the CT examination might need to be considered as well.

5. ACKNOWLEDGEMENT

This research project was supported by the Norwegian Financial Mechanism and the Hungarian Scientific Research Fund (OTKA NNF 78840)

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