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EFFECT OF CAGE DENSITY ON GROWTH AND CARCASS PERFORMANCE OF FATTENING RABBITS UNDER TROPICAL HEAT STRESS CONDITIONS

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Abstract: Three hundred crossbred New Zealand, California, Butterfly, Dutch, and Satin rabbits, weaned at 30 d and weighing 535±8 g (standard error) were assigned randomly to four treatments: 6, 12, 18 and 24 rabbits/m^2 (3, 6, 9 and 12 rabbits/cage, respectively, each cage measuring 0.5 m^2) resulting in 10 cages/treatment. During the experimental period (from weaning to 2.2 kg body weight) weekly individual live weight, cage feed intake, incidence of diarrhoea, ringworm, and injured rabbit data was recorded. The maximum temperature-humidity index ranged from 31 to 35, and so indicating severe heat stress. At the end of the experimental period 10, 20, 30 and 30 rabbits under densities of 6, 12, 18 and 24 rabbits/m^2, respectively, were slaughtered and carcass performance recorded. Average daily gain and feed intake from weaning to the end of the experimental period decreased by 0.31±0.070 and 1.20±0.25 g, respectively, for each unit that the density increased at the beginning of the experiment (P=0.001). The length of the fattening period increased by 0.91±0.16 d (P=0.001) for each unit of increment of density. However, rabbit production (expressed in kg/m^2) increased linearly and quadratically with density (P<0.008). Cage density did not affect feed efficiency, which on average was 0.214 g/g (P=0.37). Animals housed at the highest density, compared to the average of those caged at lower densities, tended to show higher incidence of ringworm (68.9 *vs* 39.4%; P=0.075) and injury (16.8 *vs* 3.03%; P=0.12), and showed higher mortality (20.5 *vs* 9.63%; P=0.043). Density did not alter the dressing out percentage nor chilled carcass weight. The proportion of scapular fat (P=0.042) increased linearly with increasing levels of density, but perirrenal fat was unaffected (P=0.22). Increasing density reduced dorsal length linearly (P=0.001), and reduced drip loss percentage linearly and quadratically (P=0.097 and 0.018, respectively).Based on these results, under our heat stress conditions, avoiding densities higher than 18 rabbits/m^2 or 34 kg/m^2 at the end of fattening is recommended.

Key words: cage density, growing performance, carcass performance, heat stress.

INTRODUCTION

Cage density during rabbit fattening is an important factor that influences labour, investment cost, performance, and accordingly, profitability. In Europe, cage density varies in commercial farms from 14 to 23 rabbits/m^2 (or from 720 to 425 cm^2/rabbit) (Trocino and Xiccato, 2006). Densities higher than 19 rabbit/m^2 reduce feed intake and growth rates, with no effect on feed efficiency or mortality (Maertens and De Groote, 1984; Aubret and Duperray, 1992). The European Food and Safety Authority (2005) recommended a minimum surface of 625 cm^2/rabbit and not more than 40 kg/m^2 at the end of fattening, in order to avoid disturbances in rabbit behaviour. However, the behaviour of rabbits depends on their age. Rabbits just after weaning (at 21 d) tend to huddle together, increasing the stocking density up to 31-61 rabbits/m^2 for the first two weeks after weaning, while older animals prefer lower densities and when caged at high densities spend less time eating (Morisse and Maurice, 1997; Matics *et al*., 2004).

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The results of these studies cannot be extrapolated to tropical conditions, where it is difficult to apply adequate environmental control, and consequently an increase in cage density can more negatively affect rabbit growth performance. In these conditions, an increase in cage density reduces feed intake and impairs growth rates, but it also seems to increase mortality (Nieves *et al*., 1996; Mbanya *et al*., 2004). The cage density recommended by these authors ranges between 5 and 16 rabbits/m^2, but they do not give any information regarding environment temperature and relative humidity.

