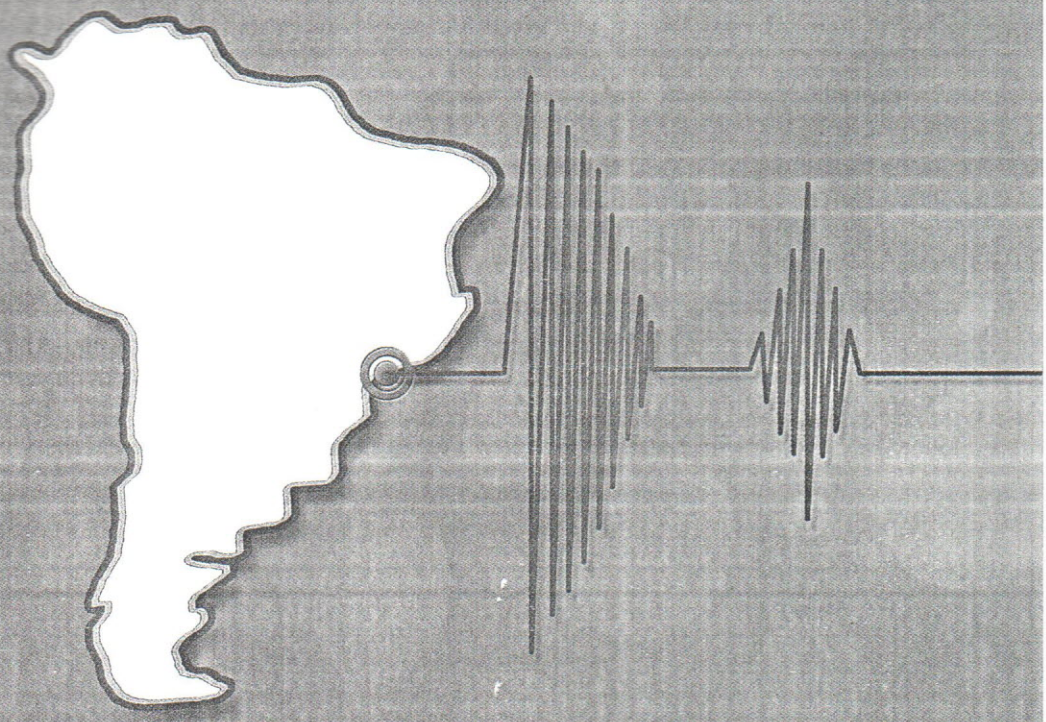

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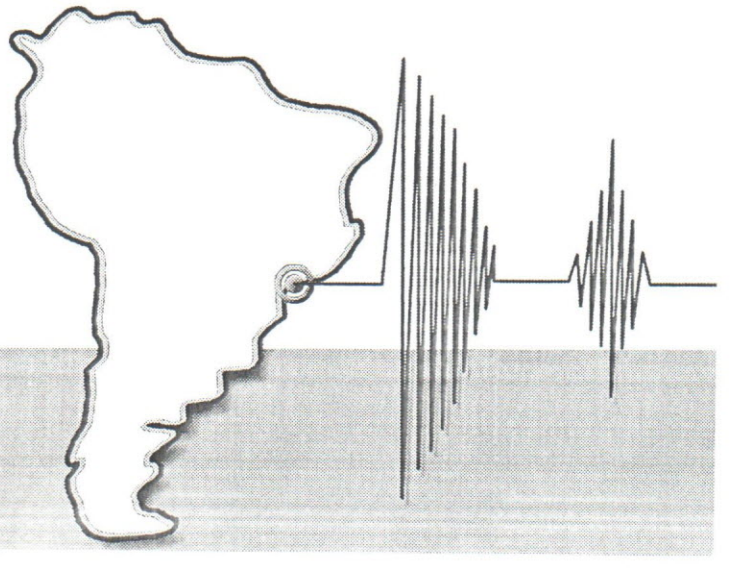

ANALYSIS OF BEEF QUALITY BY LOW RESOLUTION NMR

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Low resolution NMR has been studied as a method for rapid screening of meat quality[1]. The major NMR advantage over others spectroscopic techniques is its capacity to analyze the whole sample, not only the surface, as in infrared and fluorescence spectroscopies. The prediction of meat quality, especially in pork muscle, has been performed using transverse relaxation time (T_2). The measurements have been made with CPMG pulse sequence since it is fast and the data can be acquired in few seconds. The CPMG signals have been correlated to pork meat quality parameters such as water-hold-capacity (WHC), pH, cooking loss (CL) and others parameters that can be related to organoleptics properties (tenderness, juiciness). As the use of NMR to bovine meat analysis is not reported in literature, we evaluated the beef quality by CPMG data. We also analyzed the sample with continuous wave free precession technique (CWFP)[2], that is a new low resolution NMR technique as fast as CPMG and gives T_1 and T_2 information on the same experiment.

