Preparation Influences of Breed, sex and Sodium Butyrate Supplementation on the Performance, Carcass Traits and Mortality of Fattening Rabbits

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***Abstract*—**Twenty four New Zealand white rabbits (12 does and 12 bucks) and twenty four Flanders (12 does and 12 bucks) rabbits, allotted into two feeding regime (6 for each breed, 3 males and 3 females) first one fed commercial ration and second one fed commercial diet plus sodium butyrate (300 g/ton). The obtained results showed that at end of 8th week experimental period New Zealand white rabbits were heavier body weight than Flanders rabbits (1934.55+39.05 vs. 1802.5+30.99 g); significantly high body weight gain during experimental period especially during 8th week (136.1+3.5 vs. 126.8+1.8 g/week); better feed conversion ratio during all weeks of experiment from first week (3.07+0.16 vs. 3.12+0.10) till the 8th week of experiment (5.54+0.16 vs. 5.76+0.07) with significantly high dressing percentages (0.54+0.01 vs. 0.52+0.01). Also all carcass cuts were significantly high in New Zealand white rabbits than Flanders. Females rabbits (at the same age) were lower body weight than males from start of experiment (941.1+39.8 vs.972.1+33.5 g) till the end of experiment (1833.64+37.69 vs. 1903.41+36.93 g); gained less during all weeks of experiment except during 8th week (132.1+2.3 vs. 130.9+3.4 g/week), with lower dressing percentage (0.52+0.01 vs. 0.53+0.01) and lighter carcass cuts than males, however, they had better feed conversion ratio during 1st week, 7th week and 8th week of experiment. Addition of 300g sodium butyrate/ton of rabbit increased the body weight of rabbits at the end of experimental period (1882.71+26.45 vs. 1851.5+49.82 g); improve body weight gain at 3rd, 4th, 5th, 6th and 7th week of experiment and significantly improve feed conversion ratio during all weeks of the experiment from 1st week (2.85+0.07 vs. 3.30+0.15) till the 8th week of the experiment (5.51+0.12 vs. 5.77+0.12). Also the dressing percentage was higher in Sodium butyrate fed groups than control one (0.53+0.01 vs. 0.52+0.01) and the most important results of feeding sodium butyrate is the reducing of the mortality percentage in rabbits during 8 week experiment to zero percentage as compared with 16% in control group.

***Keywords*—**rabbit, productive performance, carcass quality, sodium byturate

I. Introduction

THE ban on using antibiotic growth promoters in the EU poses a serious challenge for rabbit meat producers. Because of the very complex and peculiar digestion of rabbit (caecotrophy, microbial fermentation), this species is susceptible to enteric diseases, particularly after weaning. Accordingly, there have been several studies with alternatives, i.e. natural feed additives to replace dietary antibiotics.

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These results have recently been summarized [4]. The seriousness of the problem is indicated by the 18-20% mortality rate [13, 12, 1, 15] and 40-55% health risk [27, 26] with antibiotic-free diets despite different natural substitutions under suboptimal conditions. Data for this issue on rabbits are scarce when compared to pigs or poultry [13]. The lack of consistency in the results obtained with additives such as probiotics, prebiotics, enzymes and organic acids can be partly explained by different experimental protocols and hygienic conditions [13]. Studies with complex preparations are useful but explanations of the results can be difficult.

Organic acids have been shown to have beneficial effects on performance. Some (e.g. butyric acid) also decrease the incidence of subclinical necrotic enteritis caused by C. perfringens, an additional beneficial effect which is highly relevant for the poultry industry [24]. Organic acids are widely distributed in nature as normal constituents of plants or animal tissues. They are also formed through microbial fermentation of carbohydrates predominantly in the caeca of poultry [25]. A wide range of organic acids with variable physical and chemical properties exists, of which many are used as drinking water supplements or as feed additives (acidifiers). Many are also available as sodium, potassium or calcium salts (and/or partially esterified). The advantage of salts over acids is that they are generally odorless and easier to handle in the feed manufacturing process owing to their solid and less volatile form. They are also less corrosive and may be more soluble in water [10].

The objectives of the present study were to investigate the effects of supplementing weanling rabbit diet with sodium butyrate on the growth performance, carcass traits, and survivability.

II. Materials and Methods

a. Animals

Twenty four New Zealand white rabbits (12 does and 12 bucks) and twenty four Flander (12 does and 12 bucks) rabbits, two months of age were allotted randomly into eight groups, each group was subdivided into two replicates(n=6)housed in galvanized wire batteries.

b. Experimental work

Experimental work includes two feeding regime; the first was feeding control groups, the animals fed commercial diet contained 2500 Kcal DE /Kg,16% CP and 11.75 % CF and the second groups were fed the same diet in addition to sodium butyrate 300 g/ton of ration. Diets were offered ad libitum twice daily at 8:00 am and 2:00 pm in addition to fresh water was available all time, residues of feed were weighed daily and then subtracted from the offered amounts to obtain the actual accumulated feed consumed per week

Rabbits were individually weighed every week before the morning meal from 8 to 16 weeks of age. At the end of the experimental period (8 weeks), three representative rabbits from each dietary group were randomly taken to study the carcass characteristics. These rabbits were fasted for approximately 18 hours before slaughtering and then individually weighed (Pre-slaughter weight) and slaughtered by severing the neck with a sharp knife according to Islamic religion. The body weight was recorded after complete bleeding to obtain the blood weight. Carcass was eviscerated after skinning and giblets (liver, heart, and kidneys) were separately weighed to determine the dressed weight and the dressed percentage. The blood, viscera, lungs, skin, limbs, and tail were termed as the offal weight.