The aim of this work is to study the effect of cage density under the heat stress conditions found in Maracaibo, Venezuela (average temperature 28ºC and relative humidity 76%; Peters *et al*., 1983), by measuring growth performance, mortality, and animal injury rates and carcass performance.

MATERIAL AND METHODS

Animals and housing

Three hundred crossbred New Zealand, California, Butterfly, Dutch, and Satin rabbits, weaned at 30 d, were transported just after weaning from a commercial farm (located in Barinas: average 26ºC and 74% relative humidity) to our facilities (seven hours distant) in Maracaibo (Venezuela). Animals were housed in flat-deck cages measuring 500×100×500 mm (0.5 m^2) equipped with one nipple drinker and one hopper feeder (30 cm available) in each cage. Water was filtered before storage in the farm water-tank. The farm is an open-air building equipped with a ventilator to recycle air and a mesh (80% shade) on the windows to avoid animals being exposed to the sun. The regional climate in Maracaibo is very dry tropical forest (Holdrige, 1978). The temperature-humidity index (THI) was calculated according to Marai *et al*. (2001):

$$\text{THI}=\text{db}^{\circ}\text{C} - [(0.31 - 0.031\ \text{RH})\times(\text{db}^{\circ}\text{C} - 14.4)],$$

where dbºC is dry bulb temperature in Celsius degrees, and RH is the relative humidity as a percentage. According to Marai *et al*. (2002) there is heat stress when THI is higher than 28.9, while under 27.8 there is no heat stress.

Experimental procedure

Rabbits were caged at 6, 12, 18 and 24 rabbits/m^2 (or 3, 6, 9 and 12 rabbits/cage) and they were assigned randomly to one of these four treatments (10 cages/treatment). The average weaning weight was 535±8.0 g (standard error) and rabbits were identified by a number written in their ears. A commercial diet was offered *ad libitum* to the animals containing (g/kg dry matter (DM)): 918 DM, 97.8 ash, 164 crude protein (CP), 36.2 ether extract, 124 crude fibre, 361 neutral detergent fibre (NDF), 186 acid detergent fibre (ADF) and 44.6 acid detergent lignin (ADL), and an estimated digestible energy value of 11.1 MJ/kg (De Blas *et al*., 1992). Individual animal weights, cage feed intake, and mortality were recorded weekly. Dead animals were not substituted. The average number of rabbits per cage and week was used to calculate growth rate and feed intake per cage and animal. Mortality, diarrhoea incidence, and injured animals were expressed in percentage per cage. During the experiment an outbreak of diarrhoea appeared just after weaning. An intramuscular injection with Diarrex H (Aldor C.A., Venezuela) for 3-4 d was used to control the infection. It contained dimetridazol, sulphamethacine, trimetoprin and tretracycline. Animals diagnosed with ringworm (Trichophyton spp.) were treated orally with ketazol (Laboratorios Vargas, Venezuela) containing ketoconazol. The experiment finished when the average weight of the rabbits in the cage reached 2.2 kg/rabbit. Then 10, 20, 30 and 30 rabbits corresponding to rabbits caged at 6, 12, 18 and 24 rabbits/m^2, respectively, were slaughtered at between between 9.30 and 11.00 am. Rabbits were stunned by a neck hit and then bled. Afterwards, they were dissected according to Blasco *et al*. (1993).

Chemical analysis

AOAC (2000) procedures were used to determine the concentrations of DM (934.01), ash (967.05), CP (968.06), ether extract (including acid hydrolysis, 920.39), and crude fibre (932.09). Dietary NDF, ADF, and ADL were determined sequentially using the fibertec system (Foss, Danemark) according to the methods of Mertens (2002), the AOAC (2000; procedure 973.187) and Van Soest *et al*. (1991), respectively.

