CHARACTERIZATION OF SEVEN BEEF BREEDS BY PRINCIPAL COMPONENT ANALYSIS OF FATTY TISSUE DEVELOPMENT AND CHEMICAL, INSTRUMENTAL AND SENSORY MEASUREMENTS

Albertí, Pere[1]; Sañudo, Carlos[2]; Mendizábal, Josean[3]; Ripoll, Guillermo[1]; Olleta, José L[2]; Panea, Begoña[2];
Alzón, Martín[3]; Indurain, Gregorio[3]
[1] Servicio de Investigación Agroalimentaria, DGA. Avda. Montañana, 930, 50016 Zaragoza. palberti@aragob.es
[2] Facultad de Veterinaria, Universidad de Zaragoza. C/ Miguel Servet, 176, 50013 Zaragoza. csanudo@posta.unizar.es
[3] Universidad Pública de Navarra. Campus Arrosadía, 31006 Pamplona. jamendi@unavarra.es

Background

Meat quality can be defined by carrying out physical, chemical and sensory analyses. Each one describes specific properties so it is sometimes difficult to obtain a global vision and some results can even appear to be contradictory. Principal Component Analysis is useful to assess meat quality in terms of multiple measurements and to characterize bovine breeds or even discriminate among hypertrophied animals (Destefanis *et al.*, 2000).

Objectives

The aim of this study was to characterize the meat quality of seven bovine breeds slaughtered at two commercial weights by means of Principal Component Analysis using instrumental and sensorial measures of meat and fatty development.

Methods

A total of 158 carcasses of bulls were used from seven breeds: Asturiana de los Valles (**AS**), Avileña (**AV**), Morucha (**MO**), Parda (**PA**), Pirenaica (**PI**), Retinta (**RE**) and Rubia Gallega (**RG**). Exactly 82 animals were light weight "veal" type and slaughtered at 300 to 350 kg live weight. The remaining 76 animals were heavy weight "yearling" type and slaughtered at 530 to 550 kg live weight. Animals were fed with concentrate and staw *ad libitum*.

Carcasses were chilled for 24 h, after which the loin of left carcass was removed. Omental (OM) and kidney (K) fat was extracted and weighted, subcutaneous (SC) and inter muscular (IM) fat were estimated from the 10th rib dissection. Adipocytes from the four fat deposits were isolated using the collagenase technique and diameter (D) of OM and K fat deposits was measured using the image analysis technique. The number (Nu) of fat cells of omental and kidney fat was also calculated (Mendizabal *et al.*, 1999).

At 24h post mortem the ultimate pH was measured at M. *longissimus dorsi* with a Crison 507 electrode. At the same time we measured the subcutaneous fat colour on the dorsal area of the carcass with a Minolta CR-200b Colorimeter. Muscle colour was measured (24 h blooming) on the M. *longissimus dorsi* 10th rib using a Minolta CM 2002 spectrophotometer into the CIE L*, a*, b* colour space. Then hue of the muscle (H*M) and fat (H*F) were calculated.

Meat texture was measured by an INSTRON 4301 equipped with one Warner-Bratzler shear blade with a triangular slot cutting edge, on meat with seven days of ageing, cooked in a water bath (75° C) until the internal temperature reached 70° C. Rectangular samples of 1 cm cross-section were cut perpendicular to the muscular fibre axis, determining the maximum load, the maximum stress, maximum strain (MxStr,), yield, and toughness (Tgh). Heam pigment concentration (Heam) was calculated using a physic-chemical method (Hornsey, 1956). The water holding capacity (WHC) was measured by applying pressure (Grau and Hamm, 1953). Chemical analyses were performed to determine protein (N), fat, dry matter (DM), ash, collagen content and solubility (Bonnet and Kopp, 1984).

The sensorial analysis was carried out by a panel of eleven trained members using a scale of 10 points to assess tenderness (Tend), juiciness (Jug), flavour intensity (FlavInt), odour intensity (OInt), flavour quality (FlavQ) and overall appraisal (OveApp), on meat aged for 7 days and cooked in a double plate grill at 200ºC until an internal temperature of 70ºC.

The statistical analysis included a Discriminate analysis and a selection of variables for the Principal Component Analysis using the package SAS v. 8.1.

