FEED RESTRICTION DURING SUMMER: EFFECT ON RABBIT CARCASS TRAITS AND MEAT QUALITY

Bovera F.*, Piccolo G., D'Urso S., Nizza S., Cutrignelli M.I.

Department of Scienze Zootecniche e Ispezione degli Alimenti, Univ. Napoli, Via F. Delpino, 1, 80137 Napoli, Italy
*Corresponding author: bovera@unina.it

ABSTRACT

The aim of the research was to evaluate the effect of feed restriction during the whole productive cycle on the carcass and meat traits of hybrid Hyla rabbits raised during the summer season. The trial was carried out on two groups, each comprising 684 weaned hybrid Hyla rabbits fed the same commercial concentrates, supplied respectively *ad libitum* (AL group) and restricted to 80% and 90% of *ad libitum* (RES group), respectively from weaning to 60 days of age and from 61 days of age to slaughter (81 days). After slaughter, carcasses were prepared according to the norms of the World Rabbit Science Association (WRSA). Moreover, pH of *Biceps femoris*, measured 1 and 24 hours post mortem, meat quality and water holding capacity were determined. The main, significant differences in carcass traits consisted in the percentage of empty gastro-intestinal tract on the body weight (7.10 vs. 5.65%, respectively for RES and AL group, $P<0.01$), dressing out percentage (67.64 vs. 70.21%, respectively for RES and AL group, $P<0.05$) and carcass length (37.09 vs. 38.73 cm, respectively for RES and AL group, $P<0.05$). The great incidence of empty gastro-intestinal tract, that affects also dressing out percentage, can be due to the higher relative intake of RES group with a consequent higher relative development of the gastro-intestinal tract.

Key words: Feed restriction, Rabbit, Growth performance, Hot climate.

INTRODUCTION

Feed restriction increases feed efficiency (Perrier and Ouhayoun, 1996; Tůmová *et al.*, 2002, 2003; Dalle Zotte *et al.*, 2005), improves digestibility of nutrients in a restricted feeding period (Tůmová *et al.*, 2003, 2004; Di Meo *et al.*, 2007) and can prevent post-weaning digestive disorders (Gidenne *et al.*, 2003).

However, carcass characteristics are important factors to consider when evaluating alternative feeding programs. Ledin *et al.* (1984a) concluded that carcass and dissection characteristics were not influenced by restriction. Perrier and Ouhayoun (1996) found that rabbits restricted from 56 days of age had lighter carcasses but carcass yield was the same as in the *ad libitum* fed rabbits. Rabbits restricted till 56 days had better carcass yield. According to Tumová *et al.* (2003) time restriction did not affect carcass weight and dressing percentage.

As, in a previous study, the authors observed that during summer feed restriction negatively affected rabbit mortality around weaning, the aim of this research was to verify if different effects of feed restriction during summer occurs also for carcass and meat traits.

MATERIALS AND METHODS

Animals and experimental design

The study was carried out on a rabbit farm near Benevento (Italy). Immediately after weaning (35 d of age) two groups, each comprising 684 hybrid Hyla rabbits, were housed in bi-cellular cages in the

same tunnel. The trial starts in June, 18th 2007. The two groups were fed the same commercial concentrates supplied respectively *ad libitum* (AL group) and restricted to 80% and 90% of *ad libitum* (RES group), respectively from weaning to 60 days of age and from 61 days of age to slaughter. Up to 60 days the rabbits were fed a "weaning" concentrate, subsequently changing to a "finishing" concentrate up to 81 d (slaughter age). Feed restriction was easily applied using the automated system present in the farm to distribute the concentrate to the cages. In this system each trough has a sensor to detect the weight of the feeds. On the basis of the *ad libitum* feed intake recorded in other rabbits of 35 days of age raised on the same farm and housed in the same tunnel of the animals used in this trial, the quantity of concentrate to administered to RES group in the first day was set. Afterwards, feed administered to RES group was adjusted daily on the basis of the intake of *ad libitum* group recorde in the previous day. The concentrates were distributed each morning at 8:00.

Samples of feeds were collected weekly and analyzed for chemical composition (AOAC, 2000). The "weaning" and "finishing" concentrates showed, on DM basis, respectively: CP 18.5 and 17.6%; EE 3.9 and 4.6%, CF 14.2 and 14.9%; NDF 36.2 and 36.4%; ADF 18.24 and 19.11%; ADL 2.36 and 2.45%. The content of digestible energy (DE) was calculated from chemical composition according to Xiccato (1989) using the equation: ED (kcal/kg)=(13.68 – 0.2472 CF) x 239. The DE content of the two concentrates resulted 2430 and 2389 kcal/kg, respectively for "weaning" and "finishing" concentrate.

