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A Bayesian approach to the effect of selection for growth rate on sensory meat quality of rabbit

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Abstract

The effect of selection for growth rate on the sensory characteristics of rabbit meat was assessed by comparing a selected and a control population of rabbits. Embryos belonging to generation 7th were frozen, thawed and implanted in does in order to produce the control group. The control group was formed from the offspring of the embryos belonging to the 7th generation. Selected animals belonging to 21st generation (S) were compared with animals of the control group (C), both were contemporary. Forty animals per group were slaughtered at 9-weeks-old. The sensory analysis was carried out on samples of the *Longissimus dorsi* muscle. The parameters evaluated were: intensity of rabbit flavour (IRF), aniseed odour (AO), aniseed flavour (AF), liver flavour (LF), tenderness (T), juiciness (J), fibrousness (F). A Bayesian analysis was performed. The ratio of the selection and control effects was analysed. There was a difference between the selected and control groups for IRF, AO, AF and LF. Conversely, no differences were found in T, J and F between groups. Selected group had 3% and 23% higher values of IRF and LF, respectively, than the control group. A relevant effect of selection on AO and AF appeared (probability of relevance $P_r = 1$), with lower values for selected animals. There was a difference between male and female groups for IRF, but this was not relevant. No differences between sexes were found for the rest of the characteristics evaluated. Selection for growth rate did not affect the main sensory characteristics of meat, like T and J but, it had a negative effect on some flavour characteristics.

Keywords: Rabbit; Genetics; Growth rate; Sensory properties; Bayesian

1. Introduction

Selection for growth rate is currently practiced in commercial sire lines for rabbit genetic improvement (Baselga & Blasco, 1989; Lebas, Coudert, Rochambeau, & Thébault, 1996). Meat rabbit production is based on three-way crosses. Does of commercial farms are crossbred females from lines selected by litter size, whereas terminal sires come from lines selected for growth rate. Selection for growth rate decreases food conversion rate and improves efficiency, but may decrease carcass and meat quality. Although several experiments have investigated the effect of selection for lean growth rate on pig carcass quality (Sellier, 1998), there are few experiments comparing selected and control populations for meat quality. In pigs, it seems that selection for lean growth rate, although changing some meat characteristics, did not have consequences for meat acceptability in panel tests (Cameron, Nute, Brown, Enser, & Wood, 1999; Oksbjerg et al., 2000). In rabbits only

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two experiments have assessed the consequences of selection for growth rate in carcass and meat quality (Larzul, Gondret, Combes, & Rochambeau, 2003; Piles, Blasco, & Pla, 2000). Piles et al. (2000) when comparing a control group and a group selected for growth rate, found poorer water holding capacity in the meat in the selected group and a decrease in the fat content of the carcass, but did not find clear differences in the fat content of the hind leg between groups. Larzul et al. (2003) in a experiment of divergent selection at 63 days found that, as body weight increases, the percentage of skin decreased, carcass yield was little affected and perirenal fat increased. However, at present there are no studies on the influence of selection for growth rate on the sensory properties of rabbit meat.

Sensory analyses are usually performed with small samples. Until now, classical statistics has been the usual way of expressing uncertainty regarding meat quality analysis, whereas Bayesian analysis have been mainly applied by animal breeders to solve complicated genetic problems (see Blasco, 2001, for a review). An advantage of the Bayesian approach through MCMC procedures is the possibility of easily constructing all kind of confidence intervals. This allows us to ask questions that we can not ask within the classical inference approach, or that require complex procedures. For example, we can find intervals of the type $[k, +\infty)$ having 95% of the probability area of the marginal posterior distribution. With these intervals we know that the probability of the trait being lower than k is 5%. We can also calculate the probability of finding relevant differences for a trait between two or more treatments. This gives high flexibility to this type of analyses.

Our objective is to study the effect of selection for growth rate on the sensory characteristics of rabbit meat using a Bayesian approach.

2. Material and methods

2.1. Animal material

The animals used in this experiment originated from a synthetic line selected for growth rate between the 4th and 9th week of life (Estany, Camacho, Baselga, & Blasco, 1992), in the Animal Science Department of Universidad Politécnica de Valencia. Embryos belonging to generation 7th were frozen, thawed and implanted in does in order to produce the control group. The procedure is described by Vicente, Viudes-de-Castro, and García (1999). The control group was formed from the offspring of the embryos belonging to the 7th generation, to avoid the effect of cryoconservation. Selected animals belonging to the 21st generation were compared with animals of the control group. Control (C) and selected (S) groups were contemporary. Forty animals per group were slaughtered at 9-weeks-old. Animals were slaughtered at the abattoir on the farm, thus they did not suffer stress due to transport. No fasting was carried out. At 24 h postmortem the *Longissimus dorsi* muscles were dissected and vacuum packed and frozen at −20 °C until required for sensory analysis.