Growth performance traits estimated were body weight by weekly weighing of rabbits at early morning before receiving any feed or water; weight gain which calculated by subtracting initial weight from final weight at the same period, feed intake and Feed conversion ratio according to (Lambert et al., 1936).

c. Statistical analysis

The data were analyzed by statistical analysis system [23], three way analysis of variance, Proc GLM. The number of animals dead was recorded during the experiment and mortality percentages were analyzed by chi-square analysis, Proc Freq.

III. Results and Discussion

a. Body weight

The mean body weight of New Zealand white rabbits was significantly higher at start of experiment ($P<0.05$) than Flanders (1009.6±41.9 and 930.6±26.5 g, respectively), also during 1st(1113.9±41.3 vs. 1003.2±26.5 g), 2nd(1226.6± 37.8 vs. 1109.3±26.8g), 3rd(1336.6±36.9 vs. 1221.6±26.9g), 4th(1440.9±36.3 vs. 1332.5±27.9g), 5th(1555.6±36.5 vs. 1442.3±28.5g), 6th weeks (1673.4±37.3 vs. 1558.2±30.6), 7th week (1798.4±38.9 vs. 1675.7±30.6g) and 8th week (1934.55+39.05 vs. 1802.5+30.99g). This significant difference in New Zealand breed could rt of experiment ts attributed to high genetic potential and high adaptation of this breed similarly [18] reported that New Zealand White rabbits had favorable direct effects on post-weaning growth and 63-d body weight.

Although females and males were at the same age at the start of experiment females were low body weight than males (941.1+39.8 vs. 972.1+33.5g) and this difference continued during 1st week (1042.9±39.9 vs. 1074.1±32.9g); 2nd week (1254.6±36.3 vs. 1303.6±32.3g); 6th week (1580.9±36.2 vs. 1650.7±34.9g, respectively); 8th week (1833.64 ± 37.69 vs. 1903.41± 36.93g) although however, these differences were of no significant differences attributed to differences in the started body weight. Moreover, the interaction of breed by sex had the same trends where New Zealand White rabbits were heavier than Flanders and males than females (Table 1) this could be attributed to the effect of androgen hormones or testosterones of males which has anabolic effect and so more weight gain.

The addition of Sodium butyrate to ration of rabbits (300 g/ton) improved the body weight of rabbits from the 1stweek (1076.9+29.5 vs. 1036.5+44.4 g) till the end of experiment after 8th week (1882.71+26.45g), although however, the difference was of no significant value, the same trend of the effect of sodium butyrate was obvious in both breeds at the final weight for Flanders (1828.8+29.7 vs. 1771.0+58.6g) and New Zealand White (1936.7+38.0 vs. 1932.0+74.9g) and in males (1932.5+33.2 vs. 1868.5+71.6 g) and in females (1832.9+37.0 vs. 1834.5+72.7 g). Also the same trend was obvious in the interaction of treatment, sex and breeds (Table 1), the improvement in body weight of rabbits by sodium butyrate could be attributed to improvement of surface of absorption of intestinal weight. Similarly, [2] and [9] reported that feeding diet containing both0.15%or 0.30% sodium butyrate in fattening rabbit resulted in heavier live weight.

b. Weight gain

The weight gain data presented in table (2) showed that New Zealand White rabbits were higher weight gain after 1st week (104.3+5.2 vs. 99.6+2.3 g/week), 2nd week (112.7+8.4 vs. 101.1+4.5 g/week); 5th week (114.7+4.6 vs. 115.9+4.1 g/week); 7th week (125.0+2.8 vs. 117.5+3.1 g/week) and significantly weight gain were during the 8th week (136.1+3.5 vs. 126.8+1.8 g/week). This could be attributed to genetic makeup of the New Zealand White rabbits, in addition, organic acids, like antibiotics, are more growth permitting than growth promoting in the sense that they can only permit the animal to grow to its genetic potential given the diet it is fed. The closer the animals are to their genetic potential, the more difficult it will be to detect any effect [3].

Variations in body weight gains between different sexes of rabbits presented in Table (2) showed that males gained more than females during 1st week (102.1+3.3 vs. 101.8+4.7 g/week), 2nd week (116.1+4.9 vs. 102.7+7.9g/week), 3rd week (110.2+2.9 vs. 105.8+1.9 g/week), 6th week (119.2+4.2 vs. 114.6+3.7 g/week), 7th week (121.8+2.7 vs. 120.7+3.3 g/week) while during 8th week female gained more than males (132.1+2.3 vs. 130.9+3.4 g/week), the weight gain of males could be attributed to androgen hormones which has anabolic effect. The same trend was observed in the interaction between the breed and sex with no significant differences which could be attributed to low number of animals in experiment.

