# DETERMINATION OF BODY COMPOSITION CHANGES OF PREGNANT DOES BY X-RAY COMPUTERISED TOMOGRAPHY

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**Abstract** - X-ray computerised tomography (CT) was used to determine the variation of body composition in 5 rabbit does (P) during their pregnancy. The animals were scanned 4 times (at insemination, at 14 and 28 days of pregnancy and 12 hours after parturition). Five nonpregnant does (NP) were also scanned at the same time. Twenty-five scans per doe were evaluated, from the scapular arch to the femoral-tibial articulation. The CT image were processed by computerised imaging technique, obtaining three dimension (3D) histograms which represented the serial number of scans (25 scans) on X-axis, the density of the picture forming pixels (in HU variables) on Y-axis and the frequency of density values on Z-axis.
The 3D histograms clearly represented the tissue composition of doe bodies, with different peaks corresponding to the m. *longissimus dorsi* and the hindleg muscles. Fat deposits were also clearly showed, with different peaks in the scapular, abdominal and pelvic regions. Body composition of does was similar at insemination and 14 days of pregnancy, with a little increase in water in the thoracic region (growth of uterine tissues and foetus) and in fat in thoracic region. On the contrary, between the 14th and 28th days of pregnancy important changes happened with a great increase in muscle and water in the abdominal region due to the foetal growth. After kindling the does appeared to have less fat in each fat depots and more water (e.g. milk) in comparison with the insemination time. On the other hand the NP showed an increase in the fat tissue (particularly in abdominal and pelvic regions) and a slight decrease in water content.

## INTRODUCTION

Various methods are used to follow the changes in body composition of rabbits during growth or reproductive activity (FEKETE, 1992). Comparative slaughter technique was used on growing rabbit (PARIGI-BINI *et al.*, 1986), because of the low cost and dimension of the animals and the large changes in body weight and composition. On rabbit females the slaughter technique was utilised on energy and protein metabolism experiments (PARIGI-BINI *et al.*, 1992; XICCATO *et al.*, 1995), but the short period of pregnancy and lactation and the great variability of body composition make this technique, which requires a large number of animals in trial, rather inaccurate. X-ray computerised tomography represents an interesting alternative, being a non-invasive, non-destructive method, which allows the changes of body composition to be checked on the same animal at different times of his life (SZENDRŐ *et al.*, 1992; FEKETE *et al.*, 1993; ROMVARI *et al.*, 1993). The method can separate the different body tissues (e.g. muscle, fat and bone) and components (e.g. water and air) on the basis of their X-ray density values. The computerised evaluation of the pictures taken in successive positions along the body (scans) produces a 3D histogram which permits description of the body tissue composition and its changes in relation to different anatomical locations. ROMVARI *et al.* (1996) presented a complete description of the method and its application on the rabbit science.

This paper presents the preliminary result of an experiment, where the same rabbits were examined successively at the time of insemination, during pregnancy and 12 hours after kindling.

