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Effect of Sex on Carcass and Meat Characteristics of New Zealand White Rabbits Aged 11 Weeks

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ABSTRACT : This experiment was conducted to determine and compare some characteristics of the meat and carcass of rabbits aged 11 weeks according to sex. In the experiment thirty male and thirty female New Zealand White rabbits were slaughtered. The weights and percentages of cold carcasses, skin with head and limbs, liver, kidney, heart, lung, fore legs, hind legs, breast and ribs, loin and abdominal wall were recorded. The values for carcass length, lumbar circumference, pH in the muscles of *Biceps femoris* and *Longissimus dorsi*, meat to bone ratio and cooking loss were also determined. The mean values for cold carcass weight and cold dressing percentage were 832 g and 48.77% in male and 849 g and 48.69% in female, respectively. In this study no significant differences were shown between male and female rabbits in the characteristics of carcass and meat except the value of pH of *Longissimus dorsi* muscle which was markedly higher in males than that in females meat. Slaughter weight was positively correlated with the weights of carcass, skin with head and limbs, lung, liver, kidney, heart and weights of joints ($p<0.01$) and dressing percentage ($p<0.05$). (**Key Words :** Rabbit, Carcass Characteristics, Meat Characteristics)

INTRODUCTION

World production of rabbit meat was estimated as 1,141,893 tons in 2005. The largest producer was China (480,000 tons) followed by Italy (225,000 tons), Spain (108,000 tons) and France (87,000 tons). However rabbit meat production was found to be very low (35 tons) in Turkey (Faostat, 2006).

Rabbit meat products can be evaluated according to carcass quality and to meat quality as for other livestock. Carcass quality has to satisfy economic objectives, such as saleable meat yield and attractiveness to consumer (Dalle Zotte, 2002). The dressing percentage is a very important economic variable in the rabbit market. Some combinations of measurements such as retail cut weights or length measurements are necessary to predict lean percentage in the carcass. Moreover, commercial cutting techniques are easier to carry out than the determination of total lean content in the carcass (Fernandez and Fraga, 1996). Information on carcass characteristics is therefore helpful for the effective utilisation of rabbit meat. New Zealand White Rabbit is the best meat type breed due to both husbandry and processor preference. This breed has the best size, growth rates, feed conversion ratios, dress-out weights and meat-to-bone ratios (Damron, 2003).

Carcass and meat quality changes markedly with the animal's age or slaughter weight (Dalle Zotte, 2002). These quality characteristics may also be affected by sex to different extent (Cavani et al., 2000). In the study of Akıncı et al. (1998), carcass quality characteristics of New Zealand White and California rabbits were found to be significantly affected by age ($p<0.01$) but not affected by sex. Relatively few studies have been made comparing the quality of the carcass and meat quality in sexes of rabbit. The purpose of this paper is to determine and compare the quality of the meat and carcass in sexes of New Zealand Rabbits aged 11 weeks according to sex.

MATERIALS AND METHODS

Animals and carcass quality variables

Thirty male and thirty female New Zealand White rabbits fed a pelleted diet (17.70% CP, 12.13 MJ/kg DE) were weighed and slaughtered at 11 weeks of age**.** Slaughtering is conducted by cutting the jugular veins and

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carotid arteries (Deltoro and Lopez, 1985). After the limbs and head were removed, each carcass was skinned, the abdomen opened, gut and internal organs removed. The weights of skin with head and limbs, liver, kidney, heart and lung were recorded. These weights were expressed as percentage of slaughter weight. The carcasses were stored at 4°C for 20 h by hanging. Cold carcass weights were recorded. Cold dressing percentage was calculated as the ratio (×100) between cold carcass weight and slaughter weight. The length of the carcass was obtained as the sum of two measurements: from the atlas vertebra to the 7th lumbar vertebra and from the 7th lumbar vertebra to the ischium insertion point. The lumbar circumference was measured at the level of the 7th lumbar vertebra, including abdominal wall (Fernandez and Fraga, 1996). Thereafter, the carcass was divided to determine the weights of joints (Mcnitt et al., 1996). The fore legs, hind legs, breast and ribs, loin and abdominal wall were weighed. Their weights were expressed as percentage of cold carcass weight. A hind leg was dissected to find its meat/bone ratio (Pla et al., 1998).