Statistical analysis

The results obtained in this study for growth performance (expressed per cage) were analyzed as a completely randomized design with the average weaning weight per cage as a linear covariate and cage density was included as a linear and quadratic covariate, by using the SAS General Linear Model procedure (SAS Inst. Inc., Cary, NC). We studied the individual growth rate, and the interaction between cage density and fattening period (considering four fattening periods: weaning (30-44 d, 44-58 d, 58-85 d, 85 d-2.2 kg BW) for the animals that finished the experiment. This interaction was analysed as a repeated measurement analysis by using a mixed model (CS covariance structure) that included weaning weight as a linear covariate, cage density as a linear and quadratic covariate, and fattening period (time effect) as classified effect. Interactions among cage density and fattening period were also included. In this model, the cage is considered as a random effect. The model used to study carcass traits included the sex as a classified effect, slaughter weight as a linear covariate, and cage density as a linear and quadratic covariate – using the SAS General Linear Model procedure. The maximum/minimum was calculated and commented when quadratic effects were significant, except if it was out of the range studied. All data is presented as least-square means.

RESULTS AND DISCUSSION

Inside the farm the relative humidity ranged from 67 to 94% and the minimum temperature varied from 21 to 29ºC (corresponding to the night, when animals eat most of the feed). According to the review of Cervera and Fernández-Carmona (1998), these temperatures would be lower than the upper critical temperature of weaned rabbits (30ºC), but higher than the value for adult rabbits (25ºC). The calculated THI ranged between 21 and 28, and according to Marai *et al*. (2002) this would not cause heat stress. At the maximum temperatures (recorded around 15:00 h, and varying from 24 to 35ºC) THI ranged from 31 to 35, and this implies a very severe heat stress which would impair growing performance.

Feed intake and growth rate (both expressed per day and rabbit) from weaning to the end of fattening was impaired by 1.20±0.25 and 0.31±0.070 g, respectively, for each unit that cage density (rabbits/m^2) increased at the beginning of the experiment (P<0.001) (Table 1). This negative effect was recorded in all the fattening stages. However, cage density had no effect on feed efficiency – which was on average 0.214 g/g (P=0.37). Accordingly, the reduction in growth rate when cage density increased is directly related to the reduction of feed intake as previously observed (Maertens and de Groote, 1984; Aubret and Duperray, 1992; Nieves *et al*., 1996; Mbanya *et al*., 2004). As a consequence, the length of the fattening period increased by 0.91±0.16 d (P=0.001) for each unit that cage density increased. The single growth rate for rabbits that finished the fattening period decreased by 0.25±0.035 g/d for each unit of increase in cage density (P<0.001) (Table 2). In these animals, the effect of cage density varied depending on the fattening period (P=0.022). During the first two weeks after weaning (from 30 to 44 d of age) the effect of cage density was worse (−0.30±0.080 g/unit of density increment; P<0.001) than those of the 44-58 and 58-85 day periods (−0.13±0.057 and −0.12±0.047 g/unit of density increment, respectively; P<0.024). These results differ from those reported by Maertens and de Groote (1984) and Aubret and Duperray (1992) who did not observe any effect on density during the 10-14 day period after weaning, or even with