The samples were collected from *Longissimus lumborium* muscle, from the 12th rib region of 13 young cows and 14 bulls. The animals were crossbread of Canchim bulls (CX) and cow Angus x Nelore (TA) and Simmental X Nelore (TS) and were confined up to ages from 18 to 24 months. The samples were analyzed at 15°C from 24 to 48 hours after slaughter. The WLC, pH and CL were measured by conventional methodologies in the samples collected in the same meat region[1].

The NMR data were obtained in a 30 cm bore superconducting magnet (2.1 T) using a single 14 mm diameter and 14 mm long coil for receiving and transmitting. The NMR console consisted of a CAT100 (Tecmag) and a Miteq 1054 preamplifier. The CPMG pulse sequence consisted of 10 μsec $\alpha = \pi/2$ pulse, τ= 0.2 msec, number of echos = 1000, NS = 4 scans and rd= 1s. The CWFP sequence consisted of 10 μsec $\alpha = \pi/2$ pulses with period T_p = 300 μsec and an offset angle $\psi = \varpi_0 T_p = 3\pi$. The CPMG and CWFP data were analyzed by partial least square (PLS) and principal components analysis (PCA) using Pirouette software (infometrix). The data were autoscaled and mean-centered. Both treatments show similar results and only mean-centered are shown.

The PLS analysis, correlating the NMR signals (CPMG and CWFP) to classical analysis (WHC, pH and CL) were performed with all samples (male and female) and separated by sex. For all samples, the PLS analysis for WHC and CL versus CPMG shows no correlation, with r ~ 0. The correlation for WHC and CL was also low for CWFP, having r = 0.15 and r = 0.3, respectively. The pH shows better correlations with NMR data, r = -0.55 and 0.45 for CPMG and CWFP data, respectively. For females, the CL correlation were r = -0.62 for both techniques, the WHC correlations were very high r = -0.82 for CPMG and null for CWFP and the pH were around 0.3 for both techniques. For male, the CL and WHC correlations were null and r = 0.35 for both techniques. The pH correlates better with CPMG data (r = -0.78) than CWFP (r = 0.2). The low correlation observed in these samples is related to very low dispersion in the measured parameters. For example, the samples pH varied from 5.27 ± 0.27. The correlations should be better for sample from animal of different ages and managements.

The CPMG and CWFP data were also analyzed by PCA. Figures 1A and 1B show the plots of PCA map (factor 1 x factor 2) for CPMG and CWFP data. The CPMG (Fig. 1A) results show no distinction between male and female. However the CWFP data (Fig. 1B) show clear separation between the sexes, with male in the negative values of PC1 and female in the positive side. Only two males are in the female side. We also performed the PCA analysis on the CL, pH and WHC data to see if these parameters were able to differentiate between sexes. Like CPMG data there was no separation between them using these parameters. This indicates that CWFP could be sensible to other(s) meat propertie(s), different from WHC, pH and CL, which

we analyzed here. A hypothesis for CWFP classification of males and females is the intramuscular fat content that normally is higher in female than in male bovines.

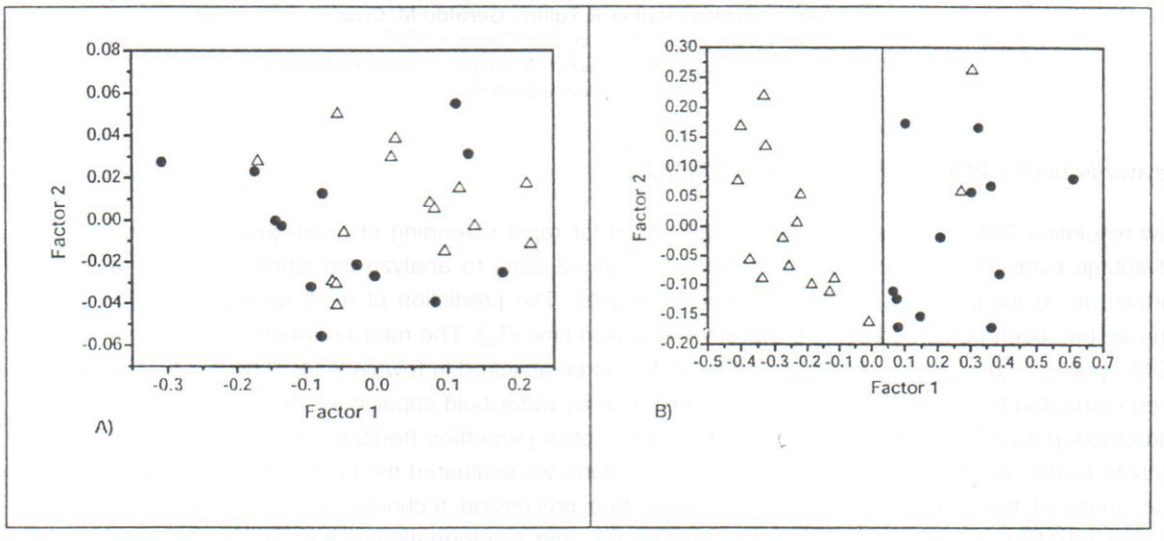

Figure 1. PCA map of factor 1 versus 2 of females (●) and males (8) bovines obtained from CPMG data (A) and CWFP data (B)

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