# USEFULNESS OF SOME CHEMICAL AND PHYSICAL ANALYSES TO PREDICT THE SENSORIAL QUALITY OF BEEF MEAT

BARGE, G. DESTEFANIS, A. BRUGIAPAGLIA.
rtimento di Scienze Zootecniche, Via Genova 6 - 10126 TORINO, Italy

ARY. The multiple linear regression on data obtained from 33 samples of Longissimus dorsi of cattle, ering for breed, sex and slaughtering weight (330 - 680 kg), has been used to study the usefulness of some umental analyses to predict the sensory quality of meat.
ave considered as dependent variables the sensory characteristics assessed by a trained panel using an 8-ts scale: appearance of raw meat; tenderness (ease of sinking, friability and residue after chewing), juic-ss (initial and sustained), overall acceptability. The independent variables included: chemical composition, colour (L, a, b, Hunter system), shear force on raw meat, water holding capacity (drip losses, water bath es, broiling losses, filter paper press method). The shear force resulted the most useful to predict the ory characteristics of cooked meat. Secondly, lighteness appeared very useful, especially for appearance. regard the water holding capacity methods, water bath losses have been the more efficient to predict nderness, juiciness and overall acceptability.
3 above-mentioned variables explained from the 64% (sustained juiciness) to the 72% (overall acceptability residue) of the total variability. Further contributions were provided by: pH and protein content (appear-e); water percentage (sustained juiciness). In our experimental conditions, the ether extract (0.16 - 2.29%) not appear to be useful to predict the meat sensory quality.

ODUCTION. The usefulness of the sensory analysis to evaluate the quality of meat is recognized by everybody, ause none of the instruments can reproduce the complex sensations of the consumer. The difficulty to prepare group of trained assessors makes it interessant, also from a practical point of view, to study the relation-ips between the instrumental and the sensory analyses, in spite of the intrinsic difficulty to predict the sorial quality of a product on the basis of chemical and physical analyses (SCZESNIAK, 1968). Nevertheless, w works on the subject have been done untill now; generally it is admitted that the measurements of the shear ce are well related to the tenderness (BAILEY and LIGHT, 1989); this has been observed on beef (SHAND et al, 85; OUALI et al, 1988) and on pork meat (DE VOL et al, 1987).
so in one of our investigations (DESTEFANIS et al, 1990), carried out on young bulls belonging to the same ed, slaughtered at 500 kg of live weight, the most effective parameter to explain the variability of the sory characteristics was the shear force, which alone accounted for the 42% of the total variability of nderness. We have been able to obtain a better prevision introducing into the models at least 5 variables, t required analyses of different nature.
n order to give a further contribution on this subject, we carried out another study using a more etherogeneous mple, such as to reflect in a larger measure the meat market in Piedmont.

ERIALS AND METHODS. 33 samples of Longissimus dorsi of cattle different for breed, sex and slaughtering ight (330-680 kg) were taken in 3 slaughterhouses 3-8 d after slaughtering, and analyzed without being ozen. Instrumental analyses included: chemical composition (water, protein, ether extract); pH; colour (L, a, by Hunter system); shear force (Warner-Bratzler) on raw meat; water holding capacity. The latter was measured ough: drip losses (percentage of weight lost by a 2 cm thick slice kept at + 5 °C for 48 h); water bath osses (discs of meat 3 cm in diameter, prepared using a cork borer, in water bath at 70 °C for 30 minutes; AULT, 1985); broiling losses (steak cooked at 70° of internal temperature); filter paper press method (GRAU and AMM, 1957). The surfaces were measured by VIA system (Barge et al, 1991) and the results were expressed as T-M and as M/T (HOFMANN et al., 1982).

The organoleptic characteristics were assessed by a trained panel using an 8-points scale, in relation to appearance of raw meat; tenderness (ease of sinking, friability, residue after chewing), juiciness (initial and sustained), overall acceptability of cooked meat (70 °C of internal temperature). Data were subjected to analysis of multiple regression by considering the sensory characteristics as the dependent variables and the instrumental analyses as the independent ones. The choice of the variables to be included in the model has been conducted through a stepwise regression procedure.