2.2. Sensory evaluation

A quantitative descriptive analysis (Stone, Sidel, Oliver, Woolsey, & Singleton, 1974) was performed by four trained tasters of rabbit meat in 20 sessions. The parameters evaluated were: intensity of rabbit flavour (IRF), aniseed odour (AO), aniseed flavour (AF), liver flavour (LF), tenderness (T), juiciness (J), fibrousness (F). The sensory analysis was carried out on samples of the *Longissimus dorsi* muscle following a complete block design (Stell & Torrie, 1980). Samples were vacuum packed and cooked in a water bath at 80 °C for 1 h. Samples were cut into four pieces and distributed in such way as to the panellist to eliminate any location effect within the loin.

2.3. Statistical analysis

As panellists had different ranges when scoring sensory traits, variables were transformed by dividing the standard deviation of each panellist, as recommended by (Brockhoff, Hirst, & Næs, 1996). The model used included, group (with two levels, S and C corresponding to selection and control groups, respectively), panellist (four panellists), session (20 levels), muscle location (four zones) and sex effects. A Bayesian analysis was performed. Bounded flat priors were used for all unknowns. Data were assumed to be normally distributed. Marginal posterior distributions of all unknowns were estimated using Gibbs Sampling. After some exploratory analyses we used one chain of 10,000 samples, with a burning period of 2000, thus marginal posterior distributions were estimated with 8000 samples each. Convergence was tested for each chain using the Z criterion of Geweke (Geweke, 1992). Details of the procedure can be found in Sorensen and Gianola (2002).

A principal component analysis was performed using the Princomp procedure of the SAS (Statistical Analysis System, 2000) package.

In sensory analyses, it is difficult to determine what a relevant difference is, thus instead of assessing the differences between the selected and control populations, the ratio of the selection and control effects is analysed. This is easily done from the results of the Gibbs sampling chains and allows us to express the superiority of the selected over the control population (or conversely the superiority of the control over the selected population) as a percentage.

3. Results and discussion

Features of the estimated marginal posterior distributions of the sensory properties are presented in Tables 1 and 2. Monte Carlo standard errors were very small. The Geweke test did not detect lack of convergence in any case. Posterior distributions of sensory properties were symmetrical. This is reflected in the similar values for means and medians, and in the symmetrical higher posterior density interval around the mean.

Table 1 shows the features of the marginal posterior distributions of the ratio of the group effects, selection/control (S/C). When S/C > 1, we consider that selected and control groups are different if the probability of S/C > 1 is more than 0.95 ($P>1$ in Table 1 more than 0.95). When S/C < 1, we consider that selected and control groups are different if the probability of S/C < 1 is more than 0.95; i.e., when $P>1$ in Table 1 is less than 0.05. According to the values of $P>1$ in Table 1, there is a difference between selected and control groups for IRF, AO, AF and LF. Conversely, no differences were found in T, J and F between groups.

Selected group had a 3% higher value of IRF than the control group, with a high posterior density interval at a 95% of probability (HPD (95%)) from 1.00% to 1.07%. We consider that a relevant difference appears when one group is at least 10% higher than the other one with a probability higher than 0.95 (P_r: probability of relevance). Although a selection effect appeared for IRF, this effect was not relevant, since the probability that the selected group being at least 10% higher than the control group was only 0.01.

Conversely, a relevant effect of selection on AO and AF appeared ($P_r = 1$), with lower values for the selected animals. By calculating the interval $(-\infty, k]$ of the marginal posterior distribution containing 95% of the probability, we can assess the maximum value that the ratio S/C can have with a probability of 0.95. This value was 0.69 and 0.63 for AO and AF, respectively, which means that the probability of the selected group being higher than 69% and 63% of the control group, respectively, is only 0.05. These sensory attributes have been previously described in rabbit meat by Oliver et al. (1997) and Hernandez, Pla, Oliver, and Blasco (2000). The greater intensity of these attributes could provide positive aromatic notes. In this sense, we could consider that selection for growth rate has a negative effect on flavour characteristics, although it is not clear that these differences could be detected by consumers.

An effect of selection for growth rate on liver flavour is also shown in Table 1, being 23% higher in the selected group than the control, with a HPD (95%) from 1.03 to 1.44. This attribute is a common descriptor in meat flavour and it has been described previously in beef (Font, Pi, Garcia-Macias, Guerrero, & Oliver, 1995). Oliver et al. (1997) and Hernandez et al. (2000) reported the same descriptor in rabbit meat. These authors considered that an increase in liver flavour could have a negative effect on consumer acceptability. However, the probability of the selected group being at least 10% higher than the control group was only 0.88, lower than 0.95, which is the threshold which we have considered the relevant value.

Table 2 shows the features of the marginal posterior distributions of the ratio of the group effects, males/females (M/F). According to the values of $P>1$ in Table 2, there is a difference between the male and female groups for IRF, being 4% higher in males than in females. However, this difference was not relevant, since the probability that the selected group being at least 10% higher than the control group was only 0.01. No differences were found for the rest of the characteristics evaluated.