Table 1: Effect of cage density on growth performance

Initial density, rabbits/m^2	6	12	18	24	SEM[1]	L[2]	P_{cov}[3]
Initial density, cm^2/rabbit	1667	833	555	417			
30 (weaning)-44 d							
Body weight at 44 d, g/rabbit	922	886	865	831	12.2	0.001	0.001
Daily gain, g/rabbit×d	22.1	20.3	18.8	14.3	2.08	0.025	0.001
Feed intake, g/rabbit×d	58.6	53.3	50.3	46.6	2.43	0.003	0.001
Feed efficiency[5], g/g	0.361	0.363	0.365	0.295	0.033	0.26	0.011
Mortality, %	8.79	8.84	7.70	12.2	3.52	0.63	0.015
44-58 d							
Body weight at 58 d, g/rabbit	1262	1198	1176	1129	20.1	0.001	0.001
Daily gain, g/rabbit×d	24.6	21.5	21.4	18.3	1.19	0.003	0.014
Feed intake, g/rabbit×d	83.4	75.7	74.7	73.0	2.83	0.032	0.001
Feed efficiency[4], g/g	0.297	0.294	0.289	0.243	0.020	0.11	0.75
Mortality[4], %	0.18	1.63	1.00	4.64	1.41	0.090	0.18
58-85 d							
Body weight at 85 d, g/rabbit	1848	1747	1700	1643	27.9	0.001	0.001
Daily gain, g/rabbit×d	20.9	19.5	18.6	17.4	0.76	0.005	0.079
Feed intake, g/rabbit×d	109	105	93.1	86.6	4.79	0.002	0.16
Feed efficiency, g/g	0.196	0.188	0.200	0.199	0.0098	0.67	0.81
Mortality, %	0.072	0.12	0.13	1.85	0.57	0.077	0.24
85 d-2.2 kg							
Final body weight, g/rabbit	2178	2233	2100	2170	37.8	0.35	0.35
Daily gain, g/rabbit×d	17.3	20.2	12.8	14.4	1.71	0.057	0.46
Feed intake, g/rabbit×d	114	113	93.7	80	4.93	0.001	0.81
Feed efficiency, g/g	0.150	0.183	0.138	0.172	0.016	0.88	0.52
Mortality, %	0.37	0.00	0.44	1.78	1.27	0.44	0.016
30 d (destete)-final							
Length, d	73.1	79.0	82.5	90.3	1.94	0.001	0.001
Daily gain, g/rabbit×d	21.3	20.4	17.5	16.0	0.83	0.001	0.001
Feed intake, g/rabbit×d	97.4	94.1	83.7	76.9	2.96	0.001	0.055
Feed efficiency, g/g	0.219	0.218	0.210	0.208	0.0095	0.37	0.041
Mortality[4], %	9.42	10.2	9.27	20.5	4.10	0.14	0.002
Ringworm[5], %	37.3	44.0	36.6	68.9	12.8	0.20	0.083
Diarrhoea, %	13.3	10.2	5.80	12.0	3.81	0.64	0.10
Injured[5], %	0.0	8.00	1.10	16.8	6.07	0.26	0.74

[1]SEM: Standard error of means (n=10 cages/treatment).
[2]Linear effect of density. Quadratic effect of density was always $P>0.30$.
[3]Effect of average weaning weight per cage.
[4]Significant effect of contrast 24 *vs* (18, 12, 6) rabbits/m^2 ($P<0.050$).
[5]Tendency effect for contrast 24 *vs* (18, 12, 6) rabbits/m^2 ($0.050 < P<0.15$).

the results of Matics *et al*. (2004) that observed a natural preference by rabbits to increase density around weaning. These negative results just after weaning might be explained by the long journey between farms just after weaning and the time required to settle into new housing conditions, which might have favoured the outbreak of diarrhoea in this period. In the final fattening period (from 85 d of age to 2.2 kg BW) the negative effect of density was again seen (−0.20±0.069 g/unit of density increment; P=0.004), which is related to the reduction of available surface as observed in both optimal climatic conditions (Maertens and de Groote, 1984; Aubret and Duperray, 1992; Morisse and Maurice, 1997) and in hotter conditions (Nieves *et al*., 1996; Andréa *et al*., 2004).

