GOOSE LIVER CLASSIFICATION BY MULTIVARIATE ANALYSIS

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SUMMARY: A discriminant analysis was applied in order to verify the discrimination ability of the grading procedure of goose livers established by Qualimeter manufacturers. A cluster analysis was then used to extend the impedance modules ranges defining the grades, thus modifying the grading method. Finally, a discriminant analysis was performed to confirm the discrimination power of the used variables over the groups formed by the cluster analysis and to obtain a classification function allowing the grading of livers with the least possible error. In the evaluation of the grading method recommended by the qualimeter manufacturers, good results were obtained, with only 6 misclassified livers, and a total of 92% correctly classed. According to the results obtained, it is possible to reach over 97% correct grading by rearranging the groups, according to the measurements of the bioelectric impedance module, and modifying the ranges defining the quality grades.

INTRODUCTION: In the last years the use of Multivariate Analysis have been increased in different fields of the scientific research (Ennis et. al.,1982). In this work, two Multivariate Analysis techniques were applied: discriminant analysis and cluster analysis for the grading of fatty goose livers in order to improve their market and processing value.

In Cuba goose livers are classified by a standard method based on weight and sensorial evaluation of color, superficial grain and consistency (Farkas, 1987), but the most important characteristic: the fat cooking-out, it can not be evaluated by these judgments, causing problems during canned elaboration. Salladerre (1978) proposed the use of Qualimeter to register the bioelectrical impedance module, measurement related with the extracellular fat content in livers.

MATERIALS AND METHODS: Fatty goose livers from Landes breed of both sex were used. The sample was drawn randomly up to 101.

The use of a portable french Qualimeter ROUGIE to measure the bioelectrical impedance module of tissue allowed to classify the livers in four category grades according to the following ranges: 0 - 30 not melting, 30 - 60 intermediate, 60 - 100 melting, and more 100 very melting (Salladerre, 1978).The measurements were made 52 h after slaughter at 5°C, measured on the right lobule upper zone.

The qualimeter sound was introduced in four places of the livers whereas the following symbolism was used: "a" right lobule upper zone, "b" right lobule central zone, "c" right lobule lower zone and "d" left lobule central zone (Salladerre, 1978). These regions are illustrated in figure 1.

The livers were classified in four quality grades according to the classification system recommended by the qualimeter manufacturers.

Statistical analysis of results were performed by two Multivariate Analysis techniques combined in the following ways.

1) Discriminant analysis to evaluate de discriminant ability of the classification system proposed by the qualimeter manufacturers (Ennis et. al. 1982 and Mardia et. al. 1979).

2) Cluster analysis to find a new grouping of the livers with the objective of extend the impedance module ranges defining the grades (Crisi et. al. 1983 and Mardia et. al. 1979).

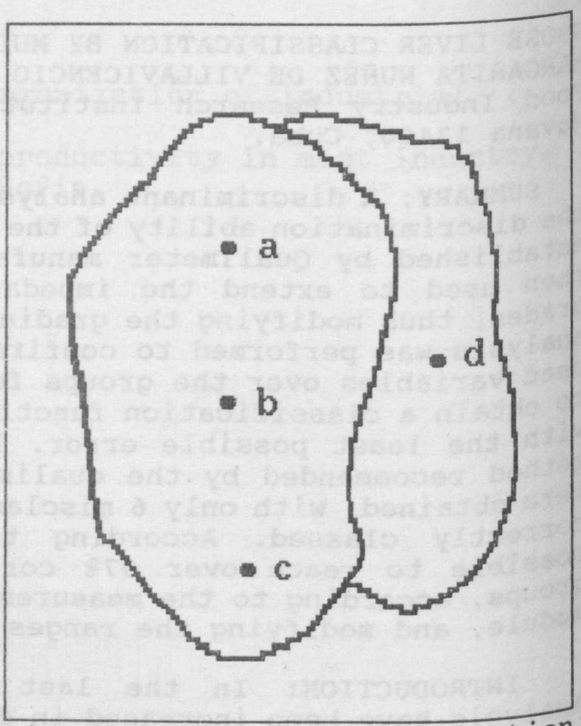

Figure 1 Qualimeter implantation zones

3) Discriminant analysis to confirm the discriminant power of the measurements in zones a, b, c and d over the group formed by the cluster analysis and to obtain a classification function allowing the grading of livers with the least possible error (Ennis et. al. 1982 and Mardia et. al. 1979).

The analysis were developed in an AT microcomputer using the Statistical Package of Social Science system (SPSS+, 1987).

RESULTS AND DISCUSSION: The livers were classified according to the instructions of the qualimeter manufacturer: 21 livers in non-melting class, 29 in the intermediate, and, 32 and 19 in melting and very-melting class, respectively.

Table 1 show classification matrix yielded by rearranging livers according with discriminant functions

The 21 livers included in the non-melting class were classified right; of the 29 in the intermediate class, three were reclassified en the non-melting class, one in melting and the rest in the originally proposed class. Of the 32 in the melting class, one classified as intermediate, and the rest in the original proposed class. Of the 32 in the very-melting class, one classified as melting and the rest were classified right.

As result, six livers were misclassified and 92% a total of were correctly classified, but the impedance modules ranges defining the non-melting and intermediate class, principally, are too close to each other which makes you classified some livers that technologi-

cally could be used as non-melting or intermediate, in inferior categories.

Table 1 Classification Matrix

Actual Group	N	Predicted Group 1	2	3	4
1 non-melting	21	21	0	0	0
2 intermediate	29	3	25	1	0
3 melting	32	0	1	31	0
4 very-melting	19	0	0	1	18
total	101	24	26	33	18

That's why we find it necessary to re-examine the limits defining these categories in order to analyze the feasibility of widening them.

To achieved then, a cluster analysis was developed so that a new grouping of the livers could be obtained, behaving more accordingly to the values found in the bioelectrical impedance module in zones a, b, c and d.

From this analysis, four clearly differentiated groups were obtained. The livers were thus rearranged and a new discriminant analysis was carried out obtaining the following Fisher's discriminant linear function:

1 $-2.9306 + 0.1239\mathbf{a} + 0.0171\mathbf{b} + 0.0807\mathbf{c} + 0.0356\mathbf{d}$
2 $-14.3999 + 0.2560\mathbf{a} + 0.0601\mathbf{b} + 0.1434\mathbf{c} + 0.1124\mathbf{d}$
3 $-36.2315 + 0.4004\mathbf{a} + 0.1637\mathbf{b} + 0.1783\mathbf{c} + 0.1666\mathbf{d}$
4 $-85.2309 + 0.6512\mathbf{a} + 0.3144\mathbf{b} + 0.2532\mathbf{c} + 0.1773\mathbf{d}$

In the classification matrix presented in Table 2 it can be seen that only two livers was misclassified and in 97% of then the grading was correct.

Table 2 Classification Matrix

Actual Group	N	Predicted Group 1	2	3	4
1 non-melting	25	25	0	0	0
2 intermediate	29	1	28	0	0
3 melting	29	0	1	28	0
4 very-melting	18	0	0	0	18
total	101	26	29	28	18

These Fisher's discriminant linear functions can be used to

classified the goose livers according to the bioelectric impedance modules measured whit the qualimeter in the a, b, c and d zones.

CONCLUSIONS: In the evaluation of the grading method recommended by the qualimeter manufacturers good results were obtained with only six misclassified livers out of 101, and a total of 92% were correctly classified.

It is possible to reach over 97% correct grading by rearranging the groups, according to the measurements of the bioelectric impedance module, and modifying the ranges defining the quality grades.

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