## MATERIAL AND METHOD

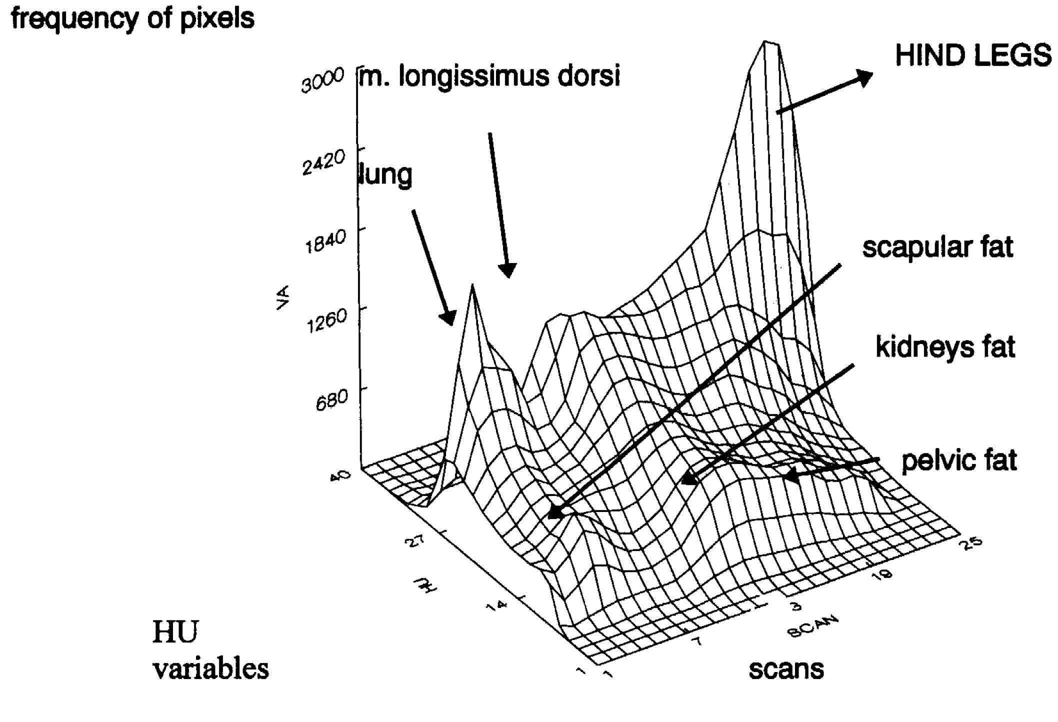
The experiment was carried out at the Faculty of Animal Science of Pannon Agricultural University using Pannon White rabbits. Five does (P), homogeneous in age and weight, were scanned four times during their first pregnancy (at insemination, at 14 and 28 days of pregnancy and 12 hours after kindling). Five non-pregnant does (NP) were also scanned at the same time as a "control group". The pictures were taken at night at the CT Biological Centre of the University. During the examination the rabbits were fixed carefully in a stretch position, lying flat in special containers with the use of 4 mg/kg Rompun (Bayer) as anesthetic to avoid abortion. Approximately 40 scans were taken from each animal. The scan thickness and also the distance between the neighbouring slides were 8 mm, so the 40 scans lapped 632 mm of the body. Finally 25 scans were evaluated from each rabbit, covering the body from the scapular arch (scan 1) to the femoral-tibial articulation (scan 25).

The CT images were evaluated using the computerised method described by ROMVARI *et al.* (1996), which assigns to each digital point (pixel) of the tomogram a density value in the Hounsfield (HU) scale, -1000 (no absorption) to +1000 (total absorption), definitively the 0 point is the density value of water. During the processing of the pictures the density values belonging to the picture-forming pixels were fixed, then the average values were calculated scan by scan from each group. The histograms on the basis of the frequency distribution's data originate in this way. For the purpose of present research only a limited range of the whole HU scale was needed, which contains the absorption interval of both the fat (-200 to -20) and muscle tissues (+20 - +200). For the evaluation the consecutive 10-10 values of the HU scales were summarised, 40 data, "HU variables" (HUv) were formed (HUv1 = $\Sigma$(-200)- (-191), HUv2 = $\Sigma$(-190) - (-181),.HUv40 = $\Sigma$(+190) - (+199)). On the bases of these variables 3D histograms were constructed, which represent the serial numbers of the pictures (1 to 25) on the X-axis, the density of the picture-forming pixels (1 to 40 HUv) on the Y-axis and the frequency of the pixels belonging to the different density values on the Z-axis.

## RESULTS AND DISCUSSION

The 3D histogram in Figure 1. was constructed from the average data of the 5 P rabbits at the time of mating. In the X-ray absorption range of the muscle tissue (around 27 HUv) three successive peaks were clearly separated from the scapular arch (scan 1) to the femoral-tibial articulation (scan 25). The first peak corresponds to the muscles of scapula and shoulders followed by a valley in the location of the lungs (scan 4 to 7), after which the peak of the m. *longissimus dorsi* can be seen. The next lower part is located at the pelvic region, separated from the last and highest peak (scan 19-25) formed by the thighs. The absorption interval of water (18-22 HUv) shows the highest frequency at the abdominal region (gut and bladder) and separates the absorption area of fat (around 14 HUv). In this X-ray absorption area three fat deposits can be seen: scapular fat (SF) on scan 2 to 5, perirenal fat (KF) on scan 12-15 and pelvic fat (PF) on scan 22-23.

