NON INVASIVE METHOD TO STUDY THE BODY COMPOSITION

OF RABBITS BY X-RAY COMPUTERISED TOMOGRAPHY

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Abstract - The most important information about the base of X-ray computerised tomography (CT) in rabbits presented in the paper. The CT gives a wide range of possibilities in the rabbit genetic and nutrition research. Its main advantages are the non invasive method and the accuracy, but on the other hand it is relatively costly. With different scanning and evaluating technics it can be used in selection program -to estimate the carcass traits for improving the dressing percentage-, in the prediction of total body composition and the measuring of the growth of important tissues in the same rabbit during the whole growing period.

INTRODUCTION

X-ray computerised tomography is suitable for the individual examination of the tissues in different depths with the help of X-ray. On the scale - named after Hounsfield, the practical founder of this method - the different tissues can be separated on the basis of the X-ray density values (HOUNSFIELD, 1980). The whole scale spreads from -1000 (no absorption) to +1000 Hounsfield units (HU) (total absorption), definitively the 0 point is the density value of water. During the 1980s Norwegian scientists proved that the different tissues of domestic animals can be characterised by not overriding HU value intervals (SKJERVOLD et al., 1981). So on the scale e.g. the density of fat tissue is between about -200 and -20, while that of the muscle tissue is between about +20 and +200 HU.

BASE OF THE PICTURE FORMING

In the Pannon Agricultural University the CT Biological Centre started working in 1990 with a Siemens Somatom DRG type, third generation CT scanner (HORN, 1991). At present the digital imaging centre has a newer, the so-called spiral CT and a NMR instrument too, which are used both in medical and animal sciences.

In Figure 1, the base of the two dimensional picture forming is shown. The described experimental object consists of nine cubes with the mark of their X-ray density values. As it can be seen the summarised density values of each level are the same on the X-ray film.
It means that this type of picture forming with its average values cover the information of different layers. The computerised tomography can eliminate the above mentioned deficiency.

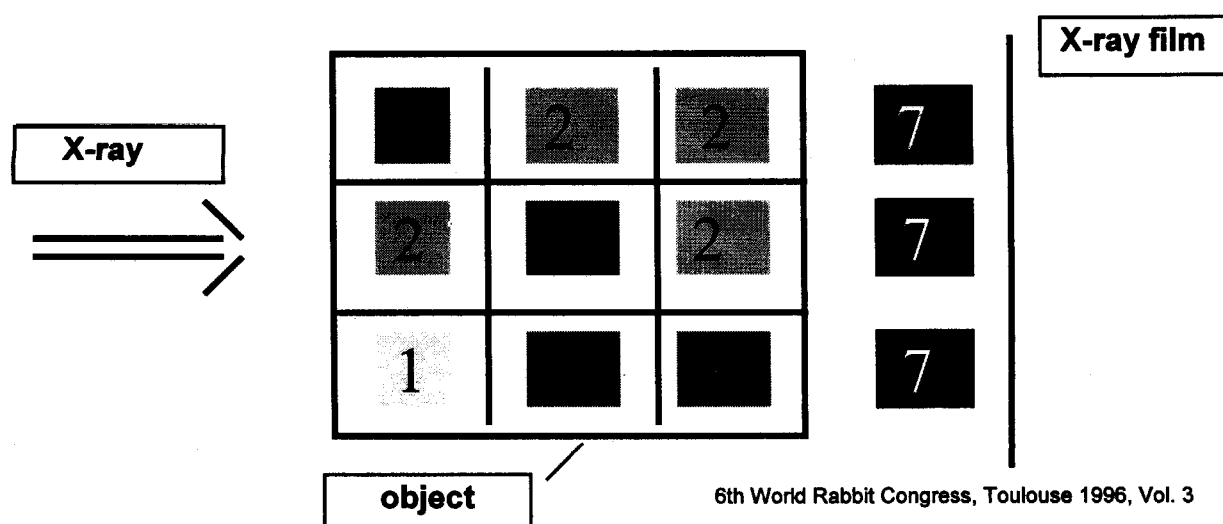**Figure 1.: Base of the two dimensional picture forming**

Figure 2 shows the operation's principle of a CT scanner. The X-ray tube and on the opposite side the detector field make a full rotation around the animal during the picture taking. In an optionally chosen degree of rotation a 1-2 ms X-ray pulse is given. For example 360 pulses times 512 detectors give 184320 observations of ray absorption. Then a computer uses these observations together with their 360 rotational positions and makes the tomogram which is a 256 x 256 (n = 65536) elements matrix. Each individual point of the matrix represents a CT value expressed in HU units and is called pixel.

