Effect of Stocking Density on Performance of Growing Rabbits in the Semi-humid Tropics

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Summary

Sixty growing rabbits were housed at densities of 6.7, 10, 13.3, 16.7 and 20 rabbits/m² in wood and poultry wire mesh cages for six weeks and fed a common diet of 22.6% CP and 2600 kcal/kg ME. Parameters measured were feed intake, weight gain, feed conversion ratio, body condition, fur condition and body bites.

Stocking density significantly (P< 0.05) affected feed intake and weight gain but not feed conversion ratio of rabbits. Rabbits stocked at densities of 6.7, 10 and 13.3 rabbits/m² had higher average daily gain than those stocked at higher densities. Feed intake was higher at higher densities. The trend shows a significant decrease in feed intake by individual rabbits as stocking density increases in week 1-2 and 3-4. Feed conversion ratio was poorer at higher densities (16.7, 20 rabbits/m²) than at lower densities (6.7, 10, 13.3 rabbits/m²). There was no definite relationship between stocking density and mortality rate of rabbits. Rabbits stocked at 6.7 to 13.3 rabbits/m² had significantly higher body condition score and fur condition compared with those stocked at 16.7 and 20 rabbits/m². There were no differences in fighty bites for all the stocking densities. It is concluded from this study that the optimum stocking density for rabbits in the semi-humid tropics is 13.3 rabbits/m².

Résumé

Effet de la densité sur la croissance des lapins en zone tropicale semi-humide

Soixante lapins en croissance ont été répartis dans des cages en bois et grillage communément utilisées pour les poulets selon les densités suivantes: 6,7; 10; 13,3; 16,7 et 20 lapins/m². Ils ont été suivis pendant six semaines et nourris uniformément avec une ration de 22,6% protéines brutes (PB) et 2600 kcal/kg d'énergie métabolisable (EM). Les paramètres mesurés étaient: l'ingestion d'aliment, le gain de poids, le coefficient de conversion alimentaire, l'état du corps, l'état du pelage et les morsures.

La densité des lapins a affecté de manière significative (P< 0,05) l'ingestion d'aliment et le gain de poids mais pas le coefficient de conversion alimentaire. Les densités de 6,7; 10 et 13,3 lapins/m² ont donné en moyenne le meilleur gain quotidien de poids comparées aux densités supérieures de lapins/m². L'ingestion alimentaire était plus élevée pour les densités supérieures de lapins/m². Il y a une tendance à la réduction de l'ingestion alimentaire par les lapins conformément à l'augmentation de leur densité pendant les semaines 1-2 et 3-4. Le coefficient de conversion alimentaire était plus faible pour les densités supérieures (16,7; 20 lapins/m²) que pour les densités inférieures (6,7; 10 et 13,3 lapins/m²). Il n'y avait pas de relation entre la densité des lapins et leur taux de mortalité. Les densités de 6,7 à 13,3 lapins/m² ont donné un meilleur résultat pour l'état corporel et l'état du pelage, comparées aux résultats pour les densités de 16,7 et 20 lapins/m². Pour toutes les densités prises en considération, il n'y a pas eu de différence en matière de morsures. La conclusion de cette étude est que la densité maximale de lapins en zone tropicale semi-humide est de 13,3 lapins/m².

Introduction

Food safety starts from the farm and could be negatively affected by management factors such as hygiene and stocking density (25). High stocking density affects the posture (standing/lying postures), feeding behaviour and welfare of animals and therefore affects productivity adversely (12). Colony size did not appear to affect spatial distribution of birds but rather, more standing behaviour and less feeding behaviour were observed in the smallest and largest colony sizes (4). Reducing pen space decreased overall average daily gain and gain/feed and tended to decrease overall average daily feed intake of pigs (14).

There appears to be an interaction between environmental temperature and stocking density on the performance of animals. Reiter & Bessei (17) observed that the temperature under the surface of the litter, at litter surface and at 10 cm above litter surface increased significantly with increasing stocking rate of birds and concluded that high temperature between and underneath the birds was the main

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cause of reduced weight gain at high stocking rate. High stocking density reduced live weights of broiler chickens (23) and had greater influence on daily weight gains of pigs than the type of litter (9). Average daily gain of pigs in the first half of the finishing period was negatively influenced by group size and positively influenced by number of feeding spaces (24).