**Figure 1 : Body composition of pregnant does at 0 days of pregnancy (at mating)**




No important changes can be noticed in the body tissue composition of P does at the 14th day of pregnancy (Figure 2). Figure 3 represents the difference in the density frequencies in the P does between insemination and middle pregnancy. Only a little increase in muscle and water content was observed in the abdominal region (scans 13 to 18) as a consequence of the uterine tissue and foetus development. Also water and fat *content* increased in the thoracic region probably associated with the liveweight gain of the young females.

**Figure 2 : Body composition of pregnant does at 14 days of pregnancy**

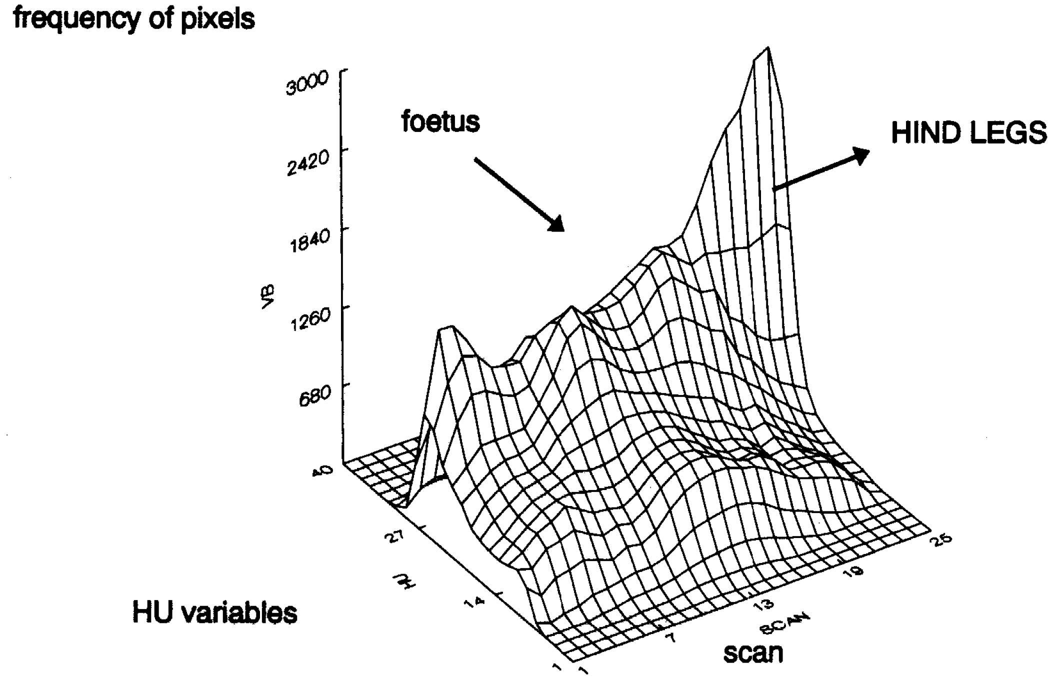
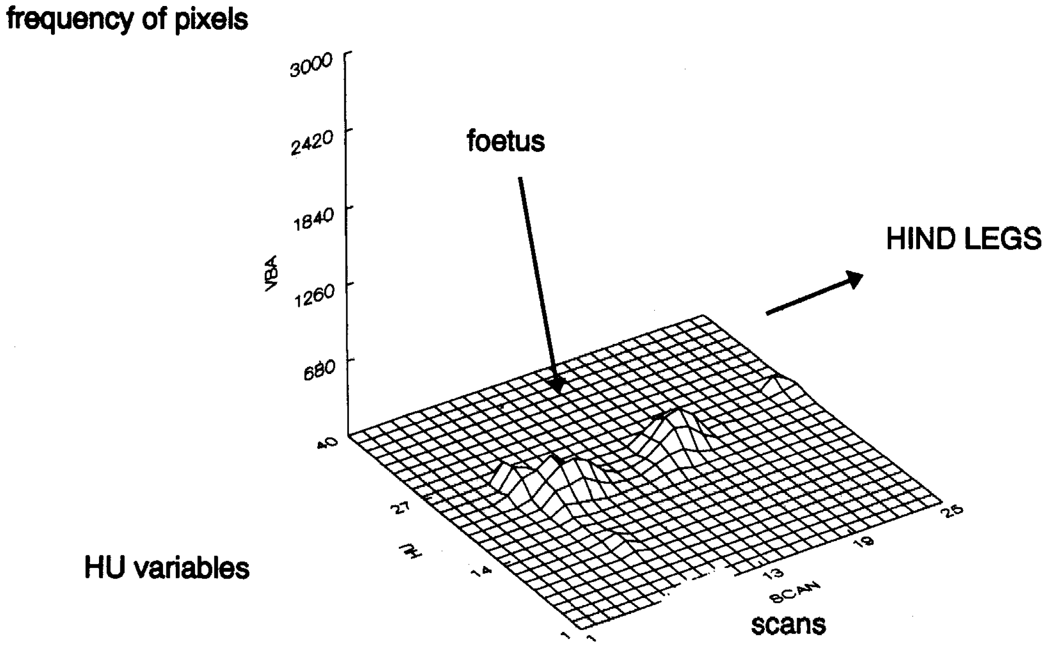