Figure 2 : The X-ray tube and the detector field
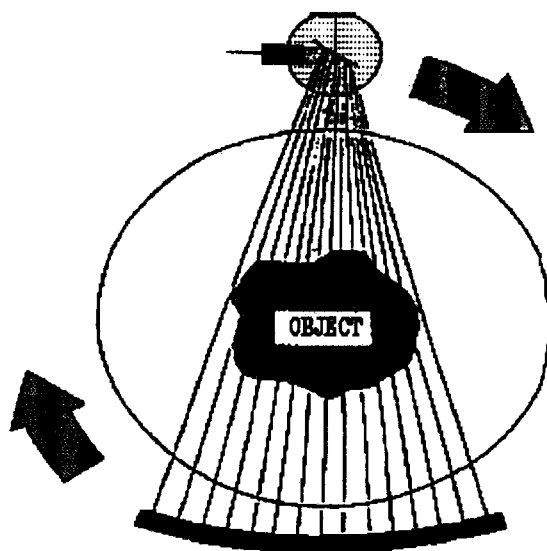
Usually the CT pictures are taken at night after eight hours' starving, because the full gastrointestinal tract results bed picture quality. The rabbits are fixed with belts on stretch position, lying flat in special "plexiglass containers" during the examination without using anaestethics (Figure 3.). This kind of placing is useful for growing rabbits because the animals can't move and the legs are well separated from the body. In the case of the pregnant does anaestethics are used instead of fixing with belts to protect the foetus against an abortion.

Figure 3 : Fixed rabbit in the special container
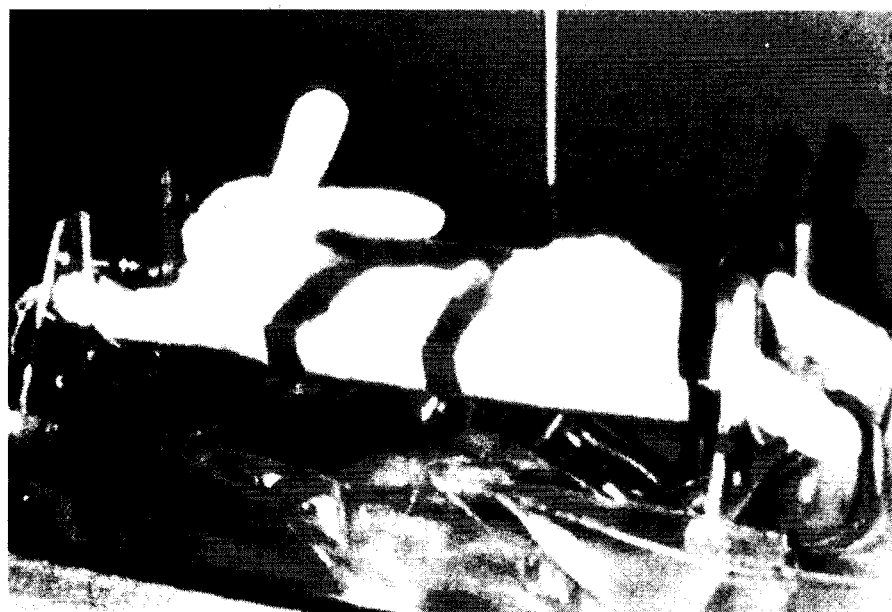
The examinations are started with the taking of the overall topogram which is like a conventional two dimensions X-ray picture. In the topogram the anatomical levels of the scans or body intervals are marked.