As the rearing densities increased, the mortality increased in poultry birds (15). Hall (8) studied the effect of two levels of house stocking density on welfare and behaviour of broilers and reported that at high stocking density, daily mortality at rearing period was greater, while incidence of leg problems, contact dermatitis and carcass bruising also increased. Pecking damage increased with stocking density, group size and a group size x density interaction in bantams (20). Group size also had a significant effect on feather condition with large group sizes having most feather damage (2). Sigognault *et al*. (22) conducted experiments with guinea-fowl chicks reared for 70 days under 24 combinations of husbandry conditions and reported that high stocking density resulted in poor feathering and poor skin condition. High stocking rate in pigs has been shown to result in high skatole levels in the carcass (7) therefore making the meat unacceptable to consumers. Risk factors for respiratory diseases included stocking density, air quality, manure management and general hygiene (26).

Rabbits are quiet animals that can grow almost anywhere in the world. They are small and therefore occupy smaller space compared with pigs, sheep, goats and cattle. In the rabbit production enterprise, farmers have to raise and produce the maximum number of marketable rabbits per year to attain high profitability (16). One way of doing this is to increase the number of rabbits stocked in a cage or house thereby maximizing available space. A high cage density reduces production costs, but this might influence the performance and increase the mortality rate of rabbits (10, 16).

In most backyard rabbit enterprises, cages are used to rear rabbits. It is important that a stocking rate is obtained which maximizes cage capacity of farmers while not adversely affecting production parameters and hence profitability of the enterprise. This is especially important in the tropics, which is characterized by high ambient temperatures. This study was carried out therefore, to evaluate the influence of stocking density on performance of growing rabbits under tropical conditions.

Material and methods

Animals

Sixty growing rabbits of between 3 and 4 months age and average weight of 1220 g were used for the study. The rabbits were kept in a completely walled house with open windows covered with poultry wire mesh. The house had windows on opposite walls for proper ventilation.

Experimental procedure

The rabbits were randomly allocated to five stocking densities of 6.7, 10, 13.3, 16.7 and 20 rabbits/m^2 corresponding to 2, 3, 4, 5 and 6 rabbits per cage in a completely randomized design. The rabbits were kept in cages made of wood and poultry wire mesh with dimensions 60 x 50 x 30 cm. The treatments were replicated three times. The rabbits were provided a concentrate meal (22% CP and 2600 kcal ME/kg) consisting on percentage basis of: maize 44.4, groundnut cake 37.2, wheat offal 15, bone meal 2.8, salt 0.3 and vitamin/mineral premix 0.3 in flat-bottomed earthen pots at 8.00 hours in the morning and forages such as lablab and groundnut haulms were fed in the evening at 15.00 hours in plastic trays. Water was supplied *ad libitum* daily in flat bottom earthen pots.

Performance parameters determined were feed intake, weight gain, feed conversion ratio, body condition, fur condition and bites. Feed intake was determined daily by weighing feed supplied, feed left over and/or wasted and subtracting feed left over and wasted from feed supplied. Body measurements were taken weekly. Body condition was scored on the scale of 1 to 5, with 1 being very poor and 5 very good by running the palm of the hand across the backbone to determine the level of muscle cover. Fur condition was scored by the presence or absence of rough skin or hair falling off the skin, on a scale of 1 to 3 with 1 being poor with very rough skin incidence and 3 good, healthy skin condition (smooth fur). Bites were determined by the presence or absence of fight wounds on the skin on a scale of 1 to 3 with 1 being no bites and 3 much skin wounds. The trial was conducted for six weeks in the hot-dry season (April-May) with minimum temperatures of 20 °C and maximum temperatures of 35 °C

Data analysis

Data collected were subjected to analysis of variance test and orthogonal pair-wise difference method was used to test for significant differences between treatments (19).

Results

Stocking density significantly ($P< 0.05$) affected group feed intake and weight gain but not feed conversion ratio of the rabbits (Table 1).

Rabbits stocked at densities of 6.7, 10 and 13.3 rabbits/m^2 had higher average daily gain (ADG) than those stocked at 16.7 and 20 rabbits/m^2. Group ADG was observed to increase with increase in stocking density from 6.7 to 13.3 rabbits/m^2 before decreasing at higher densities. Feed intake for the group increased with stocking density up to 16.7 rabbits/m^2. Feed conversion

ratio was poorer at higher densities (16.7, 20 rabbits/m^2) than at lower densities (6.7, 10, 13.3 rabbits/m^2).
The effect of stocking density on individual rabbit feed intake is shown in table 2.