Meat quality variables

The pH of the *Biceps femoris* muscle and the pH of the *Longissimus dorsi* muscle at the level of the 5th lumbar vertebra in the carcass was measured with an Orion pH meter (Orion Research Incorporated, Boston, USA) using a combined electrode penetrating 3 mm (Pla et al., 1998). Cooking loss (CL) was determined by cooking the *Longissimus dorsi* muscle (28-30 g) in an electric oven at 200°C for 30 min and weighing it 30 min later. CL is the ratio (×100) of the difference in weight between the cooked and raw muscle relative to the weight of the raw muscle (Pla et al., 1998).

Statistical analyses

Data were analysed using SPSS for windows (SPSS Inc., Chicago, IL, USA). Parameters were given as mean and standard error. We studied differences in parameters between male and female rabbits using Student t tests. Correlation coefficients between parameters were calculated (Dawson and Trapp, 2001).

RESULTS AND DISCUSSION

The mean values of the carcass and meat characteristics of New Zealand White rabbits and the correlation coefficients between some of these characteristics are presented in Table 1 and Table 2, respectively. The mean slaughter weight of male was 1,705 g, while it was 1,740 g

Table 1. The values for the mean and standard error of the carcass and meat characteristics of rabbits

Characteristics	Overall	Male	Female
Slaughter weight (g)	1,722 (17)	1,705 (26)	1,740 (23)
Cold carcass weight (g)	841 (13)	832 (18)	849 (19)
Cold carcass percentage (%)	48.73 (0.45)	48.77 (0.60)	48.69 (0.69)
Skin with head and limbs weight (g)	364.9 (5.5)	364.7 (8.2)	365.2 (7.3)
Head, skin and limbs percentage (%)	21.17 (0.20)	21.37 (0.30)	20.97 (0.26)
Lung weight (g)	8.45 (0.14)	8.50 (0.19)	8.40 (0.20)
Lung percentage (%)	0.49 (0.01)	0.50 (0.01)	0.48 (0.01)
Liver weight (g)	54.80 (0.67)	55.02 (1.07)	54.58 (0.82)
Liver percentage (%)	3.19 (0.03)	3.23 (0.05)	3.14 (0.04)
Kidney weight (g)	10.16 (0.17)	10.07 (0.24)	10.26 (0.24)
Kidney percentage (%)	0.59 (0.01)	0.59 (0.01)	0.59 (0.01)
Heart weight (g)	5.87 (0.12)	5.91 (0.15)	5.84 (0.20)
Heart percentage (%)	0.34 (0.01)	0.35 (0.01)	0.34 (0.01)
Carcass length (cm)	31.51 (0.55)	31.19 (0.76)	31.84 (0.81)
Lumbar circumference length (cm)	20.53 (0.34)	20.62 (0.50)	20.44 (0.46)
Hind legs weight (g)	308.6 (4.9)	304.5 (6.9)	312.7 (6.9)
Hind legs percentage (%)	36.72 (0.16)	36.57 (0.20)	36.87 (0.25)
Fore legs weight (g)	124.0 (2.2)	123.2 (3.4)	124.8 (3.0)
Fore legs percentage (%)	14.74 (0.12)	14.77 (0.18)	14.72 (0.16)
Breast and ribs weight (g)	196.6 (4.1)	193.4 (5.7)	199.9 (5.9)
Breast and ribs percentage (%)	23.40 (0.31)	23.18 (0.37)	23.61 (0.51)
Loin and abdominal wall weight (g)	196.9 (5.2)	193.9 (6.4)	199.9 (8.2)
Loin and abdominal wall percentage (%)	23.34 (0.44)	23.28 (0.61)	23.39 (0.64)
pH of the *Longissimus dorsi* muscle *	5.59 (0.02)	5.64 (0.02)	5.54 (0.04)
pH of the *Biceps femoris* muscle	5.73 (0.02)	5.74 (0.04)	5.72 (0.02)
Meat/bone ratio from a dissected hind leg	5.29 (0.10)	5.30 (0.12)	5.28 (0.15)
Cooking loss of the *Longissimus dorsi* muscle (%)	38.73 (0.45)	39.31 (0.58)	38.14 (0.68)

* $p<0.05$.