The incidence of ringworm and injuries was unaffected linearly or quadratically by cage density (Table 1). However, rabbits caged at the highest density, compared to the average of the three lower densities, although no significant differences were detected, tended to be more sensitive to ringworm (68.9 *vs* 39.4%; P=0.075), and to show a greater aggressiveness (reflected in the higher percentage of injured animals, especially on the ears and tail; 16.8 *vs* 3.03%; P=0.12). The aggressions begun on average at 68.8±4.8 d after weaning (the first aggression was recorded 48 d after weaning, but the two-thirds point was detected from 72 d after weaning onwards). This result indicates the negative impact of high densities on rabbit behaviour due to lack of comfort, and it is in agreement with the impairment of growth performance in the final fattening period. The highest density also increased mortality in the whole fattening period compared to the average of the three lower densities (20.5 *vs* 9.63; P=0.043). This result differs from previous studies which did not find any relation between cage density and mortality (Maertens and de Groote, 1984; Aubret and Duperray, 1992), but it is in agreement with the trend observed in tropical conditions (Nieves *et al*., 1996; Mbanya *et al*., 2004). In this study, animals with lower weaning weights were more

Table 2: Effect of cage density on individual growth performance of rabbits that reached 2.2 kg

Initial density, rabbits/m^2	6	12	18	24	RSD[1]	L[2]	P_{cov}[3]
Initial density, cm^2/rabbit	1667	833	555	417			
No. of rabbits	28	54	80	91			
30 (weaning)-44 d							
Body weight at 44 d, g/rabbit	914	892	873	842	102	0.001	0.001
Daily gain, g/rabbit×d	26.3	24.7	23.1	20.9	7.6	0.001	0.12
44-58 d							
Body weight at 58 d, g/rabbit	1248	1199	1176	1137	143	0.001	0.001
Daily gain, g/rabbit×d	24.4	22.4	22.1	21.5	5.4	0.024	0.001
58-85 d							
Body weight at 85 d, g/rabbit	1831	1742	1701	1652	207	0.001	0.001
Daily gain, g/rabbit×d	20.8	19.4	18.7	18.4	4.5	0.014	0.39
85 d-2.2 kg							
Body weight d, g/rabbit	2151	2241	2127	2206	258	0.81	0.001
Daily gain, g/rabbit×d	17.3	20.1	14.9	15.7	6.6	0.004	0.011
30 d (weaning)-2.2 kg							
Daily gain, g/rabbit×d	22.2	21.3	18.9	18.1	3.3	0.001	0.31

[1]RSD: residual standard deviation.

[2]Linear effect of density. Quadratic effect of density showed always P>0.30.

[2] Effect of weaning weight.

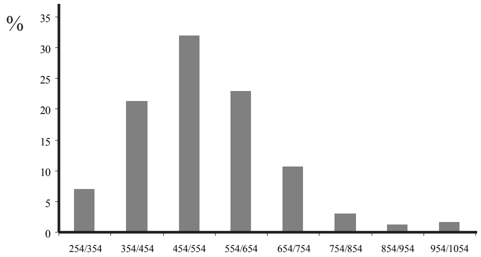

Figure 1: Rabbit distribution according to their weaning weight (n=300).

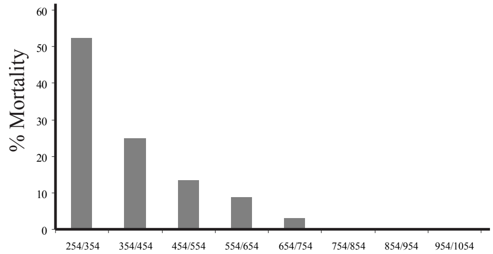

Figure 2: Relation between weaning weight and mortality during fattening (n= 300).

likely to die (Figure 1 and 2), as they probably had a lower milk intake during lactation and were more sensitive to diarrhoea. This result might suggest an advantage in delaying the weaning age.