The trend shows a significant decrease in feed intake by individual rabbits in the groups as stocking density increased in the first and second, and third and fourth weeks of the study. No significant difference in feed intake of individual rabbits was observed in the fifth and sixth week of the study. Total and daily individual feed intake reduced significantly as the stocking density increased.
A different trend was observed for individual rabbit weight gain (Table 3).

Significantly higher weight gain was obtained in stocking densities of 6.7 and 10 in the first and second weeks while in the third and fourth weeks, rabbits in densities of 6.7 and 13.3 had higher weight gain. There was no difference in weight gain for all the stocking densities in week 5-6. Total and daily weight gain was however, higher for rabbits stocked at densities of 10 and 13.3 compared with 16.7 and 20. The trend shows an increase in weight gain of individual rabbits in the groups with increase in stocking density up to 13.3 and then a reduction at 16.7 and 20 rabbits/m^2.
Rabbits stocked at 6.7 to 13.3 rabbits/m^2 had significantly higher body condition score (Table 4) compared with those stocked at 16.7 and 20 rabbits/m^2.

Table 1

Effect of stocking density on group performance of growing rabbits

Parameter	Cage density (No/m^2)					
	6.7	10	13.3	16.7	20	SEM
Rabbits per cage	2	3	4	5	6	
Initial weight (g)	1280	1249	1220	1260	1100	
Final weight (g)	1780	1750	1810	1550	1500	23.05
Ave. daily gain (g)	14^b	14.3^b	16.7^b	8^a	10.7^a	1.02
Ave. daily feed intake (g/cage)	127.6^a	172^a	210.3^b	258.3^c	218.7^b	5.25
Feed/gain ratio	9.1	12	12.6	32.3	20.5	6.22
Mortality (dead/total)	1/6	0/9	2/12	0/15	4/18	-

Means with different superscripts along rows are significantly different (P< 0.05). SEM – Standard error of mean.

Table 2

Effect of stocking density on individual feed intake of growing rabbits

Feed intake (g/rabbit)	Stocking density (No/m^2)					SEM
	6.7	10	13.3	16.7	20	
Week 1-2	975^a	883^{ab}	774.3^{bc}	653.3^c	638.2^c	42.94
Week 3-4	825^a	699^{ab}	764^{ab}	740^{ab}	640.6^{bc}	50.12
Week 5-6	933.3	866.7	900	773.3	736.8	67.78
Total*	2742^a	2448.7^{ab}	2438.7^{ab}	2166.7^{bc}	2015.6^c	148.6
Daily	65.29^a	58.3^{ab}	58.06^{ab}	51.59^{bc}	47.99^c	3.54

Means with different superscripts along rows are significantly different (P< 0.05). SEM – Standard error of mean.

* of surviving rabbit

Table 3

Effect of stocking density on individual weight gain of growing rabbits

Weight gain (g/rabbit)	Stocking density (No/m^2)					SEM
	6.7	10	13.3	16.7	20	
Week 1-2	175^{ab}	239^a	1523^b	87^c	152^b	35
Week 3-4	200^a	172^b	181^{ab}	100^c	67^c	29
Week 5-6	75	167	158	93	117	37
Total	400^{ab}	500^a	525^a	287^c	323^{bc}	63
Daily	9.5^{ab}	11.9^a	12.5^a	6.8^c	7.7^{bc}	1.5

Means with different superscripts along rows are significantly different (P< 0.05). SEM – Standard error of mean.

Table 4
Effect of stocking density on body condition score, fur condition and bites of growing rabbits

Parameter	Stocking density (No/m²)					SEM
	6.7	10	13.3	16.7	20	
Body condition	3.3[a]	4[a]	3.33[a]	2.27[b]	2[b]	0.23
Fur condition	3[a]	3[a]	2.67[ab]	2.27[b]	1.8[b]	0.23
Bites	1	1	1	1.13	1	0.08

Significantly better (P< 0.05) fur condition was observed for rabbits stocked at 6.7 and 10 than 16.7 and 20 rabbits/m². Rabbits stocked at 13.3 had similar fur condition with those stocked at lower and higher densities. The trend however showed a decrease in fur condition with increase in stocking density. There were no differences in fighty bites for all the stocking densities.