RESULTS AND DISCUSSION. Means, standard deviations and range of variables are reported in table 1. The tables 2-5 refer to the results of statistical analyses relative to the dependent variables.

APPEARANCE: it resulted well related to the lightness (r=0.650), confirming the importance of the colour in the visual evaluation of raw meat. The second variable brought into the model was the protein content, positively correlated. By means of these 2 variables, R2 reached the value of 0.72.

The pH was the third variable and the three together explained the 81% of the total variability and reduced to 0.3385 the error mean square. This result is better than the one of our previous study (DESTEFANIS et al, 1990) where $R^2$ was 0.55 by introducing 3 variables. Unlike the above mentioned research, the shear force was not introduced in the model; its coefficient of correlation with the appearance (r=-0.488) was lower than the one related to the lightness, while the relationship between these 2 independent variables was rather high (r= -0.609).

TENDERNESS: the first variable brought into the model was the shear force, negatively correlated to the three aspects of this attribute. The shear force alone accounted for the 49-51% of the total variability; this percentage is higher than the one we found in our previous research (42-43%). Other two variables linked to tenderness were: water bath losses, negatively correlated, and lightness, positively correlated. When these variables were introduced, $R^2$ values of 0.69, 0.67, 0.72 were obtained for ease of sinking, friability and residue respectively.

JUICINESS: as for the previous characteristic, the shear force was the first variable brought into the model (but its value of b was inferior to that of tenderness), explaining 44% of the total variability of the initial and 41% of the sustained juiciness.

Introducing into the model the same variables mentioned for tenderness, the $R^2$ values reaches 0.65 and 0.64 for initial and sustained juiciness. For the latter, the value increased to 0.68 when the water content was introduced.

OVERALL ACCEPTABILITY: the shear force explained by itself almost half of the total variability while in our research carried out in a rather uniform sample (DESTEFANIS et al, 1990), this parameter explained only 1/3 of the total variability. The determination coefficient reached a value of 0.64 and 0.72 by introducing the water bath losses, and the lightness.

CONCLUSIONS The results show that by means of a limited number of variables it is possible to explain the 65-81% of variability of sensory evaluations, not far from the 72 - 86% obtained by introducing all the examined variables. Among the chemical and physical analyses used for this reasearch, the most effective to predict the organoleptic characteristics of beef meat resulted the shear force on raw meat, which explain, on its own, a consistent percentage (41% - 51%) of the total variability related to tenderness, juiciness, overall acceptability. Very interesting appeared also the lightness, which was the most important variable for predicting the visual judgements; moreover this parameter gave a significant contribution to explain the variability of the other sensory characteristics. Among the determinations of the water holding capacity, water losses resulted the most effective. Therefore, by means of three analyses easily performed we can obtained indicative judgement on the eating quality.

Concerning the chemical analyses, the protein content resulted effective with respect to the visual judgement. The ether extract was not related with any sensory parameters as reported in a previous paper (DESTEFANIS et al, 1990); therefore this analysis appeared negligible to predict the organoleptic characteristics of beef meat.

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Table 5 - Overall acceptability

| Variables | $R^2$ | error mean square | b |
|---|---|---|---|
| SF | 0.48 | 1.1328 | -0.2522 |
| SF<br>WBL | 0.64 | 0.8166 | -0.2145<br>-0.1515 |
| SF<br>WBL<br>L | 0.72 | 0.6578 | -0.1295<br>-0.1618<br>0.1176 |
| All | 0.78 | | |

Table 1 - Variables.

