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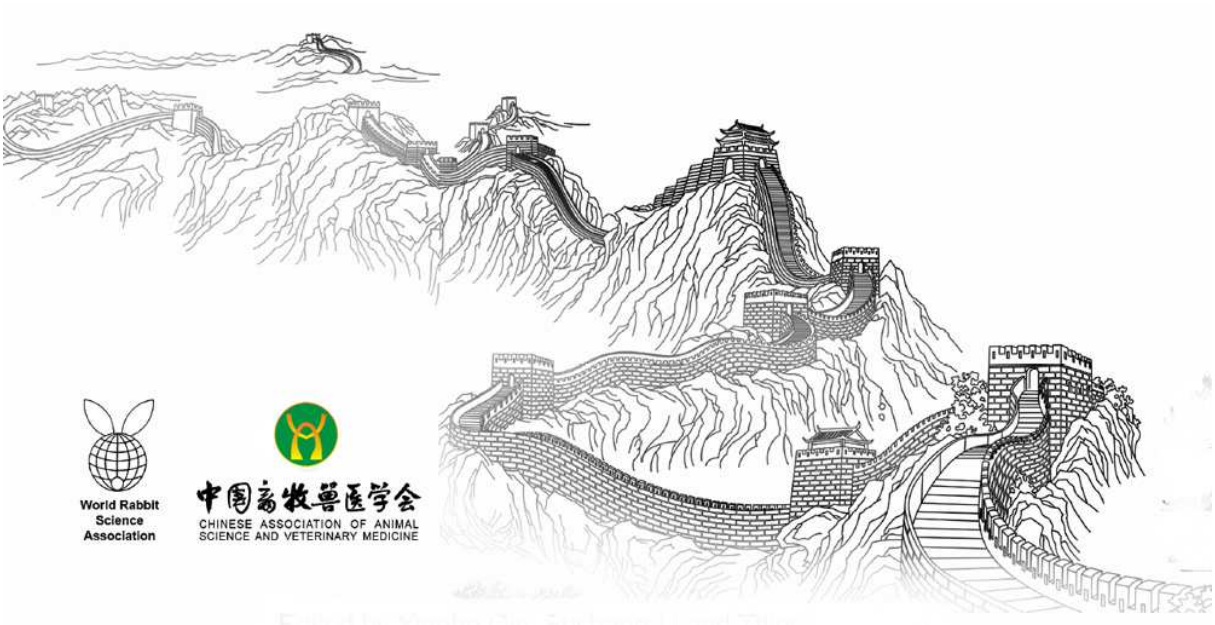

ONE WEEK FEED RESTRICTION IN EARLY WEANED RABBITS: 2- SLAUGHTER PARAMETERS AND MUSCLE FIBRE CHARACTERISTICS

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ABSTRACT

The objective of present study was to evaluate the effect of one week feed restriction with two intensities on dressing out percentage, meat tenderness, cooking loss and muscle fibre characteristics in growing rabbits. Rabbits early weaned at 25 days of age (n=96) were divided into three groups: rabbits fed *ad libitum* (AL), rabbits restricted on 50 g of feed per rabbits per day (R50) and restricted on 65 g of feed per rabbit per day (R65). The period of trial lasted from 25 to 81 days with feed restriction realised from 32 to 39 days of age. Feed restriction did not affect dressing out percentage, loin percentage, meat tenderness and cooking loss. The significant interaction of feeding regime and age was detected in fibre cross sectional area of βR and αW fibres. Group R50 had the smaller (P≤0.001) area of βR fibres at 39 and also at 81 days of age than R65 or AL groups. The largest (P≤0.001) area of αW muscle fibres was observed in R65 group at 81 days of age compared to AL and R50. Fibre type distribution was not affected by feeding regime.

Key words: Rabbit, feed restriction, early weaning, meat quality, muscle fibre.

INTRODUCTION

Early weaning of rabbits and thus the higher feed intake of solid feed in earlier period is one of possibilities how to reduce digestive problems in rabbits during fattening (Maertens and De Groote, 1990). Feed restriction prevents digestive disorders in growing rabbits after weaning. Limited feed intake decreases fat in carcass and improves feed efficiency (Di Meo et al. 2007; Gondret et al., 2000; Gidenne et al. 2009, 2012), but in some cases reduces live weight (Gondret et al., 2000). Gidenne et al. (2009) observed decreasing slaughter weight about 4.5 g per each percentage of feed restriction.