**Figure 3 : Changes in body composition between 0 and 14 days of pregnancy**




At 28 days of pregnancy (Figure 4) the peak of the foetuses definitely appeared. The qualitative difference between the maternal and foetal muscular tissue is also appreciable, the former with a typical density values of 50-70 HU (25-27 HUv) and the latter with a lower absorption range (30-40 HU or 23-24 HUv), because of higher water content of the foetal muscular tissue. On the 3D histogram in Figure 5. the difference between the 14th and 28th days of pregnancy is shown. The intensive growth of foetal tissues (mostly as muscle and water) can be observed in the abdominal region (scan 11 to 20). Figure 6 shows the body composition of P does at the end of the experiment, 12 hours after kindling.

**Figure 4 : Body composition of pregnant does at 28 day of pregnancy**

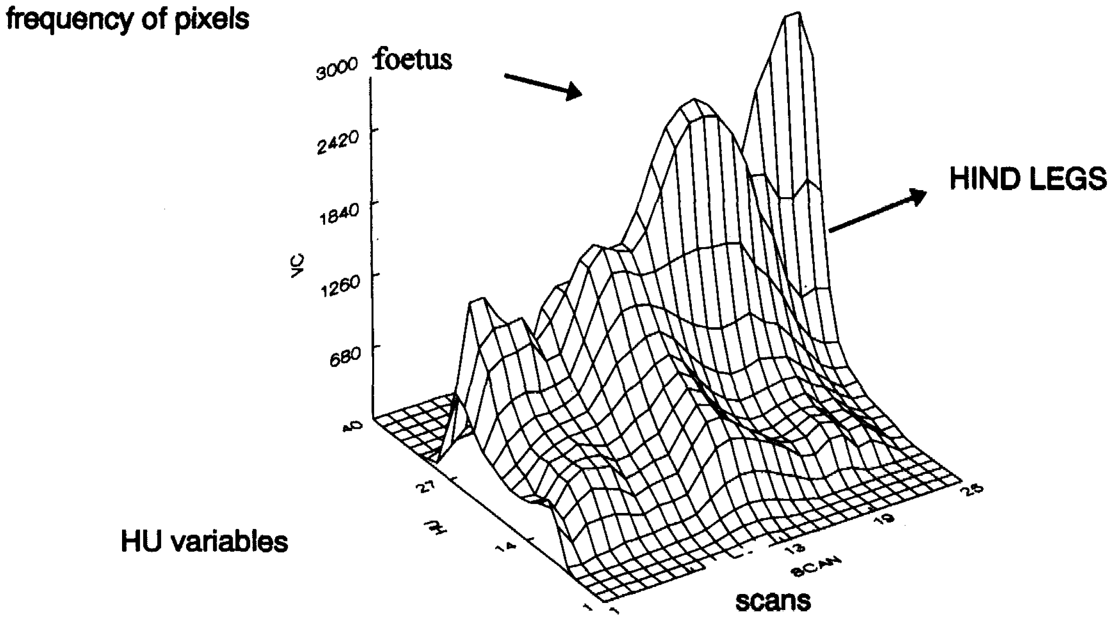