At the beginning the animals were scanned one by one, now three rabbits can be examined at the same time. On Figure 4, there is a topogram of three animals, suitable for taking both upper and side topogram and gives the possibility of the separate evaluation of rabbits. With this procedure the time consumption and the experimental costs can be definitely reduced

Figure 4 : Topogram of three rabbits with the level of the kidneys on the right and the
cross section of the m. *longissimus dorsi* and the left kidney on the left
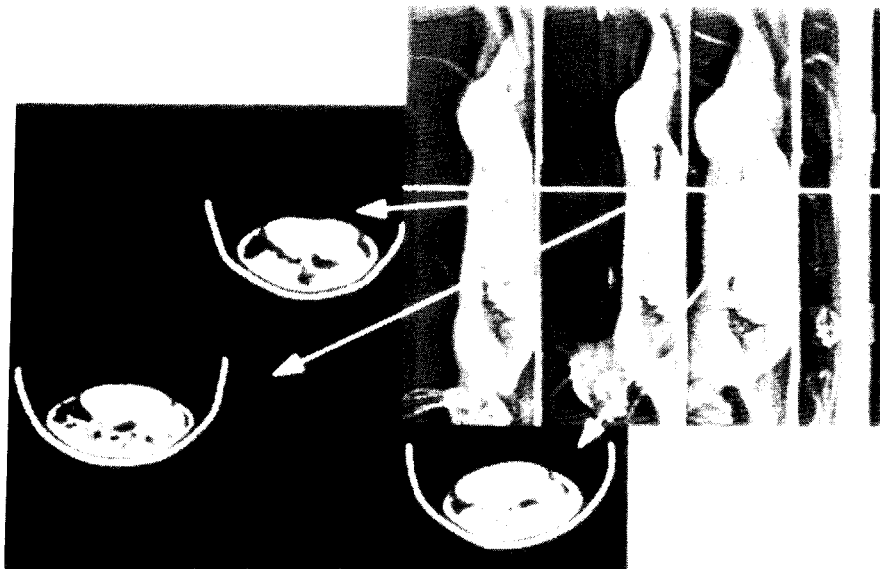
Three typical scanning methods can be used. The first is based on fix anatomical points. This is used in the breeding program of the Pannon White rabbits, where the area of the cross section of the m. *longissimus dorsi* be measured between the 2nd, 3rd and 4th, 5th lumbar vertebra (SZENDRO et al., 1992, 1994., ROMVARI et al., 1995). On Figure 5 there is an upper topogram with the marking of the above mentioned anatomical levels.

Figure 5 : Upper tomogram with the join of the 2nd, 3rd (I) and 4th, 5th (II) lumbar vertebra
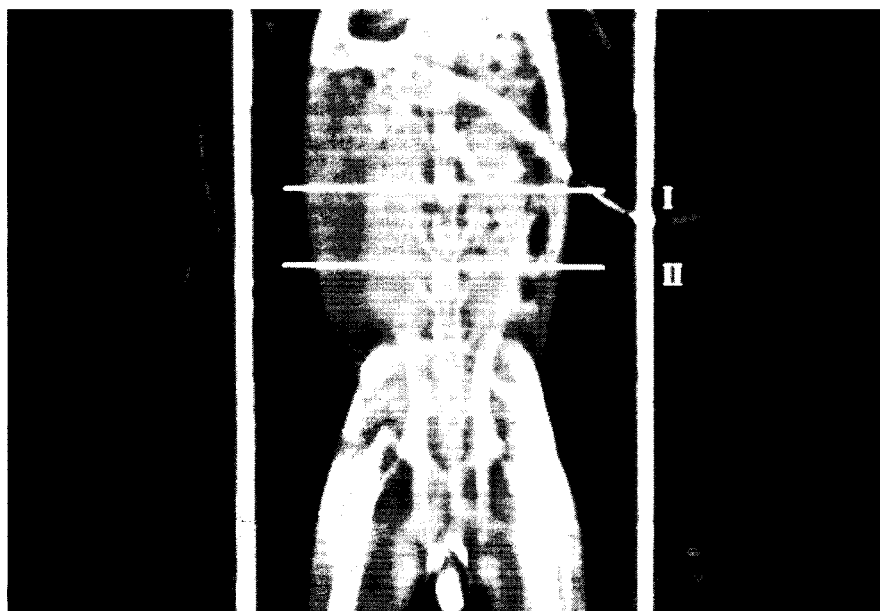
The second approach is based on serial scans. In this case information is collected from the whole body, which further on can be correlated with the results of the total body chemical analysis. On the right of Figure 7, there is a side taken topogram with the marking (double lines) of the scapular arch and the end of the femur.