Together with the influence of feed restriction on live weight, meat quality can be affected. From meat quality characteristics, meat tenderness is the most important for consumers. Carrilho et al. (2009) did not find differences between meat tenderness of restricted and *ad libitum* fed rabbits. Meat tenderness depends on structure of muscles from which fibre cross sectional area (CSA) and fibre type distribution are the most important factors. Dalle Zotte and Ouhayoun (1998) and Gondret et al. (2000) did not observe the significant differences in CSA and muscle fibre type distribution between restricted and *ad libitum* fed rabbits. Similarly Chodova et al. (2012) did not detect the effect of feed restriction on CSA of all types of muscle fibres, but percentage of muscle fibres was significantly higher in αW and lower in αR fibres in restricted rabbits compared to the *ad libitum* fed ones. No data of meat quality or muscle fibre characteristics affected by feeding regime in early weaned rabbits have been published yet.

The objective of present study was to evaluate the effect of one week intensive feed restriction with different intensity on dressing out percentage, meat tenderness, cooking loss and muscle fibre characteristics in early weaned growing rabbits.

MATERIALS AND METHODS

Animals and experimental design

In the experiment, 96 Hyplus rabbits were used. Rabbits were weaned at 25 days of age and were housed in cages for 4 rabbits (0.12 m^2 per rabbit). The groups were balanced for initial live weight. Rabbits were divided into 3 groups (8 cages of four rabbits per group): control group fed *ad libitum* (AL), restricted rabbits with feeding reduced 50 g per rabbit per day (R50) and restricted rabbits fed 65 g per rabbit per day (R65). The period of trial lasted from 25 to 81 days and feed restriction was applied from 32 to 39 days of age in both restricted groups. Before and following feed restriction rabbits were fed *ad libitum.* Water was available *ad libitum* throughout whole experiment. The commercial pelleted diet for growing rabbits had following composition: 17.1% crude protein, 20.7% crude fibre and 2.8% ether extract. During the whole experiment the temperature of 15 – 17°C, relative humidity of 55 – 60% and a twelve hour photoperiod were maintained. Eight rabbits per treatment were selected for slaughtering according to average live weight at 39 and 81 days of age. The carcass analysis was harmonised by method of Blasco and Ouhayoun (1996).

Selected physical meat characteristics and histochemical analyses

Meat tenderness was measured in the *Longissimus lumborum* muscle (LL) by the Warner-Bratzler method. The LL after dissection was frozen to –20 °C. Before analysis, the samples were defrosted at 4 °C for 24 hours, packaged in zip ties plastic bags and heated in a water bath at 75 °C for 1 hour. Cooled meat samples were cut parallel to the muscle fibres into 2×1 cm^2 cuboids. Meat tenderness was measured using an Instron Model 3342 (Instron, Norwood, USA) with a Warner-Bratzler shear blade with a triangular hole as a maximum shear force. The load cell was 20 N with a crosshead speed of 100 mm/min. The cooking loss was calculated from the difference between the weights of the raw and cooked samples.
For determination of histochemical parameters, the samples of LL were collected immediately after slaughtering. The samples were frozen in 2-methylbutane cooled by liquid nitrogen (–156°C) and stored at –80°C until histochemical analysis. For each sample, cross sections with a thickness 12 μm were cut at –20°C using Leica CM 1850 (Leica Microsystems Nussloch GmbH, Nussloch, Germany). Each section was stained according to methodology by Brooke and Kaiser (1970). Computerised image analysis NIS Elements AR 3.1 (Nikon, Tokio, Japan) was used to type muscle fibres according to nomenclature of Ashmore and Doerr (1971) as βR, αR and αW and determining the number of muscle fibres per 1 mm^2 and fibre cross sectional area (CSA). Subsequently the fibre type distribution was calculated.

Statistical Analysis

Data were processed by two-way analysis of variance (treatment and age interaction) using ANOVA procedure (SAS Institute Inc, 2003). P-value $P \leq 0.05$ was considered significant for all measurements.

RESULTS AND DISCUSSION

The dressing out percentage (Table 1) was not affected by interaction of feeding regime and age or by feeding regime, which corresponds with the data of Tůmová et al. (2006).

Table 1: The effect of feed restriction on carcass and meat quality characteristics

Group	Age (days)	Live weight (g)	Dressing out percentage (%)	Loin percentage (%)	Maximum shear force (N)	Cooking loss (%)
AL	39	1291.1[b]	53.47	14.97	31.23	38.51
	81	2856.5[a]	60.07	17.71	30.89	29.30
R50	39	988.6[c]	54.82	14.55	28.72	39.53
	81	2902.8[a]	60.22	17.97	32.72	28.13
R65	39	1043.4[c]	55.00	15.17	33.74	39.52
	81	2969.5[a]	60.47	18.36	35.17	29.14
RMSE		148.4	1.78	1.54	10.42	1.53
Significance						
Group		0.062	0.283	0.611	0.082	0.608
Age		<0.001	<0.001	<0.001	0.260	<0.001
Group×age		0.002	0.570	0.820	0.491	0.141