Dietary sodium butyrate improved rabbits' weight gain from the 5th week of experiment (115.8+5.3 vs. 109+1.3 g/week),6th week (122.5+5.6 vs. 112.2+1.8 g/week) and 7th week (123.3+3.9 vs. 119.6+2.1g/week), although however, at the start Moreover, the interaction between main effects followed the same trend of the trend of the main effect where New Zealand White gained more than Flanders, females than males except last week and sodium butyrate groups than control one (Table 2), the growth–enhancing effects of dietary organic acid salt acts directly on the immune system of the body using old age in this experiment and also the effect of the additives become apparent when rabbits are subjected to suboptimal conditions such as a less digestible diet or a less clean environment. Similarly [16] reported that feeding sodium butyrate at 3 g/kg DM intake to piglets in the first 8weeks after weaning improved the average daily gain and with no significant effect on weight gain in poultry [5].The benefits of their use, were primarily associated with changes in the gastrointestinal micro flora [19]. On the same concept, [20] mentioned that there were significant decrease (P<0.05) in number of microbial colonies when the dietary organic acid were added to the diets. The effect of organic acids addition would appear to be greater on coliform numbers than lactic acid bacteria numbers.

c. Feed conversion ratio (FCR)

Feed conversion ratio of New Zealand White rabbits was better than those of Flanders during 1st week (3.07+0.16 vs. 3.12+0.10); 2nd week (3.17+0.11 vs.3.40+0.13); 5th week (3.91+0.13 vs. 3.93+0.10); 7th week (5.38+0.16 vs. 5.56+0.14) and 8th week (5.54+0.16 vs. 5.76+0.07, respectively).

The female feed conversion ratio were better than males during 1st week of experiment (3.03+0.13 vs. 3.16+0.13) and 8th week of experiment (5.48+0.11 vs. 5.82+0.13), while males were better than females with significant difference during the 5th week of experiment (3.70+0.11 vs. 4.14+0.10). Similarly, the interaction between sex and breed showed nearly the same trend of the main effect (Table 3).

Feeding Sodium butyrate (30g/ton) for rabbits did improve significantly feed conversion ratio during 1st week of experiment (2.85±0.07 vs. 3.30±0.15); 2nd week, (2.89 ±0.11 vs. 3.62±0.15); 3rd week (2.94±0.09 vs. 3.63± 0.09); 4th week (3.42±0.13 vs. 3.94±0.13); 5th week (3.63±0.12 vs. 4.16± 0.07); 6th week (4.64±0.2 vs. 5.25±0.08); 7th week (5.20±0.14 vs. 5.69±0.14) and 8th week (5.51+0.12 vs. 5.77+0.12). This could be attributed to improvement of absorption of food from intestine by improvement of the development of intestinal villi and so surface of absorption, similarly, [9] reported that Sodium butyrate supplementation significantly (P<0.05) improved feed conversion and feed efficiency. The interaction between the treatment with breed or sex follow the same trends of the main effects with improvement of feed conversion ratio for males than females, New Zealand than Flanders and Sodium butyrate fed rabbits than control one where the benefit effect of growth promoter substances, such as antibiotics on the performance is related to a more efficient use of nutrients which results in an improved feed conversion ratio [11], this effect was also observed in birds fed formic acid diets [6].

d. Carcass traits

New Zealand White rabbits had significantly heavier (P<0.05) carcass weights (1094.17±35.38g) than Flanders breed (976.67±24.15 g); forequarter (345.76±11.18 vs. 308.63±7.63g); loins (273.54±8.84 vs. 244.17±6.04g); hindquarters (470.49±15.21 vs. 419.97±10.38g) and total giblets (liver, kidney, heart and spleen) (87.53± 2.83 vs. 78.13 ±1.93g). Moreover, breed showed highly significant difference on dressing percentage in rabbits, where New Zealand White breed had the highest significant percentage (0.54±0.01) than Flanders (0.52±0.01).

Males were higher carcass weights than females (1042.5±27.61 vs.1028.33±41.12g); Forequarters (329.43±8.72 vs.324.95±12.99g), loins (260.63±6.9 vs. 257.08±10.28g), hindquarters (448.28±11.87 vs. 442.18±17.27 g,) and total giblets (liver, kidney, heart and spleen) (83.4±2.21 vs. 82.27±3.29g) and dressing percentage (0.53±0.01 vs. 0.52±0.01).