The third method utilise that the distance between the two neighbouring scans depends on the size of the rabbits. For example always 20 scans are taken from the 5th cervical vertebra to the head of the femur. In this way the same serial number scans belong to the same anatomical point of rabbits, so different-size animals can be compared. This method is used when the building in of the muscle and fat tissues are measured.

PICTURE EVALUATING

Evaluating the CT pictures two approaches can be used. The first one is the capability of the CTPC software (BERENYI and KÖVER, 1991) used by us at the CT Biological Centre. For the whole picture or only part of it - HU interval chosen by us -, the pixels belonging to this interval are shown. And from the picture the size of the area belonging to a certain density interval can be read directly in cm².

The tomogram on Figure 6 is taken between the 3rd and 4th lumbar vertebra. For better demonstration one side of the m. *longissimus dorsi* surface is marked with light patterns. In addition to the cross section measurements optional distances can be determined on the scans.

Figure 6 : Cut of the m. longissimus dorsi with marking it's left side and width
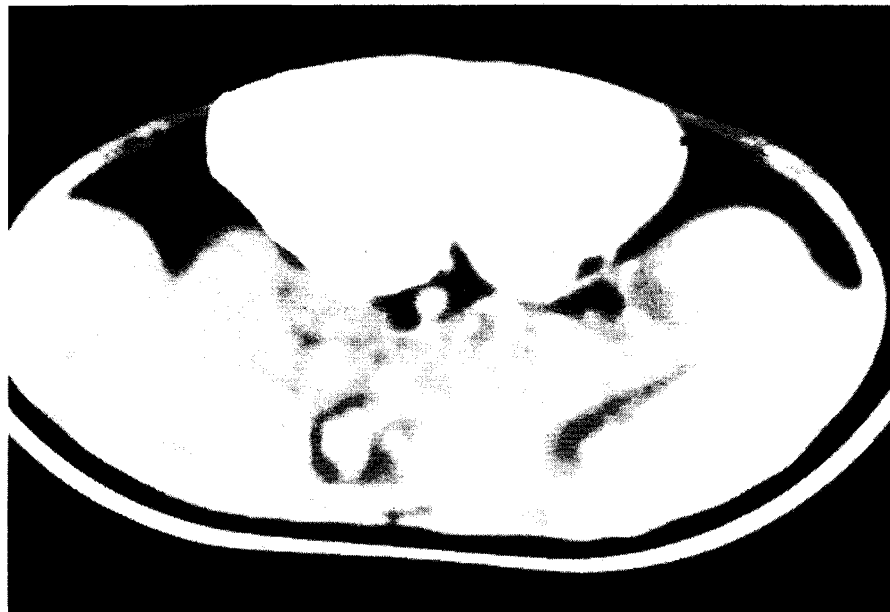
The second approach during the processing of the pictures there is a possibility to fix the density values belonging to the picture-forming pixels. The histograms on the basis of the frequency distribution's data originate in this way. For the purpose of our research usually only the part of the whole HU scale is needed, which contains the absorption interval of both the fat and muscle tissues. For the evaluation the consecutive 10-10 values of the HU scales were summarised, 40 data were formed in the interval between -200 and +200. These variables (HU variables) can be the base of the further statistical procedures (FEKETE *et al.*, 1994). On the tomogram of Figure 7 the cross section of the left kidney and of the m. *longissimus dorsi* are shown.