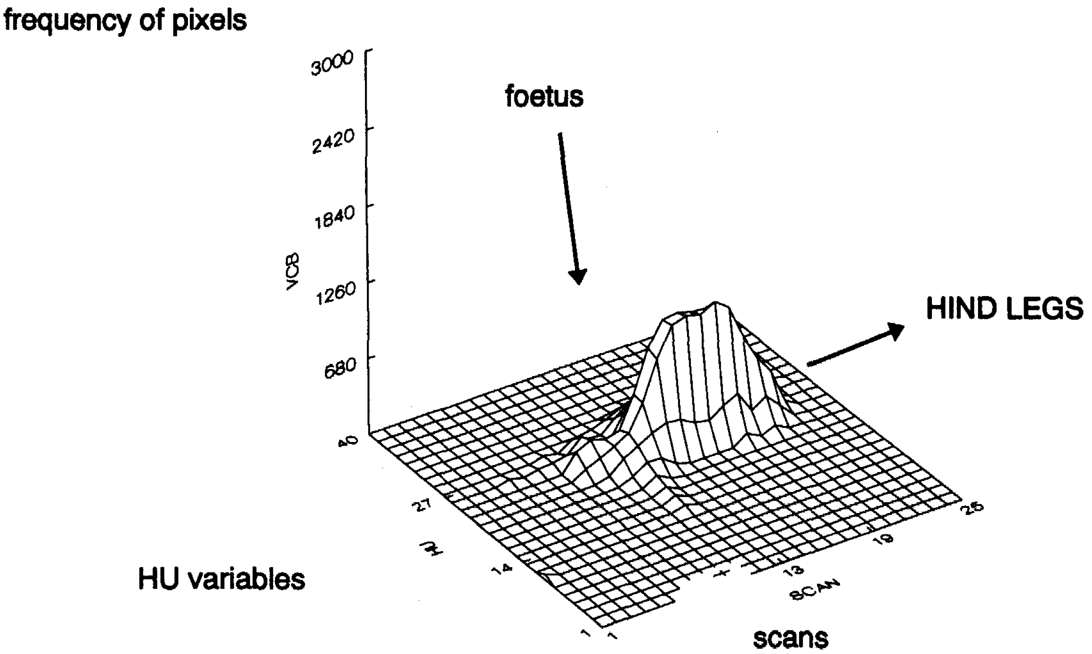



**Figure 5 : Changes in body composition between 14 and 28 days of pregnancy**




The construction of Figures 7 and 8 slightly differs from the previous ones. On its Y-axis the HUv spread from 1 to 22, so it covers only the density interval of fat and water. The 3D histogram on Figure 7 shows the difference between the does at mating and the does one day after parturition. It can be seen well that all of the fat deposits (SF, KF, PF) are decreased significantly, because the does used up their reserves under the last days of pregnancy. An increase also can be seen in the density interval of the water (18-22 HU). The probable reason of it is partly the increase of the body water content, partly the appearance of the milk in mammary gland some hours after kindling.