Feeding sodium butyrate to rabbits resulted in heavier carcass weights (1071.25±32.63 vs.999.58±34.11g, respectively), Forequarters (338.52±10.31 vs. 315.87±10.78g, respectively), loins (267.81±8.16 vs. 315.87±10.78g, respectively), hindquarters (460.64±14.03 vs. 429.82±14.67g, respectively), and total giblets (liver, kidney, heart and spleen) (85.7±2.61 vs. 429.82±14.67g, respectively). Moreover, the interaction between treatment, sex, and breeds showed the same trend (table 4). Also dressing percentage were higher in Sodium butyrate fed rabbits (0.53+0.01) than those in control group (0.52+0.01), similarly, [2] who studied the dietary supplementation of butyrate in fattening rabbits and found that average live weight and dressing percentage (58.4%) were satisfactory for rabbits aged 70 d. The carcasses showed little fat depots (3.7%) a good muscularity (5.78 muscles to bones ratio of hind leg), with a high overall commercial quality. Similarly, meat traits, pH and color of Biceps femoris and Longissimus dorsi were not affected by dietary treatments.

e. Mortality rate

[8] reported that mortality rate in rabbits was significantly reduced where fumaric acid was combined with Lacto-Sacc, [7] also reported that a mixture of dietary organic acids lowered mortality rates during the first two weeks of the birds life. Short chain fatty acids can act as bactericidal or bacteriostatic as described by [17] in the following steps 1) Undissociated forms can permeabilize and⁄or diffuse across cell membranes of pathogens, destroying their cytoplasm or inhibiting growth (inactivation of bacterial decarboxylases and catalases); 2) Intestinal dissociation liberating H ions and anions serving as a pH barrier against pathogen colonization on the brush border; 3) Lowered gastric pH;4) Gastric hydrolysis liberates H ions activating pepsinogen and inhibiting bacterial growth; and 5) Selective stimulation of the growth of beneficial bacteria.

Our results comes in close accordance with both authors where the data presented in (Table5) showed that feeding rabbits with sodium butyrate reduced mortality rate to zero% in comparing with incidence of mortality in control group (0.16%) however, this difference were non-significant ($\chi 2$=0.2).A group of Czech researchers have been studied intensively the effects of medium-chain fatty acids. In a study of [22], the inclusion of 0,5% of caprylic acid reduced post weaning mortality, without affecting any other performance trait. In a later trial, [22], testing the medium-chain fatty acids esterified in triglycerides, reached the same results, i.e. a significant reduction in post-weaning mortality, no effect on feed intake, daily gain, or carcass yield.

IV. Conclusion

It could be concluded that New Zealand white rabbits were heavier, gained more and had better feed conversion ration with better dressing percentages and carcass traits than Flanders and males were better than females for fattening in all traits of productive performances and carcass traits and feeding sodium butyrate 300/ton of ratio improve all productive traits and carcass traits and very important results were reducing the mortality rate to zero percentage compared with 16% in control group.

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TABLE I
MEANS AND THEIR STANDARD ERRORS OF THE EFFECT OF BREED, SEX AND TREATMENT ON THE BODY WEIGHTS OF RABBITS

Item		Start weight	1st week	2nd week	3rd week	4th week
Breed						
Flanders		930.6± 26.5[b]	1003.2 ±26.5[b]	1109.3 ±26.8	1221.6 ±26.9[b]	1332.5 ±27.9[b]
New Zealand		1009.6 +41.9[a]	1113.9 +41.3[a]	1226.6 +37.8	1336.6 +36.9[a]	1440.9 +36.3[a]
Sex						
Male		972.1± 33.5	1074.1 ±32.9	1190.2 ±32.3	1303.6 ±32.2	1413.9 ±32.8
Female		941.1± 39.8	1042.9 +39.9	1145.7 +37.2	1254.6 +36.3	1359.6 +35.2
Breed*sex						
Flanders	Male	914.1± 30.1	1014.6 ±29.4	1130. 5±30.9	1244.1 ±31.1	1355.9 ±32.8
	Female	893.2± 45.0	991.8± 45.3	1088.2 ±44.4	1199.1 ±44.6	1309.1 ±45.8
New Zealand	Male	1030.0 ±55.9	1133.6 ±54.5	1250.0 ±52.1	1363.2 ±51.2	1471.8 ±52.5
	Female	989.1± 64.6	1094.1 +64.2	1203.2 +56.4	1310.0 +54.1	1410.0 +50.8
Treatment						
	Treated	970.0± 29.5	1076.9 ±29.5	1189.8 ±27.2	1300.6 ±26.7	1408.1 ±26.3
	Control	940.5±	1036.5	1141.8	1253.3	1361.0