The negative effect of density on growth performance did not prevent the final rabbit production (kg/m^2) increasing linearly with density (P=0.001) (Table 3). In this case, a quadratic effect was also observed (P=0.008), as rabbit production did not increase in direct proportion to the number of rabbits – due to their lower growth rate and higher mortality at the highest cage density. Accordingly, to reduce mortality, ringworm, and injured animals, density must be below 41 kg/m^2 – which is the highest value recommended in Europe (Trocino and Xiccato, 2006). In our conditions of heat stress, a cage density of around 16-18 rabbits/m^2 produced around 34 kg/m^2, and a one week reduction in the length of the fattening period (compared to animals caged at the highest density) could be recommended. A lower density (12 kg/m^2) improves growth rate and fattening duration (by 16% and 4%, respectively), but also reduces final production per m^2 by around 29%. Under our conditions, the only way to introduce a high cage density would be to shorten the length of fattening – and accordingly significantly reduce the slaughter weight.

Table 3: Effect of cage density on final rabbit production (kg live body weight/m^2).

Initial density, rabbits/m^2	6	12	18	24	SEM[1]	L[2]	Q[3]	P_{cov}[4]
Initial density, cm^2/rabbit	1667	833	555	417				
44 d								
Live body weight, kg/m^2	4.74	9.76	14.4	17.0	0.52	0.001	0.018	0.11
No rabbits/m^2	5.31	11.0	16.7	21.0	0.26	0.001	0.20	0.001
58 d								
Live body weight, kg/m^2	6.51	12.9	19.4	22.1	0.75	0.001	0.066	0.15
No rabbits/m^2	5.29	10.8	16.5	19.8	0.53	0.001	0.066	0.001
85 d								
Live body weight, kg/m^2	9.59	18.7	27.8	31.6	1.04	0.001	0.014	0.062
No rabbits/m^2	5.27	10.8	16.5	19.4	0.59	0.001	0.021	0.001
2.2 kg								
Live body weight, kg/m^2	11.3	24.2	34.3	41.1	1.54	0.001	0.008	0.008
No rabbits/m^2	5.19	10.8	16.4	18.9	0.56	0.001	0.024	0.001

[1]SEM: standard error of the means (n=10 cages/treatment). [2]Linear effect of density. [3]Quadratic effect of density. [4]Effect of average weaning weight per cage.

Table 4: Effect of cage density and sex on carcass performance.

Initial density, rabbits/m²	6	12	18	24	Sex		RSD[1]	L[2]	P_{sex}[3]	P_{cov}[4]
Initial density, cm²/rabbit	1667	833	555	417	Males	Females				
$N_♀$	4	10	14	14						
$N_♂$	6	10	15	16						
Live body weight at slaughter (BW), g	2261	2265	2159	2198	2188	2253	130	0.041	0.022	–
Skin weight, %BW	16.1	16.8	16.9	16.8	17.3	16.0	1.19	0.27	0.001	0.48
Digestive tract weight, %BW	16.5	15.9	15.5	15.9	15.5	16.3	1.75	0.47	0.078	0.14
Hot carcass weight, %BW	62.9	62.9	62.5	62.5	62.7	62.7	2.05	0.52	0.92	0.20
Hot carcass weight (HCW), g	1386	1388	1380	1379	1384	1383	45	0.52	0.83	0.001
Chilled carcass weight (CCW), g	1230	1256	1262	1250	1252	1248	53	0.61	0.83	0.001
Dressing out percentage[7], % BW	55.7	56.9	57.2	56.6	56.7	56.5	2.48	0.56	0.88	0.014
Drip loss percentage[6], % HCW	11.3	9.62	8.52	9.41	9.54	9.85	2.50	0.097	0.88	0.016
Head weight, % CCW	10.0	9.96	10.2	10.3	10.3	9.97	0.83	0.22	0.14	0.001
Liver weight, % CCW	4.79	4.89	5.19	5.01	5.00	4.93	0.97	0.50	0.84	0.72
Kidney weight, % CCW	0.95	0.92	0.92	0.90	0.93	0.91	0.15	0.34	0.56	0.12
Other viscera weight[5], % CCW	1.97	2.08	2.07	2.03	2.07	2.01	0.32	0.98	0.44	0.17
All viscera weight, % CCW	7.71	7.90	8.18	7.94	8.00	7.86	1.17	0.65	0.66	0.38
Perirrenal fat weight, % CCW	1.63	1.81	1.54	1.54	1.63	1.63	0.53	0.22	0.97	0.001
Scapular fat weight, % CCW	0.67	0.88	0.89	0.99	0.86	0.86	0.45	0.042	0.88	0.13
Whole fat weight, % CCW	2.29	2.73	2.44	2.54	2.51	2.50	0.87	0.75	0.95	0.003
Reference carcass weight, g	1014	1033	1031	1022	1024	1026	55	0.97	0.83	0.001
Reference carcass weight, % BW	45.9	46.8	46.6	46.3	46.4	46.5	2.56	0.96	0.77	0.002
Dorsal length, cm	26.9	27.3	26.1	25.4	26.2	26.6	1.61	0.001	0.37	0.039
Thigh length, cm	7.21	7.13	7.52	7.20	7.25	7.28	0.76	0.86	0.76	0.17
Lumbar circumference[6], cm	16.3	16.7	16.5	16.1	16.2	16.5	0.86	0.13	0.11	0.001