Means with different letters on the same column differ significantly ($P \leq 0.05$)
RMSE – root mean square error; AL – *ad libitum*; R50 – 50 g of feed per rabbit per day; R65 – 65 g of feed per rabbit per day

On the other hand Gondret et al. (2000) and Gidenne et al. (2009) found lower dressing out percentage in restricted rabbits. Inconsistent results can be due to different period of feed restriction or by combination of early weaning and feed restriction. The loin percentage was not significantly affected by feeding regime or by interaction of feeding regime and age and corresponds with Tůmová et al. (2006) who did not find the effect of one week restriction on loin percentage. In agreement with Carrilho et al. (2009) feed restriction did not affect maximum shear force. Similarly, there was no effect of feeding regime on cooking loss which corresponds with observations of Gidenne et al. (2009).

Table 2: The effect of feed restriction on histological characteristics of *musculus longissimus lumborum*

Group	Age (days)	Number of muscle fibres per 1 mm^2			Fibre cross sectional area (μm^2)			Fibre type distribution (%)		
		βR	αR	αW	βR	αR	αW	βR	αR	αW
AL	39	24.0	111.5	513.0	670^{c}	598	1371^{c}	3.4	17.4	79.2
	81	6.0	24.0	279.0	1846^{a}	1322	2747^{b}	2.3	8.0	89.8
R50	39	27.5	127.0	613.5	624^{c}	555	1232^{d}	3.5	16.8	79.7
	81	7.5	24.0	273.5	1246^{b}	1206	2669^{b}	2.3	7.7	90.0
R65	39	25.1	106.9	561.7	681^{c}	587	1298^{cd}	3.9	15.5	80.3
	81	9.0	24.5	229.0	1612^{a}	1369	3064^{a}	3.9	9.1	87.0
RMSE		15.4	24.8	113.5	340	323	996	2.6	3.6	4.2
Significance										
Group		0.899	0.370	0.312	0.002	<0.001	<0.001	0.434	0.886	0.805
Age		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.292	<0.001	<0.001
Group×age		0.941	0.485	0.350	0.001	0.237	<0.001	0.772	0.435	0.355

Means with different letters on the same column differ significantly (P≤0.05)
RMSE – root mean square error; AL – *ad libitum*; R50 – 50 g of feed per rabbit per day; R65 – 65 g of feed per rabbit per day

There were no significant differences between number of muscle fibres of individual types in restricted and *ad libitum* fed rabbits (Table 2). However, the number of muscle fibres regardless of the type significantly decreased with advancing age (P≤0.001), which is connected with increasing area of muscle fibres. The significant interaction of feeding regime and age of the CSA of βR fibres (P≤0.001) showed no differences between groups at 39 days, however, at 81 days group R50 had significantly smaller area of βR muscle fibres in comparison with AL or R65 rabbits. Similar results were detected in the CSA αW muscle fibres where immmediately after feed restriction at 32 days both restricted groups had smaller (P≤0.001) CSA than AL rabbits and at 81 days of age the R65 group had the significantly largest area of glycolytic muscle fibres, while R50 group did not differ from AL. It corresponds with Dalle Zotte and Ouhayoun (1998) who observed reduction of CSA of βR muscle fibres in restricted rabbits compared to AL, but these authors found in restricted rabbits also smaller CSA of αR and αW fibres in LL. On the other hand, there was not described the effect of feed restriction applied one week after normal weaning on the CSA of all types muscle fibres (Chodova et al., 2012). The fibre type distribution was not significantly affected by interaction of treatment and age or by feeding regime alone. These results are in agreement with Gondret et al. (2000) who did not find the differences between restricted and *ad libitum* fed rabbits. On the other hand, Dalle Zotte et al. (2005) and Chodova et al. (2012) found lower percentage of αR muscle fibres in restricted rabbits.

CONCLUSIONS

The results showed that one week feed restriction in early weaned rabbits did not affect the dressing out, loin percentage, meat tenderness or cooking loss. In the current study, interaction between group and age revealed modifications in CSA of βR and αW muscle fibres depending on intensity of feed restriction. Feed restriction of early weaned rabbits did not have effect on muscle fibre type distribution.