Table 2. Correlation coefficients among some carcass and meat characteristics

	CCW	CDP	HSLW	LuW	LiW	KiW	HeW	CaL	LuCL	HLW	FLW	BRW	LAW	pHLD	pHBF	M/B	CL
SW	0.81**	0.27*	0.78**	0.43**	0.64**	0.78**	0.46**	0.17	0.14	0.83**	0.75**	0.74**	0.39**	-0.20	-0.12	-0.12	-0.23
CCW		0.78**	0.61**	0.26*	0.48**	0.77**	0.37**	0.45**	-0.06	0.97**	0.90**	0.74**	0.73**	-0.04	-0.03	-0.24	-0.28*
CDP			0.16	-0.04	0.11	0.45**	0.12	0.58**	-0.25	0.70**	0.69**	0.43**	0.79**	0.14	0.08	-0.29*	-0.22
HSLW				0.48**	0.56**	0.51**	0.45**	-0.15	0.49**	0.63**	0.49**	0.83**	0.06	-0.19	-0.24	0.18	-0.07
LuW					0.37**	0.26*	0.35**	-0.27*	0.47**	0.35**	0.20	0.35**	-0.03	-0.04	0.02	0.22	0.10
LiW						0.51**	0.30*	-0.03	0.37**	0.48**	0.39**	0.47**	0.13	-0.12	-0.16	0.13	-0.05
KiW							0.28*	0.50**	-0.17	0.75**	0.74**	0.51**	0.58**	-0.18	-0.08	-0.41**	-0.29*
HeW								0.03	0.27*	0.39**	0.26*	0.36**	0.17	0.01	-0.11	0.19	-0.02
CaL									-0.65**	0.35**	0.52**	-0.03	0.78**	0.09	0.17	-0.70**	-0.38**
LuCL										-0.02	-0.17	0.37**	-0.50**	-0.03	-0.17	0.64**	0.34**
HLW											0.87**	0.76**	0.64**	-0.02	-0.03	-0.21	-0.29*
FLW												0.60**	0.67**	0.09	0.03	-0.33*	-0.30*
BRW													0.18	-0.17	-0.15	0.12	-0.19
LAW														-0.01	0.10	-0.55**	-0.29*
pHLD															0.46**	-0.09	0.11
pHBF																-0.26*	0.02
M/B																	0.26*

* $p<0.05$, ** $p<0.01$.

SW = Slaughter weight; CCW = Cold carcass weight; CDP = Cold dressing percentage; HSLW = Skin with head and limbs weight; LuW = Lung weight; LiW = Liver weight; KiW = Kidney weight; HeW = Heart weight; CaL = Carcass length; LuCL = Lumbar circumference length; HLW = Hind legs weight; FLW = Fore legs weight; BRW = Breast and ribs weight; LAW = Loin and abdominal wall weight; pHLD = pH of the *Longissimus dorsi* muscle; pHBF = pH of the *Biceps femoris* muscle; M/B = Meat/bone ratio from a dissected hind leg; CL = Cooking loss of the *Longissimus dorsi* muscle.

for female rabbit at 11 weeks. The cold dressing percentages were 48.77 and 48.69% for male and female rabbits, respectively.

The mean values for slaughter weight, carcass weights and dressing percentages obtained in the present study were similar to those described by some researchers (Balogun and Etukude, 1991; Yalçın et al., 2001), and lower than those reported by others (Lukefahr et al., 1989; Skrivanova et al., 1999; Piles et al., 2000; Dal Bosco et al., 2002; Trocino et al., 2002). These differences might be due to the slaughter age, breeding, weaning age and feeding conditions (Deltoro and Lopez, 1986; Fernandez and Fraga, 1996). Slaughter weight and carcass weights were slightly lower and dressing percentages were higher in males than that in females, but these differences were not significant in the present study. Similarly Trocino et al. (2002) also reported that females showed higher live weight ($p<0.05$) but lower dressing percentage ($p<0.01$) due to the higher incidence of the gut content. In contrast, according to the results of Pla and Cervera (1997) dressing yield was lower for males than for females. Slaughter weight was related to carcass weight ($r = 0.81$, $p<0.01$) and dressing percentage ($r = 0.27$; $p<0.05$) significantly (Table 2).

The mean of liver weight per 100 g live weight in the present study was similar with previous studies (Chiericato and Filotto, 1989; Iyayi and Ngodigha, 1991; Gupta and Atreja, 1998; Yalçın et al., 2003). The percentage values of heart weight were consistent with those of Chiericato and Filotto (1989) and Yalçın et al. (2003) obtained with New Zealand White rabbits. The mean values of kidney percentage in this experiment were similar with the study of Yalçın et al. (2003), but lower than those found in the previous experiments with rabbits (Chiericato and Filotto, 1989; Fernandez and Fraga, 1996; Gupta and Atreja, 1998). The breed, age or weight of the rabbits used in experiments might create the differences in the percentages of liver, kidney and heart. There were no significant differences in female and male for the weights and the percentages of these traits. Similar results were obtained by Akıncı et al. (1998) and Piles et al. (2000). The weights of skin with head and limbs, lung, liver, kidney and heart were correlated positively with slaughter weight and carcass weight (Table 2).