			45.0	±44.4	±43.2	±42.8	±42.7
Breed*treatment							
Flanders		Treated	925.8±25.9	1028.3±24.7	1139.2±25.7	1247.5±26.1	1360.8±27.8
		Control	877.0±49.8	973.0±50.2	1073.5±49.5	1190.5±50.3	1298.5±51.4
New Zealand		Treated	1014.1±51.2	1125.4±50.9	1240.4±44.4	1353.8±42.1	1455.4±41.4
		Control	1004.0±72.0	1100.0±70.1	1210.0±66.3	1316.0±65.8	1423.5±64.7
Sex*treatment							
Male		Treated	1012.1±38.9	1115.8±36.3	1232.5±35.3	1347.5±34.8	1457.9±35.6
		Control	924.0±55.3	1024.0±55.8	1139.5±54.8	1251.0±54.6	1361.0±55.5
Female		Treated	927.9±42.5	1037.9±45.1	1147.1±39.0	1253.8±36.9	1358.3±34.3
		Control	957.0±73.7	1049.0±72.0	1144.0±69.8	1255.5±69.0	1361.0±68.0
Breed*sex*treatment							
Flanders	Male	Treated	939.2±33.9	1040.0±29.7	1167.5±30.7	1277.5±30.4	1392.5±34.2
		Control	884.0±53.4	984.0±54.8	1086.0±54.1	1204.0±56.5	1312.0±57.1
	Female	Treated	912.5±41.6	1016.7±41.8	1110.8±40.6	1217.5±41.4	1329.2±42.8
		Control	870.0±91.1	962.0±91.0	1061.0±89.6	1177.0±90.1	1285.0±92.4
New Zealand	Male	Treated	1085.0±58.2	1191.7±51.2	1297.5±53.5	1417.5±49.4	1523.3±51.9
		Control	964.0±100.6	1064.0±100.9	1193.0±95.6	1298.0±95.5	1410.0±96.9
	Female	Treated	943.3±78.3	1059.2±83.9	1183.3±67.3	1290.0±61.2	1387.5±54.9
		Control	1044.0±111.3	1136.0±106.2	1227.0±102.3	1334.0±101.0	1437.0±96.7

CONTINUED TABLE I

Item		5th week	6th week	7th week	8th week
Breed					
Flanders		1442.3±28.5[b]	1558.2±30.6[b]	1675.7±30.6[b]	1802.5±30.99
New Zealand		1555.6±36.5[a]	1673.4±37.3[a]	1798.4±38.9[a]	1934.55±39.05
Sex					
Male		1531.5±33.4	1650.7±34.9	1772.5±36.2	1903.41±36.93
Female		1466.4±35.2	1580.9±36.2	1701.6±37.1	1833.64±37.69
Breed*sex					
Flanders	Male	1466.8±33.5	1583.2±35.5	1700.9±34.6	1829.09±34.59
	Female	1417.7±46.7	1533.2±50.5	1650.5±50.9	1775.91±51.92
New Zealand	Male	1596.2±52.3	1718.2±54.2	1844.1±57.2	1977.73±58.54
	Female	1515.0±50.4	1628.6±49.9	1752.7±51.5	1891.36±51.03
Treatment					
	Treated	1517.4±26.4	1629.6±26.3	1749.2±26.8	1882.71±26.45
	Control	1476.8±43.8	1599.3±46.7	1722.5±48.4	1851.5±49.82
Breed*treatment					
Flanders	Treated	1469.6±28.3	1582.9±28.9	1697.9±30.0	1828.8±29.7
	Control	1409.5±52.8	1528.5±58.3	1649.0±57.7	1771.0±58.6
New Zealand	Treated	1565.3±41.3	1676.3±40.7	1800.4±40.4	1936.7±38.0
	Control	1544.0±65.7	1670.0±68.5	1796.0±73.2	1932.0±74.9
Sex*treatment					
Male	Treated	1569.0±35.5	1680.4±35.3	1800.0±35.0	1932.5±33.2
	Control	1486.5±58.9	1615.0±64.5	1739.5±68.5	1868.5±71.6
Female	Treated	1465.8±34.4	1578.8±34.3	1698.3±36.3	1832.9±37.0
	Control	1467.0±67.9	1583.5±70.7	1705.5±71.6	1834.5±72.7
Breed*sex*treatment					
Flanders	Male	1502.5±34.4	1615.0±36.3	1734.2±34.2	1869.2±32.9
		1424.0±59.5	1545.0±65.5	1661.0±64.1	1781.0±62.4
	Female	1436.7±43.6	1550.8±44.2	1661.7±47.7	1788.3±46.3
		1395.0±94.3	1512.0±104.3	1637.0±103.9	1761.0±107.3
New Zealand	Male	1635.5±50.9	1745.8±49.4	1865.8±50.0	1995.8±46.6
		1549.0±100.6	1685.0±109.5	1818.0±118.1	1956±123.99
	Female	1495.0±54.3	1606.7±54.1	1735.0±54.5	1877.5±55.6
		1539.0±96.3	1655.0±95.0	1774.0±99.5	1908.0±97.8

TABLE II
MEANS AND THEIR STANDARD ERRORS OF THE EFFECT OF BREED, SEX AND TREATMENT ON THE BODY WEIGHTS GAIN OF RABBITS

Item		1st week	2nd week	3rd week	4th week
Breed					
Flanders		99.6±2.3	106.1±4.5	112.3±2.6	110.9±2.3
New Zealand		104.3±5.2	112.7±8.4	110.0±3.3	104.3±3.9
Sex					
Male		102.1±3.3	116.1±4.9	113.4±3.4	110.2±2.9
Female		101.8±4.7	102.7±7.9	108.9±2.4	105.0±3.5
Breed*sex					
Flanders	Male	100.5±3.9	115.9±7.5	113.6±4.3	111.8±3.8
	Female	98.6±2.4	96.4±2.9	110.9±3.2	110.0±2.6
New Zealand	Male	103.6±5.3	116.4±6.9	113.2±5.4	108.6±4.5
	Female	105.0±9.2	109.1±15.6	106.8±3.8	100.0±6.2
Treatment					
	Treated	106.9±4.5	112.9±7.7	110.8±2.7	107.5±2.9
	Control	96.0±2.5	105.3±4.9	111.5±3.3	107.8±3.6