Reached the slaughter age, 24 rabbits per group, randomly chosen but homogeneous for gender, were slaughtered, at 9:00 a.m., in a specialized slaughter house after 12 h of solid fasting.
Carcasses were prepared according to the norms of the World Rabbit Science Association (WRSA) (Blasco and Ouhayoun, 1996) by removing the skin, the distal parts of the tail, fore and hind legs, urinogenital organs and the digestive tract. Hot carcasses were suspended in a ventilated area for 30 min, and then were chilled at 3–4°C until 24 h post mortem. The head, liver, lungs, thymus, trachea, oesophagus, heart and kidneys were then removed to obtain the "reference" carcass, containing only meat, fat and bone.

The following traits were recorded: LW, live weight; CCW, chilled carcass weight; RCW, reference carcass weight (carcass without head and organs); head weight; liver weight; thymus, trachea, oesophagus, lung and heart weight; dissectible fat weight of the chilled carcass (perirenal and scapular). From reference carcasses fore left leg were weighed and dissected to separate bone (HLBW) from the edible meat (HLMW) and fat.

The following were calculated: NetDoP, net dressing out percentage [100 times CCW/(LW – gastro-intestinal content)]; the weights of the following tissues as a percentage of CCW; HP, head %; LvP, liver %; LHP, set of thoracic viscera %; PFaP, perirenal fat %; SFaP, scapular fat %; and the M/B, meat to bone ratio of the hind leg (HLMW/HLBW).

The pH of *Biceps femoris* was measured at 1 and 24 h post-mortem (Alessandrini Instrument glass electrode, Jenway, Dunmow, UK; model 3030).

Water holding capacity was measured on samples (size: 25 x 25 x 5 mm) from loin meat. The weight losses were evaluated after: 1. cooking on a hot plate at 300°C until the core temperature of 70°C is reached (Wheeler *et al.*, 1990); 2. cooking in a bain-marie in a polyethylene bag at 70°C for 15 minutes (Gault, 1985); 3. pressure for 10 minutes according to Grau and Hamm (1957), measuring the weight losses

Statistical analysis

The results were analyzed by analysis of variance using the General Linear Model procedure of SAS (2000) according to the follow model: $Y_{ij} = \mu + F_i + \varepsilon_{ij}$, where Y is the single observation; μ is the general mean; F is the effect of the feeding technique (i = *ad libitum* or restricted) and ε is the error.

RESULTS AND DISCUSSION

The maximum daily temperature in the area of the trial ranged from 27.6 to 34.7°C, this one reached during the 4th and 5th week of the experiment (www.meteo.it). Live, hot carcass, chilled carcass and reference carcass weights (Table 1) were not affected by feed restriction. The incidence of empty gastro intestinal tract on live weight was significantly (P<0.01) higher for RES than AL group. According to several studies on the development of the different digestive traits during feed restriction and subsequent re-alimentation period, the stomach grew rapidly after restriction (Ledin *et al*., 1984b); the small intestine weight in the first week after restriction was higher than in rabbits fed *ad libitum* (Tumova *et al*., 2004) while the large intestine was heavier in restricted rabbits at the end of the trials (Tumova *et al*., 2006). Bovera *et al*. (unpublished data) in a similar trial made in the same farm of the present study, but during winter, do not found significant differences for incidence of empty digestive system on body weight (7.12 vs. 6.82%, respectively for *ad libitum* and restricted rabbits).

Table 1: Live weight and carcass traits of the two groups

	LW (kg)	Skin (% LW)	Empty GI (% LW)	HCar (kg)	NetDoP	CCW (kg)	RCW (kg)
RES	2.42±0.11	15.41±1.51	7.10±1.25	1.59±0.12	67.64±2.60	1.53±0.11	1.24±0.10
AL	2.50±0.17	15.58±1.11	5.65±0.81	1.55±0.13	70.21±1.36	1.50±0.14	1.26±0.16
Significance	NS	NS	**	NS	**	NS	NS

RES = restricted group, AL = *ad libitum* group; LW = live weight; GI = gastro intestinal tract; HCar = hot carcass; NetDoP = dressing out percentage calculated on the net live weight; CCW = chilled carcass weight; RCW = reference carcass weight

Our result can be due to the higher relative intake of RES group. In fact the rabbits of RES group empted the troughs earlier than AL group. So, when the feed was re-introduced in the trough the animals gobble up it. This could induce a higher relative development of the gastro-intestinal tract. Moreover, Ledin (1984b) indicated that restricting feed intake to 0.5 and 0.6 of *ad libitum* increases retention time of feed by 7 and 13 h. Also the increase in retention time can explain the higher incidence of gastro-intestinal tract in restricted rabbits. This behavior was more consistent in the summer than in the winter, probably due to the lower feed intake.