[1]RSD: residual standard deviation. [2]Linear effect of cage density. [3]Effect of sex. [4]Effect of live body weight at slaughter. [5]Thymus, trachea, oesophagus, lungs and heart. [6]Quadratic effect of cage density (P<0.05). [7]Quadratic trend of cage density (0.05 < P<0.15).

Although rabbits were slaughtered when the average weight of the cage was 2.2 kg/rabbit, a negative effect of cage density is observed on slaughter weight (*P*=0.041), and this has been used as a covariate when carcass traits were analysed (Table 4). Cage density had a minor influence on the carcass compared to growth traits, and this is in agreement with previous works (Aubret and Duperray, 1992; Xiccato *et al*., 1999; Combes and Lebas, 2003). The proportion of scapular fat increased with cage density (*P*=0.042). An older age at slaughter when cage density is increased might explain this observation (Dalle Zotte *et al*., 2002). However, this result should be confirmed as no effect was detected on the proportion of perirrenal fat (*P*=0.22), and scapular fat might have been removed with the skin. Cage density linearly reduced dorsal length (*P*<0.001) which is another signal of the lack of comfort in animals caged at high densities.

Drip loss percentage increased linearly and quadratically (*P*=0.097 and 0.018, respectively) with decreasing densities, showing a minimum value for a density of 18 rabbits/m^2. The slaughter of younger animals (with almost the same weight: 2.2 kg) when cage density decreased might account for this result – as other authors have detected an increase in drip loss percentage when age at slaughter decreases (Xiccato *et al*., 1993; Bernardini *et al*., 1995). This result is related to the quadratic trend (*P*=0.12) of cage density on the dressing out percentage – which showed a maximum at 17.1 rabbits/m^2. Cage density also quadratically affected the lumbar circumference and obtained a maximum value at 14.3 rabbits/m^2. The sex had little influence on carcass traits. Females were heavier at slaughter compared to males (*P*=0.022) and had a lower skin weight proportion (*P*<0.001). They also tended to have a higher digestive tract weight (*P*=0.078) and a longer lumbar circumference (*P*=0.11). Neither cage density nor sex had effect on hot, chilled, and reference carcass weight, viscera weight, nor on the proportion of dissectible fat weight (scapular and perirrenal) and thigh length.

CONCLUSIONS

A cage density above 6 rabbits/m^2 impaired growth performance during fattening, with minor effects on carcass traits, but improved rabbit production (expressed in kg/m^2). A high density (24 rabbits/m^2) increased mortality, ringworm, and the number of injured animals with respect to animals caged at lower densities. Accordingly, under our heat stress conditions, it is recommended to use a maximum density of 18 rabbits/m^2 (or 34 kg/m^2 at the end of fattening) to avoid difficulties and maximise rabbit production (kg/m^2).

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