Breed*treatment						
Flanders		Treated	102.5±3.5	110.8±7.1	108.3±2.2	113.3±2.7
		Control	96.0±2. 5	100.5±4.7	117.0±4.9	108.0±3.7
New Zealand		Treated	111.3±8.4	115.0±13.9	113.3±5.0	101. 7±4.8
		Control	96.0±4.6	110.0±8.6	106.0±3.9	107.5±6.4
Sex*treatment						
Male		Treated	103.8±5.7	116.7±6.5	115±3.7	110.4±3.5
		Control	100.0±2.4	115.5±8.0	111.5±6.1	110.0±5.1
Female		Treated	110.0±7.2	109.2±14.1	106.7+3.7	104.6±4.8
		Control	92.0±4.2	95.0±3.5	111.5±2.9	105.5±5.2
Breed*sex*treatment						
Flanders	Male	Treated	100.8±7.0	127.5±9.9	110.0±1.8	115.0±5.0
		Control	100.0±3.54	102.0±8.5	118.0±9.4	108.0±6.0
	Female	Treated	104.2±2.0	94.2±3.5	106.7±4.0	111.7±2.5
		Control	92.0±2.6	99.0±5.1	116.0±4.3	108.0±5.2
New Zealand	Male	Treated	106.7±9.6	105.8±6.5	120.0±6.9	105.8±4.4
		Control	100.0±3.5	129.0±11.3	105.0±7.4	112.0±8.9
	Female	Treated	115.8±14.4	124.2±27.9	106.7±6.7	97.5±8.6
		Control	92.0±8.6	91.0±4.58	107.0±3.4	103.0±9.7

CONTINUED TABLE II

Breed			5th week	6th week	7th week	8th week
Flanders			109.8±2.0	115.9±4.1	117.5±3.1	126.8±1.8^{b}
New Zealand			114.7±4.6	117.8±3.9	125.0±2.8	136.1±3.5^{a}
Sex						
Male			117.6±4.4^{a}	119.2±4.2	121.8±2.7	130.9±3.4
Female			106.8±1.9^{b}	114.6±3.7	120.7±3.3	132.1±2.3
Breed*sex						
Flanders	Male		110.9±3.2^{b}	116.4±4.9	117.7±1.9	128.2±2.7
	Female		108.6±2.5^{b}	115.5+6.7	117.3±5.9	125.5±2.4
New Zealand	Male		124.4±7.9^{a}	122.0±6.9	125.9±4.9	133.6±6.4
	Female		105.0±2.9^{b}	113.6±3.5	124.1±2.8	138.6±2.8
Treatment						
	Treated		109.3±1.3	112.2±1.8	119.6±2.1	133.5±2.1
	Control		115.8±5.3	122.5±5.6	123.3±3.9	129.0±3.7
Breed*treatment						
Flanders	Treated		108.8±2.1	113.3±2.5	115.0±2.9	130.8±1.83
	Control		111.0±3.7	119.0±8.6	120.5±5.8	122.0±2.6
New Zealand	Treated		109.8±1.5	111.0±2.5	124.2±2.5	136.3±3.7
	Control		120.5±10.0	126.0±7.5	126.0±5.5	136.0±6.4
Sex*treatment						
Male	Treated		111.1±1.7	111.4±2.6	119.6±2.3	132.5±2.7
	Control		125.5±9.2	128.5±7.9	124.5±5.4	129.0±7.0
Female	Treated		107.5±1.8	112.9±2.4	119.6±3.6	134.6±3.3
	Control		106.0±3.7	116.5±7.8	122.0±6.0	129.0±3.1
Breed*sex*treatment						
Flanders	Male		110±3.16	112.5±3.8	119.2±3.0	135.0±1.8
			112±6.44	121.0±10.1	116.0±2.5	120.0±2.2
	Female		107.5±3.1	114.2±3.5	110.8±4.7	126.7+2.1
			110±4.47	117.0±15.1	125.0±11.6	124.0±4.9
New Zealand	Male		112.2±1.6	110.3±3.9	120.0±3.9	130.0±5.2
			139±15.68	136.0±12.4	133.0±9.4	138±13.3
	Female		107.5±2.14	111.7+3.6	128.3+2.5	142.5±4.3
			102±5.83	116.0±6.8	119.0±4.8	134.0±2.5

TABLE III
MEANS AND THEIR STANDARD ERRORS OF THE EFFECT OF BREED, SEX AND TREATMENT ON THE FEED CONVERSION RATIO OF RABBITS

