INTERPRETATION OF SENSORIAL EVALUATION OF IBERIAN HAM BY RASCH MODEL

Carmen García, Jorge Ruiz, Lourdes Martín, Ramón Cava, Juan F. Tejeda y Pedro Alvarez[1]

Tecnología de los Alimentos, Facultad de Veterinaria, Universidad de Extremadura, Avda. de la Universidad s/n
10071 Cáceres, SPAIN.
[1]Economía Aplicada y Organización de Empresas, Facultad de Económicas y Empresariales, Universidad de Extremadura.

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Background

Iberian ham is a high quality meat product produced from Iberian pigs breed fattened on pasture with acorns or on feed (Ventanas *et al.*, 1992). Iberian hams from pigs fed on acorns are referred in the market as higher quality than hams from fodderfed pigs. We have used descriptive analysis of these types of ham to establish a detailed qualitative and quantitative specification of their sensory characteristics. Usually, ANOVA and Multivariate analysis have been employed to interpret data (Powers, 1988). We propose Rasch model as fresh way to measure quality of Iberian ham according to sensorial analysis.

Objectives

The aim of this paper is to show an application of latent traits theory to Biometry, using the Rasch model as an instrument for measurement to interpret the results of Iberian ham descriptive analysis.

Methods

A test with 26 questions (items) has been presented to 15 judges for evaluate 8 hams (5 from acornfed pigs and 3 from fodderfed pigs). Quality of Iberian ham can be considered as a latent variable (x_{ni}) defined by the following items:

- Yellow colour of fat (δ_1)
- Roseate colour of fat (δ_2)
- Fluid aspect of fat (δ_3)
- Red colour of lean (δ_4)
- Bright of lean (δ_5)
- Ham slice marbling (δ_6)
- Odour intensity (δ_7)
- "Acorn ham" odour (δ_8)
- Tenderness of fat (δ_9)
- Fluidity of fat (δ_{10})
- Dryness of lean (δ_{11})
- Fibrousness of lean (δ_{12})
- Juiciness of lean (δ_{13})
- Tenderness of lean (δ_{14})
- Salty taste (δ_{15})
- Sweet taste (δ_{16})
- Bitter taste (δ_{17})
- Flavour intensity (δ_{18})
- After-taste (δ_{19})
- Meat cured flavour (δ_{20})
- Rancid flavour (δ_{21})
- Roast flavour (δ_{22})
- Nutty flavour (δ_{23})
- Caramel flavour (δ_{24})
- Mouldy flavour (δ_{25})
- "Cellar ham" flavour (δ_{26})

These items (δ) are those criteria which it is presumed that "quality" depends on and allow ham to be assessed according to this "quality".

Like any other variable "quality" of Iberian ham is conceived as a line with direction, along which items (δ_i) and ham assessments (β) are located. More distance along the line implies more quality for the hams and more capability to explain the quality for the items (Fig 1)

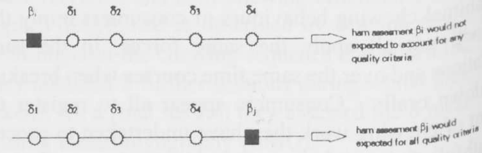

Figure 1.

The probability of having quality when a ham "n" has been scored 1 on item i is given by the formula (a) and the probability of scoring 0 on item i, by the formula (b).

$$\text{(a)}\quad P\{X_{ni}=1\,|\,\beta_n,\delta_i\}=\frac{e^{(\beta_n-\delta_i)}}{1+e^{(\beta_n-\delta_i)}}$$

$$\text{(b)}\quad P\{X_{ni}=0\,|\,\beta_n,\delta_i=1-Pr\{X_{ni}=1\,|\,\beta_n,\delta_i\}=1-\frac{e^{(\beta_n-\delta_i)}}{1+e^{(\beta_n-\delta_i)}}=\frac{1}{1+e^{(\beta_n-\delta_i)}}$$

This is the formula that George Rasch (Rasch, 1980) choose in his development of latent trait theory.

The amount computed for each quality criterion level for each ham, assessed by all judges, is expressed on a 1 to 10 scale (Alvarez *et al.*, 1993).

Parameters β_n and δ_i are estimated by the maximum likehood method for 10 categories using the PROX (Wright and Douglas, 1977) and UCON (Wright and Mead, 1976) algorithms.

Results and Discussion

We have constructed a quality variable line and located the 26 items (δ_i) and 156 hams assessment (β_n) along it from our observations (García *et al.*, 1996). Scores of hams on items are assessed according to the level of quality criterion by judges.

