USE OF NON-MEDICATED FEED WITH THE ADDITION OF POMEGRANATE BY-PRODUCTS IN COMMERCIAL RABBIT FATTENING

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ABSTRACT

Rabbit meat has excellent nutritional properties for the human diet. The commercial rabbit-farming sector is experiencing a severe crisis. In this study we tested whether fattening commercial rabbits with non-medicated feed, with 20% addition of 3 different pomegranate by-products (pomace, shell or seed extract), affected production traits and meat quality compared to a conventional strategy. 72 weaned rabbits were used, reared indoors in cages with 6 rabbits each (571 cm²/head). Ad libitum fattening lasted 30 days and the animals were divided into 12 groups of 6 rabbits each. The treatments include 3 replicates (6 rabbits each, n=18). The control group received medicated concentrate until day 21 of fattening and non-medicated withdrawal feed until slaughter. The other three received 20% pomegranate by-product integrated in non-medicated withdrawal feed: pomace (n=18), shell (n=18) and seed extract (n=18). Productive traits were recorded and a brief economic study was carried out. Rabbits were slaughtered in a commercial abattoir and carcasses were transported refrigerated to the lab. The ultimate meat pH was measured and meat colour was assessed by CIELAB coordinates. The L. dorsi was removed for the analysis of meat texture by Warner–Bratzler (WB). The data were analyzed using GLM procedure including the fixed effects of feeding strategy. Production and quality variables were within the range of commercial acceptability for consumers. Only slight differences between treatments were observed. In general, the meat in the pomace group was 71% tenderer than the industrial group ($p \leq 0.05$). The meat in the seed group was less luminous than the others and data would suggest that the treatment strategy affording the greatest net income is pomace. Our findings show that 20% of expensive industrial concentrate could be replaced by cheap pomegranate by products, avoiding the use of medicated concentrate and obtaining similar o slightly better results than those obtained in conventional strategies.

Key words: Rabbit, Fattening, non-medicated feed, pomegranate by products, meat quality

INTRODUCTION

Rabbit meat has excellent nutritional properties for the human diet and is widely consumed in Mediterranean countries, forming part of the healthy Mediterranean diet (Dalle Zotte and Szendrő, 2011). However, high levels of industrialization of the production system and the use of concentrated feed, far-removed from the natural diet of the species, have meant that this traditional product has lost its image of a local, sustainable product (Petracci and Cavani, 2013). Today the Spanish commercial rabbit-farming sector is experiencing a severe crisis that may even endanger its survival (Baviera-Puig et al. 2017). Improving the image of the sector vis-a-vis consumers by presenting a more sustainable product without the use of medicated industrial concentrated feeds and using a by-product with healthier bio functional characteristics, is an alternative that we need to explore. Following the EU tendency, a specific Spanish national strategy has been developed to minimize the use of medical products in production animals. The use of local vegetable by-products, not usable for the human diet, is a possible method for reducing feeding costs and a way to add value to rabbit meat (Baviera et al. 2017). In this study we tested whether fattening commercial rabbits with non-medicated feed, with 20% addition of three different pomegranate (*Punica granatum*) by-products of the juice industry (pomace, shell or seed extract), affected productive traits and meat quality, compared to a conventional industrial fattening that uses medicated concentrate.

MATERIALS AND METHODS

Seventy two weaned New Zealand rabbits, 35 days old, with a mean weight of 879 (±32) g were reared indoors in standard, uniform environmental conditions (temperature: 21.3 ± 1.7ºC, relative humidity: 60.3 ± 6.21%, 16 h light period), using traditional, individual, flat-deck type cages, each with six rabbits (571 cm^2/head). Rabbits were fed ad libitum for 30 days. The animals were divided into 12 groups of 6 rabbits each, balanced by weight and sex. Each treatment had 3 replicates with 6 rabbits each (n=18). One was the control group that received medicated industrial concentrated feed until day 21 of fattening. After 21 days they received non-medicated withdrawal feed until slaughter. The other three received 20% pomegranate by-product integrated into non-medicated withdrawal feed: pomace (n=18), shell (n=18) and seed extract (n=18). Water was permanently available from a nipple drinker.