**Figure 6 : Body composition of kindled does (12 hours after kindling)**

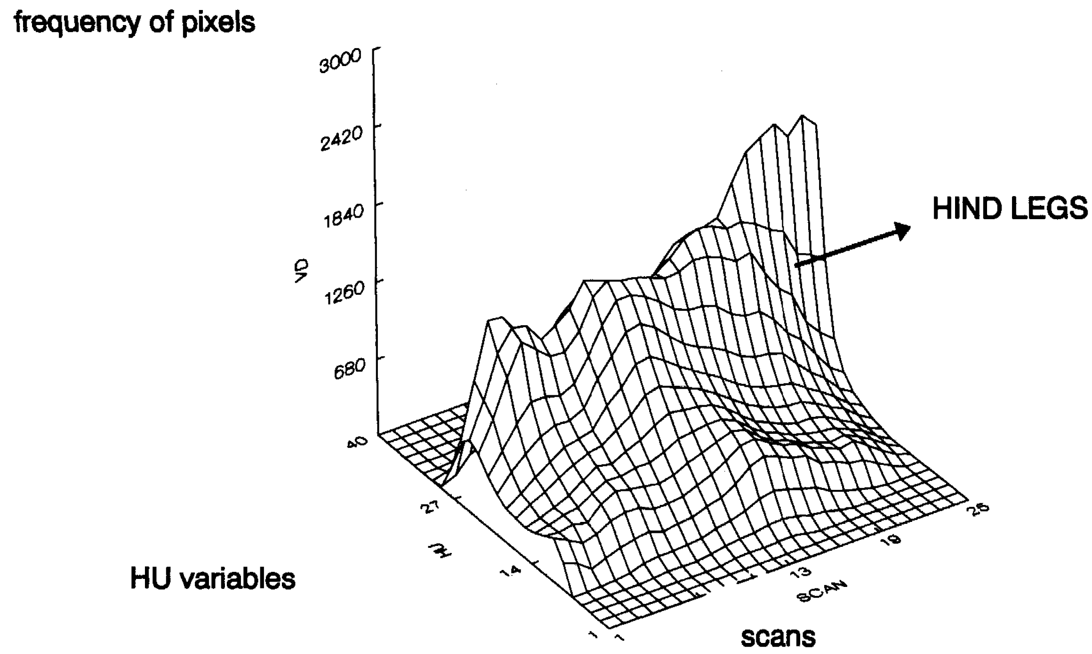
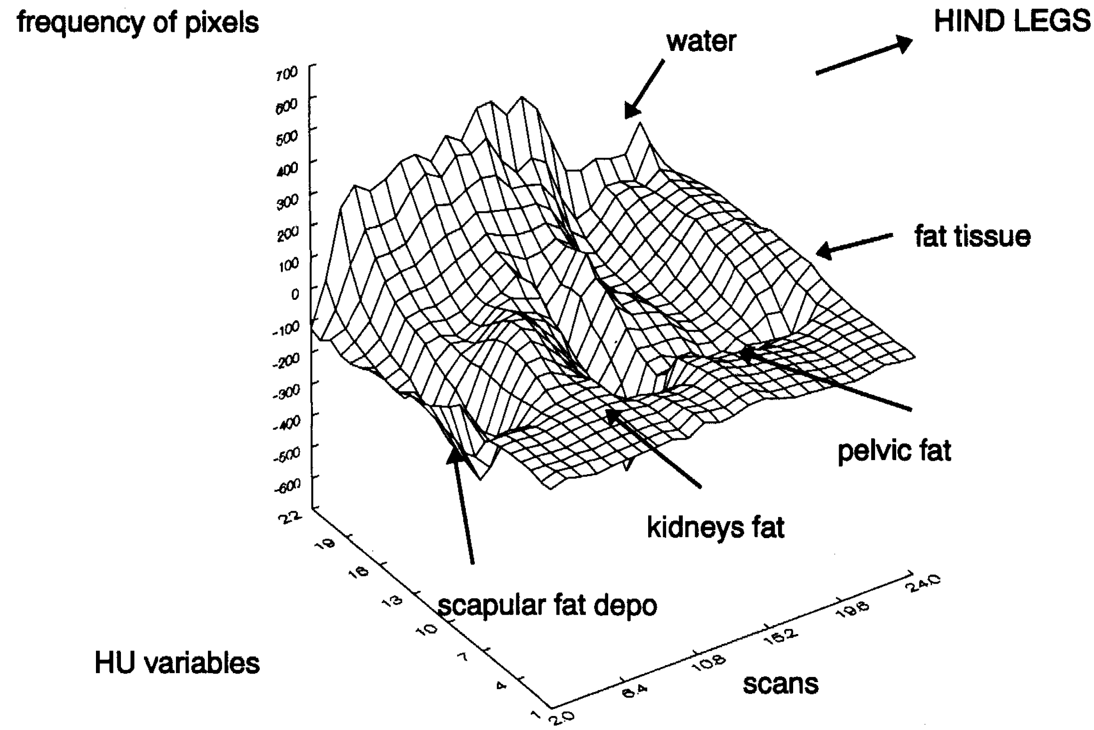