As a consequence of the higher incidence of GI tract, dressing out percentage was significantly lower (P<0.01) for RES group. Lazur *et al.* (2004) in orylag rabbit genotypes (Chinchilla and Castor) restricted from 8 to 18 weeks (at 90 and 74%, respectively) found dressing out percentages significantly (P<0.05) lower in restricted groups.

Excluding carcass length, no significant differences were found between the parameters reported in Table 2. According to Palsson (1955), internal organs are not affected by feed restriction.

Table 2: Slaughter rate (as chilled carcass percentage) and carcass measurements

	LvP	LHP	HP	SFaP	PFaP	CL (cm)	CC (cm)
RES	6.01±0.76	1.48±0.20	9.13±0.81	0.30±0.11	1.01±0.30	37.10±1.58	18.41±0.66
AL	5.73 ±0.94	1.54±0.20	9.32±0.63	0.38±0.20	1.32±0.51	38.73±1.79	18.54±1.21
Significance	NS	NS	NS	NS	NS	*	NS

RES = restricted group, AL = *ad libitum* group; LvP = liver; LHP = lungs, thymus, trachea, oesophagus, heart; HP = head; SFaP = interscapular fat; PFaP = perirenal fat; CL = carcass length; CC = carcass circumference

Ad libitum group showed higher contents of scapular and perirenal fat but the high variability (high standard deviation) of this parameter fail to reach statistically significance. Differences in carcass length are difficult to explain. Taking into account that, even if not significantly, AL group showed higher live and left leg weights than RES group, it is possible to suppose that, being the bone an early developed tissue, the feed restriction during the first period after weaning, could reduce bone length. On the other hand, bone weight in fore leg was not statistically different between the groups, but higher for AL rabbits.

According to this, bone weight from left leg dissection is not statistically different between the groups (Table 3).

Table 3: Left leg traits and carcass pH (mean ± standard deviation)

	LL (g)	Bones (g)	Meat (g)	Fat (g)	M/B	pHBF1	pHBF24
RES	167.4±17.8	28.74±3.41	133.7±16.7	2.83±1.08	4.71±0.81	6.93±0.10	5.54±0.17
AL	173.2±23.7	29.86±5.47	139.2±22.0	3.20±1.26	5.15±1.19	6.95±0.19	5.56±0.21
Significance	NS	NS	NS	NS	NS	NS	NS

RES = restricted group, AL = *ad libitum* group; LL = left leg; M/B = meat to bone ratio; pHBF1 = pH of Biceps faemoris measured 1 h after slaughter; pHBF24 = pH of Biceps faemoris measured after 24 hs of refrigeration at 4 °C

The M/B ratio was unaffected by diet treatments even if RES group showed a lower value than AL group (Table 3). Also pH values were unaffected by feed restriction according to the finding of Dalle Zotte and Ouhayoun (1995) and Tůmova *et al.* (2006). Finally, water holding capacity and the main traits of meat quality (Table 4) were unaffected by feed restriction.

Table 4: Water holding capacity and meat quality

	HPL (%)	BML (%)	Pressure (%)	Moisture (%)	Fat (%)	Protein (%)	Ash (%)
RES	48.36±5.14	29.15±2.84	17.36±1.91	73.13±1.12	3.05±0.83	22.00±0.67	1.18±0.07
AL	45.27±6.94	27.73±2.42	17.19±2.55	73.15±1.20	3.11±1.10	21.77±1.09	1.14±0.09
Significance	NS	NS	NS	NS	NS	NS	NS

RES = restricted group, AL = *ad libitum* group; NS = not significant; HPL =hot plate losses; BML = baine-marie losses

CONCLUSIONS

Feed restriction applied during summer at 20% from 35 to 60 days and at 10% from 61 to 81 days, did make worse dressing out percentage (due to a higher incidence of empty GI tract on live weight) of the carcasses and reduces carcass length. The other traits of the carcasses were not affected by feed restriction. These considerations suggest paying attention in the use of feed restriction when the rabbits were under heat stress condition.