| | mean | s.d. | range |
|---|---|---|---|
| Independent: | | | |
| Water (W) % | 75.14 | 1.1655 | 73.13 - 78.25 |
| Protein (P) % | 21.76 | 0.9015 | 19.64 - 23.33 |
| Ether extract (EE) % | 0.97 | 0.5796 | 0.16 - 2.29 |
| pH | 5.58 | 0.2857 | 4.94 - 6.24 |
| Colour: L | 34.89 | 4.5005 | 27.20 - 45.28 |
| $a_L$ | 16.31 | 3.4559 | 10.43 - 23.37 |
| $b_L$ | 9.37 | 1.5353 | 6.76 - 12.97 |
| Shear force (SF) kg | 10.03 | 4.0023 | 4.97 - 19.20 |
| Drip losses (DL) % | 2.36 | 0.6670 | 0.93 - 4.15 |
| Water bath losses (WBL) % | 29.37 | 3.9309 | 22.80 - 37.91 |
| Broiling losses (BL) % | 23.66 | 4.2750 | 14.88 - 31.17 |
| F.p. press method: T-M: $cm^2$ | 6.84 | 1.1133 | 4.56 - 8.92 |
| M/T | 0.51 | 0.0600 | 0.42 - 0.62 |
| Dependent: | | | |
| Appearance | 5.70 | 1.2687 | 2.90 - 7.40 |
| Tenderness | | | |
| ease of sinking | 5.63 | 1.5398 | 1.90 - 7.44 |
| friability | 5.52 | 1.5705 | 1.90 - 7.40 |
| residue | 5.19 | 1.5120 | 1.80 - 7.46 |
| Juiciness: | | | |
| initial | 5.02 | 1.1377 | 1.80 - 7.11 |
| sustained | 4.92 | 1.1851 | 2.00 - 7.03 |
| Overall acceptability | 5.32 | 1.4547 | 1.60 - 7.39 |

Table 2 - Appearance.

| variables | $R^2$ | error mean square | b |
|---|---|---|---|
| L | 0.42 | 0.9604 | 0.1831 |
| L | | | 0.1722 |
| P | 0.72 | 0.4727 | 0.7762 |
| L | | | 0.2351 |
| P | | | 0.8465 |
| pH | 0.81 | 0.3385 | 1.6532 |
| All | 0.86 | | |

Table 3 - Tenderness.

| | variables | $R^2$ | error mean square | b |
|---|---|---|---|---|
| ease of sinking | SF | 0.49 | 1.2430 | -0.2699 |
| | SF | | | -0.2346 |
| | WBL | 0.61 | 0.9740 | -0.1419 |
| | SF | | | -0.1497 |
| | WBL | | | -0.1521 |
| | L | 0.69 | 0.8212 | 0.1174 |
| | All | 0.77 | | |
| friability | SF | 0.50 | 1.2701 | -0.2778 |
| | SF | | | -0.2451 |
| | WBL | 0.60 | 1.0463 | -0.1314 |
| | SF | | | -0.1624 |
| | WBL | | | -0.1414 |
| | L | 0.67 | 0.9053 | 0.1144 |
| | All | 0.75 | | |
| residue | SF | 0.51 | 1.1485 | -0.2707 |
| | SF | | | -0.1783 |
| | L | 0.61 | 0.9576 | 0.1318 |
| | SF | | | -0.1362 |
| | L | | | 0.1452 |
| | WBL | 0.72 | 0.7185 | -0.1312 |
| | All | 0.80 | | |

Table 4 - Juiciness.

| | variables | $R^2$ | error mean square | b |
|---|---|---|---|---|
| initial | SF | 0.44 | 0.7510 | -0.1881 |
| | SF | | | -0.1579 |
| | WBL | 0.60 | 0.5484 | -0.1215 |
| | SF | | | -0.1070 |
| | WBL | | | -0.1276 |
| | L | 0.65 | 0.5003 | 0.0703 |
| | All | 0.72 | | |
| sustained | SF | 0.41 | 0.8588 | -0.1891 |
| | SF | | | -0.1571 |
| | WBL | 0.58 | 0.6326 | -0.1285 |
| | SF | | | -0.0950 |
| | WBL | | | -0.1361 |
| | L | 0.64 | 0.5547 | 0.0858 |
| | SF | | | -0.1054 |
| | WBL | | | -0.0932 |
| | L | | | 0.0837 |
| | W | 0.68 | 0.5202 | -0.2333 |
| | All | 0.73 | | |