The base pellet feed contained alfalfa forage flour, vetch, fescue, ray-grass, barley, sunflower seed meal, corn gluten feed, soybean hulls, palm kernel pressure cake, sugar cane molasses, wheat bran, calcium carbonate, palm vegetable oil, sodium chloride, vitamins and minerals. The chemical composition of the feed was analyzed in the four groups (dry matter: 91.54, 91.75, 91.78, 93.27; ether extract: 4.61, 5.10, 3.24, 3.60; crude protein: 14.08, 13.64, 12.50, 15.38; neutral detergent fibre: 53.46, 40.91, 41.09, 52.02; acid detergent fibre: 33.60, 20.36, 20.49, 39.27 and acid detergent lignin: 7.84, 4.11, 3.87, 13.75 for control, pomace, shell and seed extract, respectively). Feed consumption and growth rate were recorded weekly (group data n=6). Average daily gain and the average feed conversion ratio were estimated. A brief economic study of each fattening strategy was carried out. The approximate incomes and costs were estimated for each strategy, considering two sales strategies: direct sales (DS) or conventional sales with intermediaries (NDS). Feeding cost was estimated as 70% of total cost.

After 30 minutes road transport (without fasting) using 1 cage per six-rabbit replicate, all of the rabbits were slaughtered at a commercial abattoir. During 1 hour lairage at the abattoir the rabbits remained in cages. A gentle shower was applied before slaughter in order to optimize electrical stunning. After slaughter, and once the carcasses had cooled properly, they were transported refrigerated to the Meat Laboratory of the University of Zaragoza (4 ºC for 24 h). The meat pH was measured with Crison 507 electrode at 24 h post-mortem in the M. *Longissimus dorsi lumborum*. Meat colour (L. dorsi) was measured after 24 h blooming. Meat colour was expressed as colour CIELAB coordinates L* (lightness), a* (redness), and b* (yellowness). Chroma (C*) and hue-angle (h*) values were calculated as C* = (a*2+b*2)1/2 and h* = tan 1(b*/a*), respectively. The *L. dorsi* was removed from both sides and the right side was sliced into three steaks for instrumental analyses. For meat texture analyses, samples were vacuum-packaged and frozen at 18°C. For the analysis, thawed steaks (internal temperature 17–19°C) were cut transversely, and analyzed as cooked meat by the WB procedure following the technique described in María et al., 2006. Thaw loss was determined by weighing each whole muscle prior to freezing and again after thawing and blotting dry with tissue paper. Thaw loss of the whole muscle was expressed as a percentage of the initial weight prior to freezing. Cooking loss was recorded by weighing the samples before and after cooking.

The data were analyzed using the GLM procedure in SAS (SAS, 1988), fitting a model that included the fixed effects of feeding strategy (alternative vs conventional). A multiple comparison procedure with the option LSD was used with $p \leq 0.05$ taken as significant.

RESULTS AND DISCUSSION

Least square means (±SE) for performance and meat quality traits for rabbits fattened with alternative and industrial feeding regimes are presented in Table 1. The results of the production and quality variables were within the range of commercial acceptability for consumers. Only slight differences were observed between treatments.

Table 1: Least square means (±SE) for productive traits for rabbits fattened with alternative (unmedicated feed with 20% addition of three different pomegranate by-products) and industrial feeding regime (medicated feed plus withdrawal non medicated feed).

Variable	Seed	Shell	Pomace	Industrial
Initial age (days)	35	35	35	35
Days of fattening	30	30	30	30
Final age (days)	65	65	65	65
Total Live weight (kg) of a group of 6 rabbits (3 replicates/treatment)				
Initial live weight)	5.01 (±0.44)	5.48 (±0.44)	5.52 (±0.44)	5.09 (±0.44)
Live weight week 1	6.66 (±0.47)	6.67 (±0.47)	7.11 (±0.47)	6.78 (±0.47)
Live weight week 2	8.45 (±0.48)	8.16 (±0.48)	8.73 (±0.48)	8.61 (±0.48)
Live weight week 3	10.11(±0.41)	9.73 (±0.41)	10.50 (±0.41)	10.42 (±0.41)
Live weight week 4	11.34 (±0.40)	11.30 (±0.40)	12.20 (±0.40)	11.95 (±0.40)
Live weight at slaughter	12.50 (±0.38)	12.10 (±0.38)	13.03 (±0.38)	13.31 (±0.38)
CCI* (#)	3.56 (±0.21)	4.09 (±0.21)	2.94 (±0.21)	2.96 (±0.21)
Costs and incomes				
Total feeding cost (€)	6.92	7.03	5.74	7.67
Total cost (€)	8.99	9.14	7.46	9.97
Revenue (4.95 €/kg) *ds*	38.31	34.95	38.61	38.46
Revenue AFC *(€) ds*	31.39	27.92	32.87	30.79
Revenue ATC *(€) ds*	29.32	25.81	31.15	28.49
Revenue (2.95 €/kg) *nds*	22.83	20.83	23.01	22.92
Revenue AFC *(€) nds*	15.91	13.77	17.27	15.25
Revenue ATC *(€) nds*	13.84	11.69	15.55	12.95