Item		1st week	2nd week	3rd week	4th week
Breed					
Flanders		3.12±0.10	3.4±0.13	3.3±0.12	3.61±0.08
New Zealand		3.07±0.16	3.17±0.18	3.34±0.11	3.8±0.18
Sex					
Male		3.16±0.13	3.15±0.16	3.23±0.10	3.52±0.10
Female		3.03±0.13	3.42±0.15	3.40±0.13	3.88±0.16
Breed*sex					
Flanders	Male	3.17±0.18	3.29±0.21	3.25±0.16	3.5±0.13
	Female	3.06±0.08	3.52±0.16	3.34±0.18	3.72±0.1
New Zealand	Male	3.15±0.19	3.02±0.25	3.21±0.13	3.55±0.16
	Female	2.99±0.27	3.32±0.26	3.46±0.18	4.04±0.31
Treatment					
	Treated	2.85 ±0.07^{b}	2.89±0.11^{b}	2.94±0.09^{a}	3.42±0.13^{b}
	Control	3.30±0.15^{a}	3.62±0.15^{a}	3.63±0.09^{b}	3.94±0.13^{a}
Breed*treatment					
Flanders	Treated	2.85±0.06	3.02±0.14	2.80±0.11	3.46±0.14
	Control	3.34±0.15	3.72±0.17	3.71±0.08	3.74±0.09
New Zealand	Treated	2.85±0.13	2.75±0.18	3.08±0.12	3.38±0.22

		Control	3.26±0.26	3.51±0.26	3.55±0.16	4.14±0.24
Sex*treatment						
Male		Treated	2.87±0.07	2.67±0.18	2.98±0.16	3.27±0.15
		Control	3.41±0.20	3.55±0.2	3.45±0.1	3.74±0.12
Female		Treated	2.83±0.13	3.1±0.11	2.91±0.08	3.57±0.2
		Control	3.19±0.22	3.68±0.24	3.81±0.14	4.14±0.23
Breed*sex*treatment						
Flanders	Male	Treated	2.85±0.10	2.98±0.24	2.81±0.22	3.31±0.21
		Control	3.44±0.29	3.54±0.31	3.62±0.06	3.66±0.15
	Female	Treated	2.85±0.08	3.06±0.16	2.79±0.10	3.60±0.19
		Control	3.23±0.06	3.90±0.14	3.80±0.15	3.82±0.08
New Zealand	Male	Treated	2.88±0.10	2.36±0.18	3.14±0.23	3.22±0.22
		Control	3.37±0.31	3.57±0.28	3.27±0.17	3.82±0.18
	Female	Treated	2.81±0.26	3.14±0.16	3.02±0.09	3.54±0.39
		Control	3.15±0.45	3.46±0.47	3.83±0.24	4.46±0.43

CONTINUED TABLE III

Item			5th week	6th week	7th week	8th week
Breed						
Flanders			3.93±0.10	5.08±0.15	5.56±0.14	5.76±0.07
New Zealand			3.91±0.13	4.87±0.16	5.38±0.16	5.54±0.16
Sex						
Male			3.70±0.11[b]	4.99±0.15	5.6±0.14	5.82±0.13
Female			4.14±0.10[a]	4.96±0.17	5.35±0.16	5.48±0.11
Breed*sex						
Flanders	Male		3.8±0.12	5.02±0.18	5.5±0.09	5.69±0.06
	Female		4.05±0.15	5.13±0.26	5.62±0.27	5.83±0.14
New Zealand	Male		3.6±0.17	4.95±0.24	5.69±0.27	5.95±0.26
	Female		4.22±0.13	4.78±0.21	5.07±0.11	5.13±0.09
Treatment						
	Treated		3.63±0.12[b]	4.64±0.2[b]	5.20±0.14[b]	5.51±0.12
	Control		4.16±0.07[a]	5.25±0.08[a]	5.69±0.14[a]	5.77±0.12
Breed*treatment						
Flanders	Treated		3.63±0.12	4.97±0.32	5.31±0.21	5.66±0.12
	Control		4.18±0.11	5.17±0.11	5.77±0.18	5.84±0.09
New Zealand	Treated		3.62±0.22	4.32±0.21	5.1±0.19	5.37±0.21
	Control		4.15±0.10	5.32±0.12	5.61±0.23	5.69±0.24
Sex*treatment						
Male	Treated		3.44±0.2	4.61±0.24	5.26±0.19	5.64±0.21
	Control		3.91±0.07	5.31±0.12	5.88±0.17	5.98±0.16
Female	Treated		3.81±0.14	4.68±0.33	5.15±0.21	5.39±0.13
	Control		4.41±0.08	5.19±0.11	5.51±0.22	5.56±0.17
Breed*sex*treatment						
Flanders	Male		3.62±0.21	4.79±0.33	5.54±0.12	5.77±0.11
			3.96±0.13	5.21±0.16	5.47±0.14	5.62±0.07
	Female		3.64±0.16	5.14±0.58	5.08±0.39	5.55±0.22
			4.39±0.13	5.13±0.15	6.08±0.29	6.06±0.10
ew Zealan	Male		3.27±0.33	4.42±0.36	4.98±0.34	5.50±0.42
			3.87±0.06	5.40±0.20	6.28±0.21	6.33±0.24
	Female		3.97±0.22	4.22±0.23	5.22±0.22	5.23±0.10
			4.43±0.09	5.25±0.16	4.95±0.10	5.05±0.15