Hams separation (Table 1a) indicates the efficiency of a set of items to separate those hams measured. Items separation (Table 1b) indicates how well a sample of hams is able to separate those items used. Where these statistics are expressed as reliabilities, they range from 0.0 to 1.0. The higher the value the better the separation that exist and the more precise the measurement.

TABLE 1a SUMMARY OF 156 MEASURED (NON-EXTREME) HAMS

	RAW SCORE	COUNT	MEASURE	ERROR	INFIT MNSQ	INFIT STD	OUTFIT MNSQ	OUTFIT STD
MEAN	92.8	26.0	47.59	.58	1.01	.0	1.04	.2
S.D.	22.4	.0	1.67	.02	.43	1.6	.50	1.7
RMSE	.58	ADJ.S.D.	1.57	HAM SEP	2.69	HAM SEP REL.	.88	

TABLE 1b SUMMARY OF 26 MEASURED (NON-EXTREME) ITEMS

	RAW SCORE	COUNT	MEASURE	ERROR	INFIT MNSQ	INFIT STD	OUTFIT MNSQ	OUTFIT STD
MEAN	557.0	156.0	50.00	.25	1.05	.3	1.04	.2
S.D.	243.4	.0	3.01	.04	.31	2.7	.30	2.6
RMSE	.25	ADJ.S.D.	3.00	ITEM SEP	12.03	ITEM SEP REL.	.99	

The distance among items also identifies the direction and meaning of the variable. The least raw score items are those that imply higher measurements and explain poorly ham quality. On the other hand, the items with higher raw score imply lower measurements and are the ones that better explain this quality (fig.2). Similarly, hams assessment (β) with lower and higher raw score, imply poor and excellent quality respectively (fig.3)

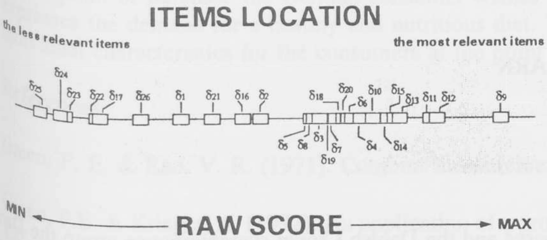

Figure 2.

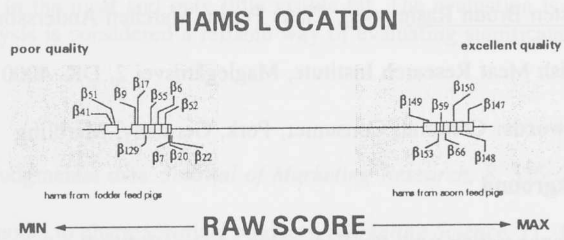

Figure 3.

This model also is able to find out judges consistency and items validity. This validity parameters are determined in base of the discrepancy between a particular observation and its expectation, identifying those individual observations which values that contradict their use in the estimation of useful measures and calibrations.

Item function validity is determined by an analysis of the validity of the sample or responses to that item. The response codes are listed in their sequence order in the data file. The residuals are standardized response score residuals which have a modelled expectation of 0, and a variance of 1. Negative residuals indicate that the observed response was smaller than expected.

If a judge answers in a coherent way and in agreement with expected responses, the residual scores will be near to 0. On the other hand, if these answers have too high or too low scores, the residual scores will be positives or negatives values, the higher absolute value, the more the answer differs with expected values. This expected value is obtained from the total answer of every judges for all hams.

In table 2 are showed the scores for each item that a judge rate to an individual ham. If the residual score of an item differs to 0, this implies that this judge does not scores the expected in this item.

TABLE 2

Item	δ_1	δ_2	δ_3	δ_4	δ_5	δ_6	δ_7	δ_8	δ_9	δ_{10}	δ_{11}	δ_{12}	δ_{13}	δ_{14}	δ_{15}	δ_{16}	δ_{17}	δ_{18}	δ_{19}	δ_{20}	δ_{21}	δ_{22}	δ_{23}	δ_{24}	δ_{25}	δ_{26}
Score	4	2	7	6	6	8	8	9	7	7	3	4	8	2	9	1	2	7	9	8	7	2	3	2	2	2
Residual score	0	-2	0	0	0	1	1	2	0	0	-2	-2	1	-3	1	-2	0	0	2	1	1	0	0	0	0	0

Conclusions

Applying Rasch model as an instrument for measurement ham quality, all the scores has been summarized into a number which is the measure for hams and items quality. The application of this model to Iberian ham sensorial analysis is a good method to determinate the ham quality and shows the higher quality of ham from acornfed pig with objectivity.

Fit analysis is a good way to find out how the items and hams work, and to identify items and hams with those causes that bring about high residuals through unexpected scores, as well as judges consistence.

This methodology can be applied to any kind of meat products and different set of items and different judges.

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