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Applicability of computer tomography in the prediction of egg yolk ratio in hen’s eggs

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ABSTRACT - Applicability of computer tomography (CT) was examined for the in vivo determination of egg yolk ratio in commercial hen’s eggs. Altogether 60 eggs were measured by CT, and two different evaluation methods were tested for the prediction of the egg yolk ratio. Because of the overlapping of the X-ray density values of the yolk and albumen, the evaluation based on the X-ray absorption seems not to be useful for the in vivo prediction of the egg yolk ratio. The determination of the surface of the egg yolk on the cross-sectional images resulted in a 69.3-74.1% accuracy of prediction, depending on the number of scans involved in the evaluation.

Key words: Hen, Egg, Computer tomography, Prediction.

Introduction – In former experiments it has already been studied whether the size or the composition of the egg had greater effect on the viability of the offspring. However, in these examinations correlations were mainly determined between different species, therefore the available information about intra-specific correlations is scarce. The clarification of these correlations was mainly hindered by the lack of a reliable technique/equipment, capable of determining the egg composition in vivo. Using the so-called TOBEC (Total Body Electrical Conductivity) method for the non-destructive determination of egg composition, Williams et al. (1997) have found significant correlations between the measured values and some egg constituents in different species of birds. Similar results were obtained also by Milisits et al. (2005) using hen’s eggs in their investigation. The aim of the present study was to examine, whether computer tomography (CT) is suitable for the in vivo prediction of egg yolk ratio.

Material and methods – The experiment was carried out with 60 hen’s eggs originated from a 36 weeks old ROSS-308 hybrid parent stock and collected on the same day. All of the eggs were weighted before the CT measurements and positioned thereafter for the scanning in standing/upright position. The eggs were scanned with a SIEMENS Somatom Plus 4 Expert spiral CT scanner at the Institute of Diagnostic Imaging and Radiation Oncology.
of the Kaposvár University. During each scanning session 10 eggs were measured simultaneously with the following parameters: slice thickness: 5mm, feed: 5mm, pixel spacing: 0.5859 x 0.5859mm, tube voltage: 120kV, dose: 185mAs, reconstruction algorithm: AB50. All of the obtained data were saved and stored in a DICOM file format. The images were analysed by the Medical Image Processing V1.0 software developed by the above mentioned institution.

After the CT measurements, all of the eggs were broken and their yolk and albumen were separated. After weighing the yolk, its ratio to the whole eggs was calculated. For predicting the egg yolk ratio in vivo, prediction equations were created by means of the linear regression method using the CT data as independent variable in the model. For the determination of the prediction equations the SPSS statistical software package (SPSS for Windows, 1999) was used.

Results and conclusions – As first step of the evaluation the X-ray density values of the pixels (picture elements) were used to determine the egg yolk ratio in the hen’s eggs in vivo. Using this evaluation method it was established that the X-ray density values of the egg yolk clearly differ from that of the animal’s fatty tissues. While X-ray density values of the animal’s fatty tissues ranges from -200 to -20 on the so-called Hounsfield-scale, the values of the egg yolk varies between -10 to +30. The reason of this could be the higher water and protein content of the yolk, which results in an increase of the X-ray density values in the egg yolk. Because of the overlapping of the X-ray density values of the yolk and albumen, this evaluation method seems not to be useful for determining the egg yolk ratio in hen’s eggs (Figure 1).

As another method of the evaluation, the surface of the egg yolk was determined on the cross-sectional images for predicting the egg yolk content in vivo. As first step of this evaluation only one scan per egg was used for testing the accuracy of prediction. Using the scan taken at the germinal disc resulted in a 69.3% accuracy of prediction (Figure 1). Only a slightly better accuracy was obtained, when the two (Figure 2) or four (Figure 3) neighboring (±1 or ±2) scans were also involved into the evaluation:

The accuracy of prediction based on the data of the scan taken at the germinal disc was tested on independent samples (n=20) and the following results were obtained: MSE=2.82; r=0.639 (P=0.002).

Based on the results it was concluded, that computer tomography seems to be a useful method for the prediction of egg yolk ratio. The obtained accuracy of prediction seems to be precisely enough for using this technique in further investigations in order to examine the effect of egg composition on the egg’s hatchability and hatched chick’s development.
Figures 1-3. Correlation between the egg yolk ratio in hen’s eggs and egg yolk ratio on the CT scans based on the data of one (Figure 1), three (Figure 2) and five (Figure 3) CT images.

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