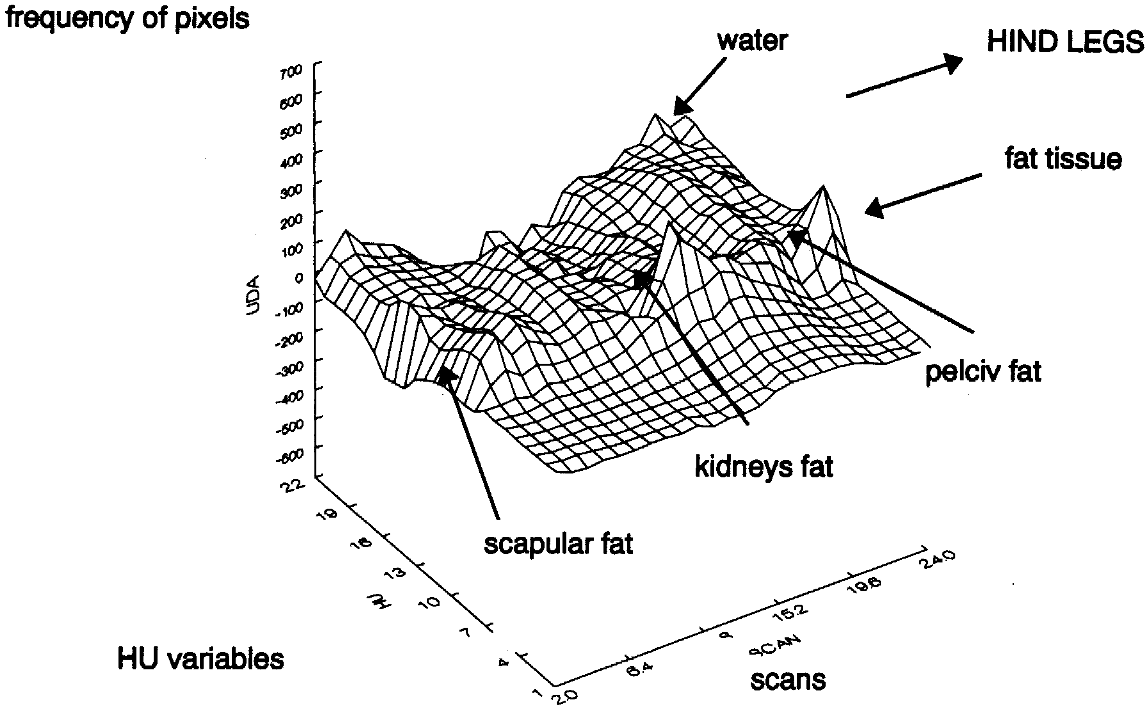

**Figure 7 : Changes in body composition of the pregnant does between the insemination and 12 hours after kindling (density interval of fat and water)**




On Figure 8 there is the difference in body composition between the beginning and the end of the experiment in case of control group (NP). Compared with the pregnant group, a slight increase of the fat deposits and a decrease of the water content can be seen.

The results of this research are in well accordance with the data observed by PARIGI-BINI *et al.* (1990), which found a positive energy balance in pregnant does in the first 20 days of pregnancy, but an energy transfer from the maternal body to the foetus in the last 10 days (as protein and fat). Nevertheless the energy balance of the whole pregnancy was positive even though in non pregnant does the increase of fat tissue (and therefore in energy) was much higher.

**Figure 8 : Changes in body composition of the non-pregnant does (control group) between the beginning and the end of the experiment (density interval of fat and water).**




More information is needed to complete the evaluation of CT as a suitable method to measure the changes on rabbit body composition: in particular it is necessary to correlate the changes in density values with the body chemical composition (now in progress), to permit the estimation of the tissue and energy balance in the reproducing does by CT. This method permits to differentiation of the changes in tissue composition in relation to the anatomical location and gives more accurate and complete information than other techniques of animal metabolism research.

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