Discussion

Stocking density significantly influenced growth rate of birds, with those in low-density groups being on the average, 27 g (1.8%) heavier than those in the high-density groups (6). Kaczor and Szyndler (11) however, reported decreased body weight of broilers with increase in stocking density at nine weeks old. Reduced live weight of broilers (23) and decreased weight gain of kids (21) at high stocking density have also been reported. Martrenchar *et al.* (13) attributed the decrease in body weight with increasing stocking density to a decrease in floor space. Change in average daily gain with increase in stocking density observed in this study, is similar to what was obtained by Prawirodigdo *et al.* (16) where rabbits stocked at 14.4 rabbits/m² performed better than those stocked at 8.6 and 11.5 rabbits/m². Rabbits stocked at densities of 11.6 and 15.4/sq.m were reported to gain at a significantly greater rate than those at 19.3 and 23.2/sq.m (10) indicating an improvement in performance as density increases up to an optimum level.

Beremski (1) reported that increasing stocking density of birds above 16/m² decreased access to feed and water resulting in significant decrease in gain. Increasing stocking density significantly decreased dry matter intake of kids (21). The reduction in feed conversion efficiency in this study could also be related to overcrowding resulting in lack of comfort. The reduction in feed intake observed for rabbits stocked at 20 rabbits/m² indicates probably a reduction in feeding space or lack of comfort due to overcrowding.

Increased incidence of contact dermatitis and carcass bruising in broilers at high stocking density was reported by Hall (8). Skin lesions as a result of overcrowding was reported to be responsible for downgrading 5-10% of guinea fowl carcasses in France, while high stocking density resulted in increased incidence of injured carcasses from 13.5 to 53% (22). Cain (3) reported that feather pecking significantly reduced with increasing floor space/bird. There appear to be no definite relationship between stocking density and mortality rate of rabbits. Maertens and De Groote (10) obtained similar results. Reduction in body and fur condition at 16.7 and 20 rabbits/m² observed in this study indicates a reduction in acceptability of such rabbits to consumers especially where rabbits are marketed live because most consumers prefer rabbits with good body condition and smooth furs.

Stocking density was found to have no effect on total number of aggressive interactions of prepubertal lambs, because they associated preferentially with flock mates (18). While, scratch scores were significantly correlated with stocking density at all ages in broiler chickens (5). The absence of a significant effect of stocking density on fighty bites observed in this study shows that the rabbits were not aggressive to one another and therefore did not fight much even when stocked at the highest density. This could likely be because the rabbits were mainly females, while the males had not reached sexual maturity.

Results obtained from this study are similar with studies carried out in Belgium (10) and United States of America (16). The optimum stocking density of 13.3 rabbits/m² obtained in this study, is however, higher than the optimum stocking density of 6 rabbits/m² reported in literature (16). However, the fact that high densities were used by these researchers (14.4 and 15.4 rabbits/m² at 19 °C) without affecting growth rate could indicate that the optimum stocking density is also likely to be affected by temperature. This could probably explain why at stocking densities of 16.7 and 20 rabbits/m² growth rate was adversely affected in this study.

Conclusion

It is concluded from this study that increasing stocking density from 6.7 to 20 rabbits/m² significantly affected feed intake, weight gain, body condition score and fur condition but not feed/gain ratio and mortality rate of rabbits. Stocking rabbits at densities exceeding 13.3 rabbits/m² had significant negative effect on rabbit growth rate for the cage dimensions used in this study under tropical conditions.