ACKNOWLEDGEMENTS

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ONE WEEK FEED RESTRICTION IN EARLY WEANED RABBITS: SELECTED SLAUGHTER PARAMETERS AND MUSCLE FIBRE CHARACTERISTICS

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The Message

- Feed restriction with different intensity in early weaned rabbits
- No effect of feed restriction on selected meat quality characteristics
- Modifications in cross sectional area of βR and αW muscle fibres

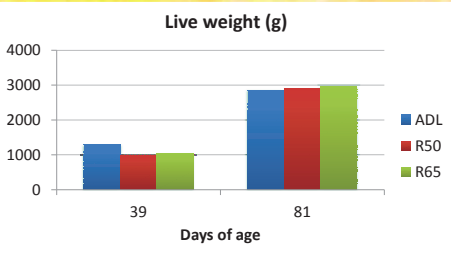
Introduction

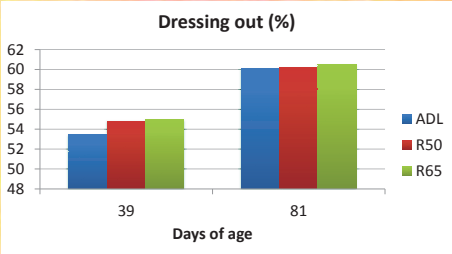
Early weaning of rabbits and thus the higher feed intake of solid feed in earlier period is one of possibilities how to reduce digestive problems in rabbits during fattening (Maertens and De Groote, 1990). Feed restriction prevents digestive disorders in growing rabbits after weaning, decreases fat in carcass and improves feed efficiency (Gidenne et al., 2009, 2012), but in some cases reduces live weight (Gondret et al., 2000). Together with the influence of feed restriction on live weight, meat quality can be affected.

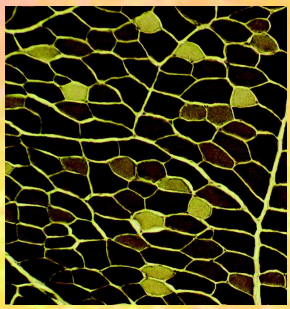
Methods

- 96 Hyplus rabbits weaned at 25 days of age and housed in cages for 4 rabbits (0.12 m^2 per rabbit)
- **Three groups:** - control group fed *ad libitum* (AL)
  - restricted rabbits with feeding reduced 50 g per rabbit per day from 32 to 39 days of age (R50)
  - restricted rabbits fed 65 g per rabbit per day from 32 to 39 days of age (R65)
- **Composition of commercial pelleted diet:** 17.1% crude protein, 20.7% crude fibre and 2.8% ether extract
- **Microclimate:** temperature of 15 – 17°C, relative humidity of 55 – 60% and a twelve hour photoperiod
- **Slaughtering:** 8 rabbits per group according to average live weight at 39 and 81 days of age
- **Meat tenderness:** measured in the *Longissimus lumborum* muscle (LL) cooked samples (75°C for 1 h) by the Warner-Bratzler method using an Instron Model 3342 (Instron, Norwood, USA)
- **Cooking loss:** calculated from the difference between the weights of the raw and cooked samples
- **Histology:** - LL samples frozen in 2-methylbutane cooled by liquid nitrogen (–156°C) and stored at –80°C.
  - Cross sections (12 µm thickness) were cut at –20°C using Leica CM 1850 (Leica Microsystems Nussloch GmbH, Nussloch, Germany)
  - Staining according to methodology by Brooke and Kaiser (1970), nomenclature Ashmore and Doerr (1971)
  - Determining muscle fibre characteristics: computerised image analysis NIS Elements AR 3.1 (Nikon, Tokio, Japan)
- **Statistical Analysis:** two-way analysis of variance (treatment and age interaction), ANOVA procedure (SAS Institute Inc, 2003)

Results







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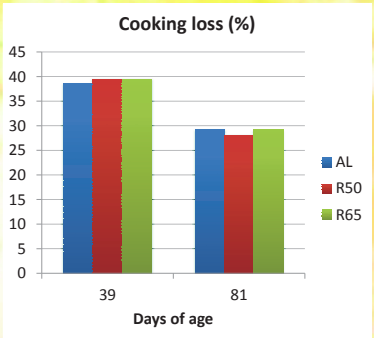
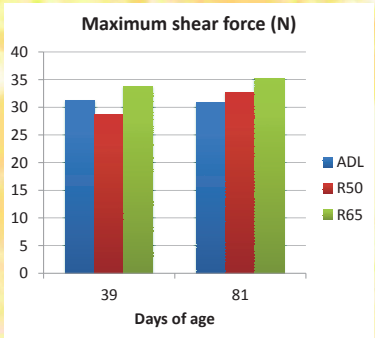
^{a,b,c,d} P ≤ 0.05, RMSE – root mean square error, AL: *ad libitum*; R50: 50 g of feed per day and rabbit; R65: 65 g feed per day and rabbit





Conclusion

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