TABLE IV
MEANS AND THEIR STANDARD ERRORS OF THE EFFECT OF BREED, SEX AND TREATMENT ON THE CARCASS TRAITS OF RABBITS

Item		Carcass	Forequarter	Loin	Hindquarter
Breed					
Flanders		976.67±24.15[b]	308.63±7.63[b]	244.17±6.04[b]	419.97±10.38[b]
New Zealand		1094.17±35.38[a]	345.76±11.18[a]	273.54±8.84[a]	470.49±15.21[a]
Sex					
Male		1042.5±27.61	329.43±8.72	260.63±6.9	448.28±11.87
Female		1028.33±41.12	324.95±12.99	257.08±10.28	442.18±17.68
Breed*sex					
Flanders	Male	984.17±18.55	311±5.86	246.04±4.64	423.19±7.98
	Female	969.17±46.89	306.26±14.82	242.29±11.72	416.74±20.16
New Zealand	Male	1100.83±40.61	347.86±12.83	275.21±10.15	473.36±17.46
	Female	1087.5±61.96	343.65±19.58	271.88±15.49	467.63±26.64
Treatment					
	Treated	1071.25±32.63	338.52±10.31	267.81±8.16	460.64±14.03
	Control	999.58±34.11	315.87±10.78	249.9±8.53	429.82±14.67
Breed*treatment					
Flanders	Treated	974.17±22	307.84±6.95	243.54±5.5	418.89±9.46
	Control	979.17±45.6	309.42±14.41	244.79±11.4	421.04±19.61
New Zealand	Treated	1168.33±20.76	369.19±6.56	292.08±5.19	502.38±8.93
	Control	1020±53.62	322.32±16.94	255±13.4	438.6±23.06
Sex*treatment					

Male		Treated	1065.83 +56.1	336.8±17.73	266.46±14.03	458.31±24.12
		Control	990.83±61.07	313.1±19.3	247.71±15.27	426.06±26.26
Female		Treated	1076.67 ±39.07	340.23±12.34	269.17±9.77	462.97±16.8
		Control	1008.33 +36.89	318.63±11.66	252.08±9.22	433.58±15.86
Breed*sex*treatment						
Flanders	Male	Treated	948.33±21.28	299.67±6.72	237.08±5.32	407.78±9.15
		Control	990±100.54	312.84±31.77	247.5±25.14	425.7±43.23
	Female	Treated	1000±36.06	316±11.39	250±9.01	430.0±15.5
		Control	968.33±13.02	305.99±4.11	242.08±3.25	416.38±5.6
New Zealand	Male	Treated	1183.33 +38.44	373.93±12.15	295.83±9.61	508.83±16.53
		Control	991.67±92.39	313.37±29.2	247.92±23.1	426.42±39.73
	Female	Treated	1153.33 ±21.28	364.45±6.72	288.33±5.32	495.93±9.15
		Control	1048.33 ±70.97	331.27±22.43	262.08±17.74	450.78±30.52

CONTINUED TABLE IV

Item		Gastrointestinal	Giblets	Dressing
Breed				
Flanders		410.2±10.14^{b}	78.13±1.93^{b}	0.52±0.01^{b}
New Zealand		459.55±14.86^{a}	87.53±2.83^{a}	0.54±0.01^{a}
Sex				
Male		437.85±11.6	83.4±2.21	0.53±0.01
Female		431.9±17.27	82.27±3.29	0.52±0.01
Breed*sex				
Flanders	Male	413.35±7.79	78.73±1.48	0.52±0
	Female	407.05±19.7	77.53±3.75	0.51±0.01
New Zealand	Male	462.35±17.06	88.07±3.25	0.54±0.01
	Female	456.75±26.03	87±4.96	0.53±0.01
Treatment				
	Treated	449.93±13.71	85.7±2.61	0.53±0.01
	Control	419.83±14.33	79.97±2.73	0.52±0.01
Breed*treatment				
Flanders	Treated	409.15±9.24	77.93±1.76	0.52±0.01
	Control	411.25±19.15	78.33±3.65	0.52±0.01
New Zealand	Treated	490.7±8.72	93.47±1.66	0.55±0
	Control	428.4±22.52	81.6±4.29	0.52±0.01
Sex*treatment				
Male	Treated	447.65±23.56	85.27±4.49	0.53±0.01
	Control	416.15±25.65	79.27±4.89	0.52±0.01
Female	Treated	452.2±16.41	86.13±3.13	0.54±0.01
	Control	423.5±15.5	80.67±2.95	0.52±0.01
Breed*sex*treatment				
Flanders	Male	398.3±8.94	75.87±1.7	0.51±0.01
		415.8±42.23	79.2±8.04	0.52±0.02
	Female	420±15.14	80±2.88	0.52±0.01
		406.7±5.47	77.47±1.04	0.51±0.01
New Zealand	Male	497±16.15	94.67±3.08	0.55±0.01
		416.5±38.8	79.33±7.39	0.52±0.02
	Female	484.4±8.94	92.27±1.7	0.55±0.01
		440.3±29.81	83.87±5.68	0.53±0.02