Literature

1. Beremski Ch., 1982, Effect of stocking density and length of rearing on the productivity of broilers. Nutr. Abstr. Rev. series B. **52**, 1, 44-45. No. 369.
2. Bilcik B. & Keeling L.J., 1999, Changes in feather condition in relation to feather pecking and aggressive behaviour in laying hens. British Poultry Science, **40**, 4, 444-451.
3. Cain J.R., Weber J.M., Lockamy T.A. & Creger C.R., 1984, Grower diets and bird density effects on growth and cannibalism in ring-necked pheasants. Poultry Science, 63,3, 450-457.
4. Channing C.E., Hughes B.O. & Walker A.W., 2001, Spatial distribution and behaviour of laying hens housed in an alternative system. Applied Animal Behaviour Science, **72**, 4, 335-345.
5. Elfadil A.A., Vaillancourt J.P. & Meek A.H., 1996, Impact of stocking density, breed, and feathering on the prevalence of abdominal skin scratches in broiler chickens. Avian Diseases, **40**, 3, 546-552.
6. Elwinger K., 1995, Broiler production under varying population densities-a field study. Archiv für Geflügelkunde, **59**, 4, 209-215.
7. Hansen L.I., Larsen A.E., Jensen B.B., Hansen-Moller J. & Barton-Gade P., 1994, Influence of stocking rate and faeces deposition in the pen at different temperatures on skatole concentration (boar taint) in subcutaneous fat. Anim. Prod. **59**, 1, 99-110.
8. Hall A.L., 2001, The effect of stocking density on the welfare and behaviour of broiler chickens reared commercially. Animal Welfare, **10**, 1, 23-40.
9. Kaczor A. & Szyndler J., 1999, Living conditions and body weight gains of fattening pigs kept on different litters. Roczniki Naukowe Zootechniki, **26**, 4, 365-376.
10. Maertens L. & De Groote G., 1984, Influence of the number of fryer rabbits per cage on their performance. J. Appl. Rab. Res. **7**, 4, 151-155.
11. Mandlekar S.M. & Thatte V.R., 1986, Effect of stocking density on growth of broilers reared in cages. Indian J. Poultry Science, **21**,2, 149-150.
12. Martrenchar A., Morisse J.P., Huonnic D. & Cotte J.P., 1997, The influence of stocking on some behavioural, physiological and productivity traits of broilers. Veterinary Research, **28**, 5, 473-480.
13. Martrenchar A., Huonnic D., Cotte J. P., Boilletot E. & Morisse J.P., 1999, Influence of stocking density on behavioural, health and productivity traits of turkeys in large flocks. British Poultry Science, **40**, 3, 323-331.
14. Matthews J.O., Southern L.L., Bidner T.D. & Persica M.A., 2001, Effects of betaine, pen space, and slaughter handling method on growth performance, carcass traits, and pork quality of finishing barrows. Journal of Animal Science, **79**, 4, 967-974.
15. Oliveira J.E., de Sakomura N.K., Figueiredo A.N., Lucas Junior J., de Santos T.M.B., dos De Oliveira J.E., De Lucas Junior J. & Dos Santos T.M.B., 2000, Effect of thermal insulation under the roof on performance of broiler chickens stocked at different densities. Revista Brasileira de Zootecnia, **29**, 5, 1427-1434.
16. Prawirodigdo S., Raharjo Y.C., Cheeke P.R. & Patton N.M., 1985, Effect of cage density on the performance of growing rabbits, J. Appl. Rab. Res. **8**, 2, 85-88.
17. Reiter K. & Bessei W., 2000, Effect of stocking density of broilers on temperature in litter and at bird level. Archiv für Geflügelkunde, **64**, 5, 204-206.
18. Ruiz de la Torre J.L. & Manteca X., 1999, Behavioural effects of social mixing at different stocking densities in prepubertal lambs. Animal Welfare, **8**, 2, 117-126.
19. SAS, 1987, Institute INC, 1987, SAS/STAST. Guide for personal computers, Version 6. ed. pp. 697-978.
20. Savory C.J., Mann J.S. & Macleod M.G., 1999, Incidence of pecking damage in growing bantams in relation to food form, group size, stocking density, dietary tryptophan concentration and dietary protein source. British Poultry Science, **40**, 5, 579-584.
21. Sevi A., Muscio A. & Campanaro G., 1995, Effect of stocking density on productive performance and behaviour of artificially reared female kids. Zootecnica e Nutrizione Animale, **21**, 2, 111-117.
22. Sigognault A., Drouin P., Toux J.Y., Guittet M. & Bennejean G., 1994, Cutaneous lesions in guinea fowl broilers: influence of stocking density, sex and lighting regimen. Proceedings of the 8th International Congress on Animal Hygiene, St. Paul, Minnesota, USA, 12-16 September 1994. AW21-AW24.
23. Sorensen P., Su G. & Kestin S.C., 2000, Effects of age and stocking density on leg weakness in broiler chickens. Poultry Science, **79**, 6, 864-870.
24. Spoolder H.A.M., Edwards S.A. & Corning S., 1999, Effects of group size and feeder space allowance on welfare in finishing pigs. Anim. Science, **69**, 3, 481-489.
25. Stark K.D.C., 2000, Food safety achieved through herd management. SAT, Schweizer Archiv für Tierheilkunde, **142**, 12, 673-678.
26. Stark K.D.C., Pfeiffer D.U. & Morris R.S., 1998, Risk factors for respiratory diseases in New Zealand pig herds. New Zealand Veterinary Journal, **46**, 1, 3-10.

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