ACKNOWLEDGEMENTS

The authors thank Mrs. Maria Ferrara for her technical collaboration and the rabbit farm “Marciano” (BN).

REFERENCES

AOAC 2000. Official methods of Analysis 17th Edition. *Association of Official Analytical Chemists, Arlington, Virginia, USA.*

Blasco A., Ouhayoun J. 1996. Harmonisation of criteria and terminology in rabbit meat research. Revised proposal. *World Rabbit Sci., 4, 93–99.*

Dalle Zotte A., Remignon H., Ouhayoun J. 2005. Effect of feed rationing during post-weaning growth on meat quality, muscle energy metabolism and fibre properties of *Biceps femoris* muscle in the rabbits. *Meat Sci., 70, 301–306.*

Dalle-Zotte A., Ouhayoun J. 1995. Post-weaning evolution of muscle energy metabolism and related physico-chemical traits in the rabbit. *Meat Sci., 39, 395–401*.

Di Meo C., Bovera F., Marono S., Vella N., Nizza A. 2007. Effect of feed restriction on performance and feed digestibility in rabbits. *Ital. J. Anim. Sci., 6 (Suppl. 1), 765-767.*

Gault N.F.S. 1985. The relationship between Water-holding capacity and cooked meat tenderness in some beef muscles as influenced by acidic conditions below the ultimate pH. *Meat Sci., 15, 13-30.*

Gidenne T., Feugier A., Jehl N., Arveux P., Boisot P., Briens C., Corrent E., Fortune H., Montessuy S., Verdelhan S. 2003. Un rationnement alimentaire quantitatif postsevrage permet de réduire la fréquence des diarrhées, sans dégradation importante des performances de croissance: résultats d’une étude multi-site. *In: Proc. 10èmes Journ. Rech. Cunicole, Paris, France, 29–32.*

Grau R., Hamm R. 1957. Fleischwirts, 6, 36. *Cit. from GRAU R. 1978. Carne e prodotti carnei. Edagricole, Bologna*.

Lazur C., Thebault R.G., Allain D. 2004. Effect of feed restriction on rabbit meat quality of the Rex du Poitou. *Meat Sci., 67, 479–484.*

Ledin I. 1984a. Effect of restricted feeding and realimentation on compensatory growth, carcass composition and organ growth in rabbit. *Ann. Zootech., 33, 33–50.*

Ledin I. 1984b. A note on the effect on different feeding levels on the rate of digesta passage in rabbits. *Acta Agric. Scand., 34, 67–70.*

Meteo.it 2007. Estate 2007: appena più calda della media al Nord, abbastanza calda al Centro, caldo quasi record al Sud. *http://www.meteo.it/clima/statistiche/index.htm*

Palsson H. 1955. Conformation and body composition *In: Progress in the physiology of farm animals. Vol. II. Butterworth, London, UK.*

Perrier G., Ouhayoun J. 1996. Growth and carcass traits of the rabbit a, comparative study of three modes in feed rationing during fattening. *In: Proc. 6th World Rabbit Congress, 1996 July, Toulouse, France, 102.*

SAS 2000. SAS/STAT® Software: Changes and Enhancements through Release 8.1. *SAS Institute Inc., Cary, NC, USA.*

Tůmová E., Skřivan M., Skřivanová V., Kacerovská L. 2002. Effect of early feed restriction on growth in broiler chickens, turkeys and rabbits. *Czech J. Anim. Sci., 47, 418–428.*

Tůmová E., Skřivanová V., Skřivan M. 2003. Effect of restricted feeding time and quantitative restriction in growing rabbits. *Arch. Geflűgelkde, 67, 182–190.*

Tůmová E., Skřivanová V., Zita L., Skřivan M., Fučíková A. 2004. The effect of restriction on digestibility of nutrients, organ growth and blood picture in broiler rabbits. *In: Proc. 8th World Rabbit Congress, 2004 September, Puebla, Mexico. 1008–1014.*

Tůmová E., Zita L., Štolc L. 2006. Carcass quality in restricted and ad libitum fed rabbits. *Czech J. Anim. Sci., 51, 214–219.*

Wheeler T.L., Savell J.W., Cross H.R., Lunt D.K., Smith S.B. 1990. Effect of post mortem treatments on the tenderness of meat from Hereford, Brahman and Brahman-cross beef cattle. *J. Anim. Sci., 68, 3677-3686.*

Xiccato G. 1989. Quale sistema energetico per il coniglio. *Professione allevatore, 2, 1-8.*