Figure 7 : Construction of the histogram (left) from the pixel density values of the market area.
The anatomical location of the cut (centre) is shown on the side taken topogram (right)
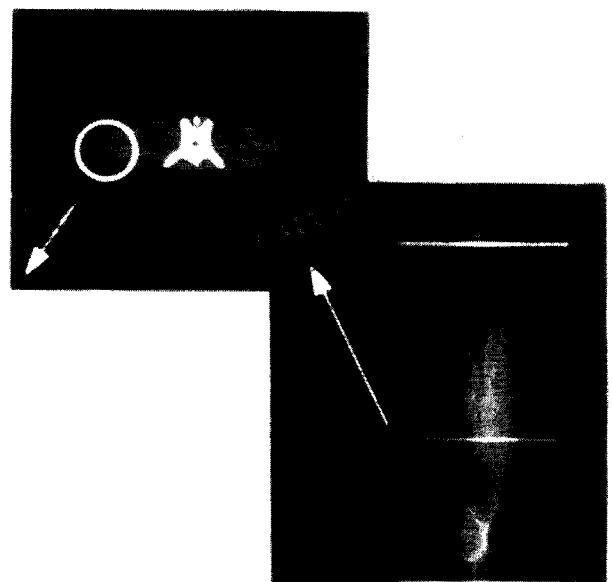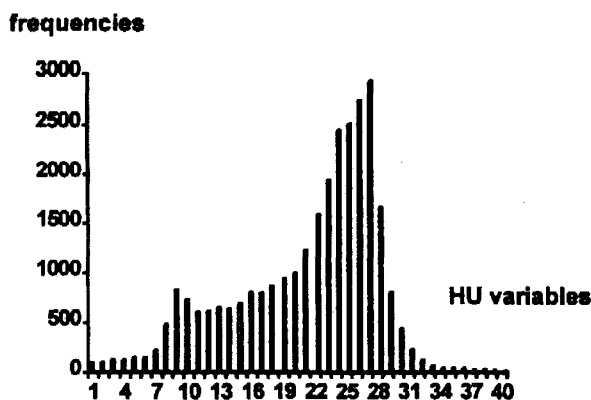
On its right there is a side taken topogram with the mark of the current anatomical location. The histogram on the left was constructed from the pixels density values of the marked area. It has two peaks: one for the fat and one for the muscle tissues.

FEKETE *et al.* (1993) have investigated nonpregnant and pregnant does on days 14, 21 and 28 of gestation. Figure 6 shows a tomogram of a rabbit at four weeks' pregnancy where the scan was taken between the 3rd and 4th lumbar vertebra.

On Figure 8 there are four histogram curves. They were constructed from the basic data of the scans which cut the foetus. The embryonal growth can be seen well.

Figure 8 : Histograms of does at different stages of pregnancy between -200 and +200 HU interval
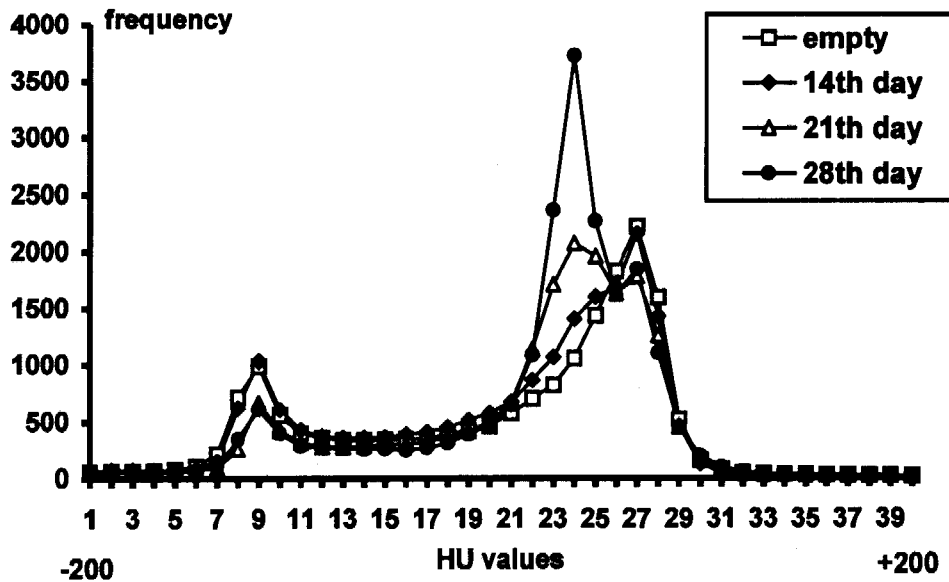
Every CT picture is taken by a scan thickness from 1 to 12 mm. It means that the picture-forming pixel can be considered a prism having volume. So in the case of the examined scan or body interval we can define how big part of its whole volume falls within the HU interval. It gives the possibility to estimate the volume of e.g. fat tissue.