*CCI: concentrate conversion index (kg per live weight kg); significant diff. P< 0.05. ds: direct sale. Concentrate cost euro/kg: industrial 0.33; alternative 0.26. Direct sale to consumer (ds), price: 4.95 euro/kg; no direct sale (nds), price: 3.75 euro/kg. AFC: after feeding cost. ATC: after total cost. Feeding cost represents approx.. 70% of total costs. €=Euro. (#) Group data (replicate n=6). *CCI: concentrate conversion index.

The carcass weight was somewhat lower in the seed group (p <0.05). Slight differences were observed in favour of the control group in terms of cooking losses. However, thawing losses were lower in the pomace group. In general, the meat of the pomace group is slightly tenderer than the others. Some colour differences were also observed but always within the normal range for this type of meat. The meat of the seed group was less luminous than the others. Rabbit meat, together with veal and poultry meat, is classified as white meat. It is lighter in colour than red meat due to a lower myoglobin content of muscle fibers (Cifuni et al. 2016). The approximate economic study suggests that the strategy that reports greater net income is that using pomace. If it were also possible to assign an economic value for safer, healthier and more sustainable meat, this benefit would increase significantly. It is thus important to inform about and disseminate the virtues of this type of proximity meat that employs cheap local by-products not suited to the human diet and which would otherwise be wasted. Our findings show that 20% of expensive industrial concentrate can be replaced by cheap pomegranate extract, completely avoiding the use of medicated concentrate and obtaining similar o slightly better results than those obtained in conventional industrial fattening. The pomace strategy for rabbit fattening has a further added value, which is the use of a by-product of traditional local pomegranate production, rich in polyphenols.

Table 2: Least square means (±SE) for meat quality traits for rabbits fattened with alternative (non-medicated feed with 20% addition of three different pomegranate by-products) and industrial feeding regime (medicated feed plus 1 week withdrawal non-medicated feed).

Variable	**Seed**	**Shell**	**Pomace**	**Industrial**
Total Carcass weight (kg) of a group of 6 rabbits	7.74 (±0,3)	7.06 (±0.3)	7.80 (±0.3)	7.77 (±0.3)
Carcass yield (%) (#)	61.88 (±0.81)	58.36 (±0.81)	59.86 (±0.81)	60.61 (±0.81)
Indiv. Carcass weight (g)	1301 ±32a	1177 ±32b	1300 ±32a	1299 ±32a
pH_u (24 h *post mortem*)	5.75 ±0.01	5.74 ±0.01	5.75 ±0.01	5.70 ±0.01
Thawing losses (%)	12.28 ±0.65b	10.76 ±0.65b	9.98 ±0.65a	10.92 ±0.65ab
Cooking losses (%)	16.63 ±1.12ab	17.66 ±1.12b	19.09 ±1.12b	14.18 ±0.98a
Meat texture by WB				
Newtons (N)	3.33 ±0.19a	2.50 ±0.19b	2.61 ±0.19b	3.54 ±0.16a
Maximum load (kg)	2.10 ±0.14a	2.31 ±0.14a	2.01 ±0.14b	2.37 ±0.12a
Maximum strength (kg)	2.20 0.16b	2.18 0.16b	1.86 0.16b	2.63 0.14a
Toughness (kg/cm2)	0.90 ±0.10b	0.81 ±0.10b	0.69 ±0.10b	1.18 ±0.09a
Meat colour CIELAB				
L* (lightness)	51.86 ±0.48b	53.72 ±0.48a	54.57 ±0.48a	53.53 ±0.42a
A* (redness)	-1.26 ±0.13a	-1.59 ±0.13b	-1.34 ±0.13ab	-1.08 ±0.11a
B* (yellowness)	5.18 ±0.33c	9.78 ±0.33b	9.79 ±0.33b	6.77 ±0.29a
Chroma*	5.36 ±0.33c	9.93 ±0.33b	9.90 ±0.33b	6.88 ±0.28a
Hue*	-66.2 ±6.21b	-80.6 ±6.21ab	-82.16 ±6.2a	-73.00 ±5.4ab

Chroma*=(a*2 + b*2)1/2; Hue =1/tan (b*/a*). Significant diff. $p \leq 0.05$. WB: Warner Bratzler

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