The values for carcass length were smaller and lumbar circumference values were larger than those of some researchers (Fernandez and Fraga, 1996; Dal Bosco et al., 2002). Carcass length was correlated ($p<0.01$) positively with carcass weight and dressing percentages and negatively with lumbar circumference. According to the results obtained by Fernandez and Fraga (1996), lumbar circumference and carcass lengths increased with slaughter weight. However in the present study low correlation coefficients were obtained between slaughter weight and these carcass measurements. No differences in these measurements between males and females were found in the present study.

The percentage values of the fore legs and hind legs were in agreement with those reported by some researchers (Pla et al., 1998; Piles et al., 2000; Yalçın et al., 2003). The results for the percentage values of loin and abdominal wall were similar to those obtained in other experiments with New Zealand White rabbits (Deltoro and Lopez, 1986; Chiericato and Filotto, 1989). The weights of the fore legs, hind legs, breast and ribs, loin and abdominal wall were correlated positively ($p<0.01$) with slaughter weight, carcass weight and dressing percentage. However the values for the percentages of breast and ribs, fore legs and hind legs were higher than the results of Deltoro and Lopez

(1986). There were no differences between female and male in the weight and percentages of these carcass traits. In other experiments no differences between sexes were observed in the percentages of hind legs (Deltoro and Lopez, 1986; Piles et al., 2000; Trocino et al., 2002), fore legs (Piles et al., 2000). Deltoro and Lopez (1986) found significant differences between sexes for the percentages of breast and ribs, abdominal wall and fore legs, however, these differences were very small (not exceeding 0.5%) and probably would not have any economic significance.

The pH of the *Biceps femoris* muscle was higher than that of the *Longissimus dorsi* muscle in this study because it corresponds to a more oxidizable muscle (Ouhayoun and Delmas, 1988; Pla et al., 1998). The pH values of meat were similar to those reported in other works (Pla and Cervera, 1997; Hernandez et al., 1998; Pla et al., 1998; Trocino et al., 2002). The pH for males was higher than for females in the *Longissimus dorsi* muscle ($p<0.05$) in the present study as also shown by some researchers (Pla and Cervera, 1997; Pla et al., 1998).

Meat to bone ratio of the hind leg is the best predictor for the meat to bone ratio of the carcass (Hernandez et al., 1996). The values of meat to bone ratio were similar to that of Dal Bosco et al. (2002) and higher than those found from other experiments (Lukefahr et al., 1989; Pla and Cervera, 1997; Pla et al., 1998; Trocino et al., 2002). No differences were measured between sexes for the values of meat to bone ratio in this study. These results were in agreement with the results of some researchers (Pla and Cervera, 1997; Piles et al., 2000; Trocino et al., 2002). In the present study meat to bone ratio of the dissected hind leg was positively correlated with lumbar circumference ($r = 0.64$) and negatively correlated with carcass length ($r = -0.70$) and the weight of loin and abdominal wall ($r = -0.55$).

Cooking losses of the meat were similar to those obtained by Hernandez et al. (1998) and Pla et al. (1998) and higher than those found by some researchers (Pla and Cervera, 1997; Trocino et al., 2002). These differences might be due to the age, slaughter weight of rabbits and cooking techniques of meat. Pla et al. (1998) reported that cooking losses of the meat were higher in the lightest rabbits and smaller in the heaviest. No differences between sexes were observed in this study. This agrees with some researchers (Pla and Cervera, 1997; Pla et al., 1998; Piles et al., 2000; Trocino et al., 2002).

As a result, weights of organs and joints and dressing percentages are found to be lower than experiments made in some countries due to the smaller slaughter weight at 11 weeks of age, in this study. Slaughter weight was positively correlated with the weights of carcass, lung, liver, kidney, heart and weights of joints ($p<0.01$) and dressing percentage ($p<0.05$). To increase the slaughter weight of rabbits, heavier genotypes could be used or the age of slaughter could be delayed. Slaughtering rabbits at heavier weights could increase all of the desirable characteristics such as the weight of joints. No significant differences were found between male and female rabbits in the characteristics of carcass and meat except the value of pH of *Longissimus dorsi* muscle.

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