There is a three-dimension histogram on Figure 9 which was made from the pixel density data of serial scans (ROMVARI *et al.*, 1993).

Figure 9 : 3-dimension histogram of rabbits of 3.5 kg
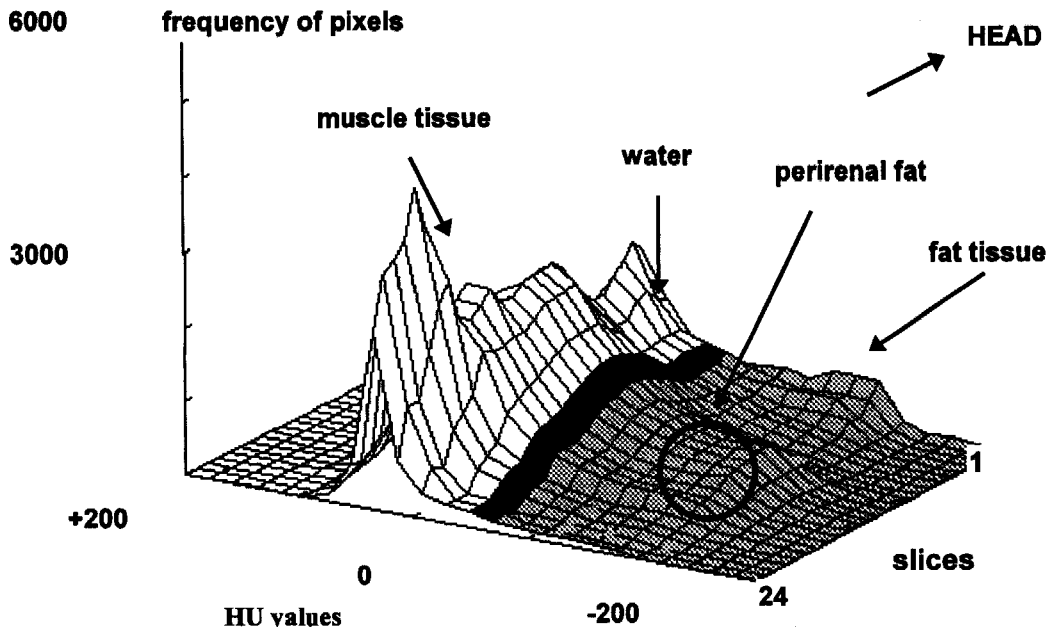
24 pictures were taken from a rabbit of 3.5 kg live body weight with total overlapping, where the scans with 8 mm thickness stand next to each other. The serial numbers of the pictures are on X-axis, the HU variables on Y-axis (numbering from 40 to 1 after reducing by 10 from + 200 to - 200) and the frequency of density values on Z-axis. On the drawing mountain formed by the interval of the muscle tissue characteristic peaks are well separable. When starting from the head the first one is the periphery of the scapular arch. The following lower part is the interval of the lungs (4-5 scans), after which the biggest peak, the m. *longissimus dorsi* can be seen. The next lower part is the periphery of the pelvic (19 - 20th scan) which is separated from the last peak formed by the thighs. The fatness of the scapular arch and the perirenal fat (marked with a circle) appears on scan 1-3 and 12-14, respectively. By summarising the area under the 3 dimension surface the volume of the different tissues are predictable (ROMVARI *et al.*, 1994).

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Grundlagen zur untersuchung von kaninchen mit dem röntgen-tomographen - Der Vortrag faßt die wichtigsten Fakten hinsichtlich der Untersuchung von Kaninchen mit dem Röntgen-Tomographen (CT) zusammen. Der CT bietet der Kaninchenzucht zahlreiche Möglichkeiten zur Erforschung von Wachstum und Fütterung. Größter Vorteil ist die Genauigkeit und die « in vivo » Untersuchung, von Nachteil sind dagegen die hohen Kosten. Die verschiedenen Aufnahme-(scanning) und Auswertungstechniken ermöglichen im Selektionsprogramm die Schlachtwertschätzung zur Verbesserung der Schlachtausbeute, die Bestimmung der Körperzusammensetzung (total body composition) sowie den Aufbau des Muskel- und Fettgewebes während des Wachstums.