Table 3 shows the coefficients of correlations between the sensory properties studied. A principal component (PC) analysis was carried out to examine the relationships between the different traits studied. Relationships between the different sensory properties are shown in Fig. 1. The three PC explain 70% of total variation

Table 1
Sensory properties of rabbit meat

S/C	Mean	Median	HPD (95%)	$P>1$	P_r	k_1	k_2	MC_{SE}	Z
IRF	1.03	1.03	1.00, 1.07	0.96	0.01	1.06	1.00	0.0002	−0.11
AO	0.59	0.58	0.47, 0.71	0.00	1.00	0.69	0.49	0.0007	−1.82
AF	0.52	0.51	0.39, 0.65	0.00	1.00	0.63	0.41	0.0007	0.49
LF	1.23	1.22	1.03, 1.44	0.99	0.88	1.41	1.06	0.0011	1.21
T	1.00	0.99	0.96, 1.04	0.49	0.00	1.04	0.97	0.0002	−0.18
J	1.01	1.01	0.95, 1.07	0.57	0.01	1.06	0.96	0.0004	−0.32
F	1.02	1.02	0.95, 1.09	0.70	0.01	1.08	0.96	0.0003	1.18

Features of the marginal posterior distributions of the ratio of the group effects, selection/control (S/C).
IRF: intensity of rabbit flavour; AO: aniseed odour; AF: aniseed flavour; LF: liver flavour; T: tenderness; J: juiciness; F: fibrousness.
HPD (95%): high posterior density interval at a 95% of probability; $P>1$: probability of S/C > 1; P_r: Probability of relevance, the probability that one group being at least a 10% higher than the other group; k_1: limit of the interval $(-\infty, k_1]$ containing a probability of 95%; k_2: limit of the interval $[k_2, +\infty)$ containing a probability of 95%; MC_{SE}: Monte Carlo standard error; Z: Z-score of the Geweke test.

Table 2
Sensory properties of rabbit meat

M/F	Mean	Median	HPD (95%)	$P>1$	k_1	k_2	MC_{SE}	Z
IRF	1.04	1.04	1.00, 1.07	0.98	1.07	1.01	0.0002	−0.81
AO	1.03	1.02	0.83, 1.22	0.42	1.20	0.87	0.0010	0.14
AF	1.11	1.10	0.87, 1.37	0.80	1.34	0.91	0.0016	−0.56
LF	0.98	0.98	0.81, 1.14	0.40	1.13	0.84	0.0009	1.12
T	0.97	0.97	0.93, 1.01	0.09	1.01	0.94	0.0003	−1.54
J	0.97	0.91	0.91, 1.03	0.16	1.02	0.92	0.0003	−0.21
F	1.04	1.04	0.97, 1.10	0.84	1.09	0.98	0.0003	−0.47

Features of the marginal posterior distributions of the ratio of the group effects, males/females (M/F).
IRF: intensity of rabbit flavour; AO: aniseed odour; AF: aniseed flavour; LF: liver flavour; T: tenderness; J: juiciness; F: fibrousness.
HPD (95%): high posterior density interval at a 95% of probability; $P>1$: probability of S/C > 1; k_1: limit of the interval $(-\infty, k_1]$ containing a probability of 95%; k_2: limit of the interval $[k_2, +\infty)$ containing a probability of 95%; MC_{SE}: Monte Carlo standard error. Z: Z-score of the Geweke test.

(29%, 24% and 17%, respectively). The first PC was explained by IRF, T and F. These variables are positively correlated. Each PC represents an independent cause of variation, thus traits near each other are positively correlated and traits separated by 90° are independent. AO and AF are located on the second PC far from the origin, explaining an independent cause of variation, not being related with IRF, T and F, J and LF were not well represented by the first two PCs. When data were represented on the plan defined by the first two PCs, selected and control animals were not grouped separately (figure not shown) showing no clear differentiation between groups.

Table 3
Coefficients of correlation between the different sensory properties

	IRF	AO	AF	LF	T	J	F
IRF	1	0.03	−0.12	−0.05	0.51	−0.005	0.52
AO		1	0.59	−0.09	0.08	−0.04	0.14
AF			1	−0.21	0.01	−0.03	0.06
LF				1	0.18	0.25	0.07
T					1	0.28	0.34
J						1	0.16
F							1

IRF: intensity of rabbit flavour; AO: aniseed odour; AF: aniseed flavour; LF: liver flavour; T: tenderness; J: juiciness; F: fibrousness.

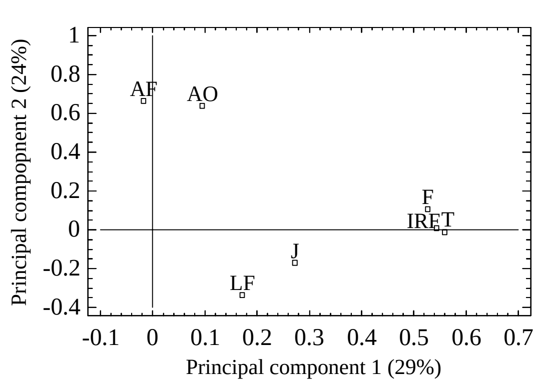

Fig. 1. Projection of the variables in the plane defined by the two principal components.

In summary, selection for growth rate has not affected the main characteristics of meat rabbit, like T and J, but had a negative effect on some flavour characteristics.

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