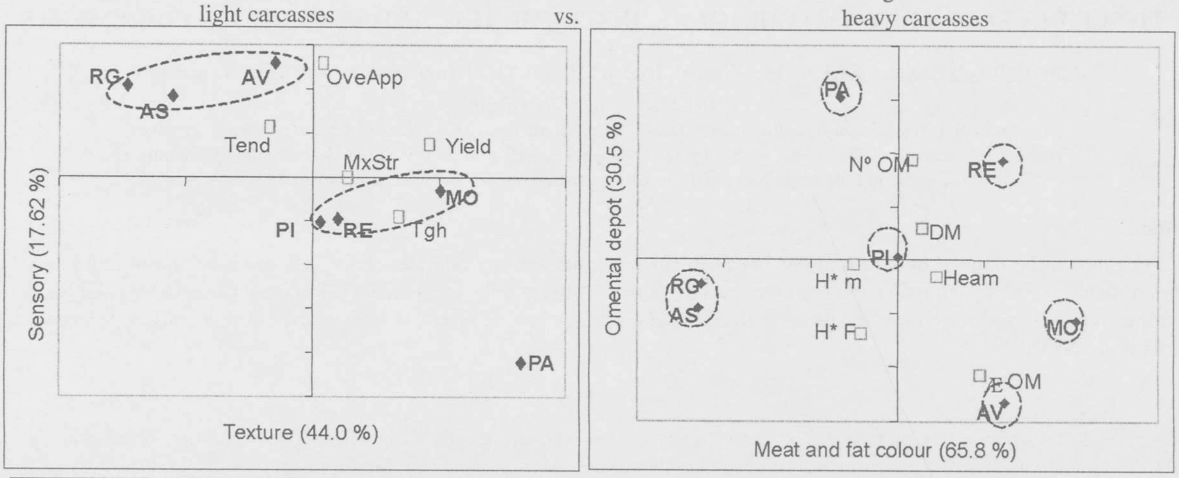
Results and discussions

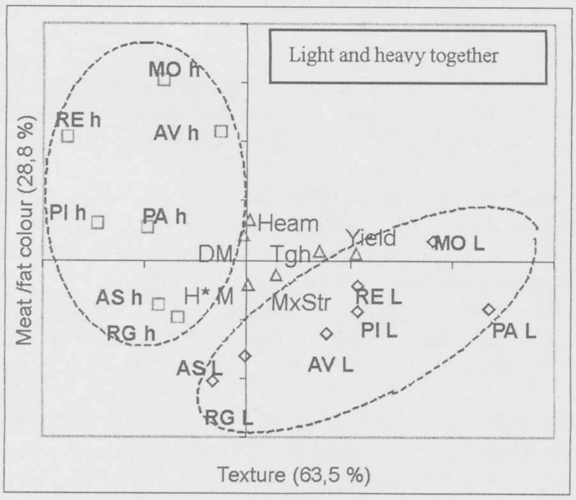
From the 32 variables initially studied, 14 were selected by Discriminant Analysis on light weight type (DIM, DPR, NuOM, DM, N, Ash, pH24, Tend, OverApp, FlavInt, OInt, Yield, MxStr, Tgh) and 10 variables on heavy weight type (NuOM, DOM, WHC, Heam, HueF, HueM, Tgh, Jug, IntFlav).

According to the Principal Components Analysis (Figure1), 62 % of the observed variance could be explained using the selected variables for light weight animals. The first Principal Component explained 44% of the variance and is defined by the texture variables which were positively related to meat quality such as yield, toughness and maximum strain. The second principal component explained 17.6% of the variance and is defined by the sensory variables, which were positively related with meat quality such as overall acceptability and tenderness. The RG, AS and AV breeds are grouped in a quadrant with good sensory results and low values in terms of texture. The rest of the breeds are in the opposite quadrant (being PA low far), with lower sensory and higher texture values.

About 96% of the observed variance was explained by the variables in heavy weight animals. The first principal component explained 65.8 % of the variance. It was characterized by the diameter of the adipocytes of the omental deposit, the concentration of heam pigments in muscle and the dry matter content of meat. It was related negatively with muscle hue and the hue of the subcutaneous fat. The second factor explained 30.5% of the variance and was defined by the characteristics of the omental fat deposits. This factor was correlated positively with the number of adipocytes and negatively with adipocytes diameter.

Figure 1. Principal Component Analysis of meat and fat characteristics of beef meat at two carcass weights:
light carcasses vs. heavy carcasses





Abbreviations are explained in the text

As slaughter weight increases, the differences between breeds were more associated with fat variables while the instrumental texture and sensory tenderness values are less important. This may be because the enzymatic systems of older animals are more powerful and decrease texture differences through ageing (Sañudo *et al.*, 2003).

Heavy carcasses from RG and AS breeds were separated by the first factor since the meat was pale with little fat deposits with high hue values. The meat from AV and MO was red with hypertrophied fat cells due to a more intense hypertrophic process. The RE breed had red meat and PA had large quantities of omental fat, characterized more by the high number of cells than by its size. The values for PI were intermediate between the other breeds.

When light and heavy carcasses were analysed together, the effect of slaughter weight appeared to be more important than breed differences. The first Principal Component was related to texture (63.5% of variance) and the second Principal Component was related to meat and fat colour (29% of variance).

Comparing 300 and 550 kg live weight, there were important differences among breeds in terms of the development of the fatty deposits. This was mainly due to the hypertrophy of adipocytes as a result of the greater activity of lipogenic enzymes. The process was more important in the omental and kidney deposits than in subcutaneous or inter- muscular fat deposits (Indurain, 2002).

Conclusions

Beef meat characteristics were more conditioned by commercial type or slaughter weight than by breed. At light carcass weight, meat characteristics were influenced by differences in textural and sensory quality. At heavier weights, the features of the fat deposits and muscle and fat colour attributes were the most important factors.

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Acknowledgements

Research financed by INIA research project SC-97-019