Influence of birth weight and litter size on the preweaning growth performance and survival of guinea pigs (*Cavia porcellus* L.).

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ABSTRACT

Birth records, preweaning growth and mortality data recorded in two consecutive parities on 121 kids of 39 female guinea pigs were analysed to determine the influence of birth weight (BW) and litter size (LS) on preweaning growth and survival. Results show highly significant differences (P<0.01) in the mean birth weight (MBW) between single males(97.82±2.13g) and twin males (78.69±2.40g). The same trend was also observed for the females being 86.17±4.0 g for single births as against 73.72±1.80 g for twins. Corresponding mean weaning weights (MWW) at 3 weeks of age, independent of sex were higher (P<0.01) for single births than twins births. Comparisons for the preweaning mean daily weight gain(MDWG) as reflected by the birth weight ranges (BWR) (50-69.9, 70-89.9, >90g) showed a highly significant variation (P<0.001). A higher MDWG was consequently observed with the BWR above 90g followed by 70-89.9 and the 50-69.9 BWR respectively. As a result, the highest (P<0.001) mean weaning weights were obtained with the higher birth weight ranges. Preweaning mortality records showed a survival percentage for the four different BWR (<49.9,50-69.9, 70-89.9, >90g) to be 16.67, 64.52, 95.83 and 96.65 % respectively. The difference between single and twin birth in the percentage survival was 6.10%. Higher BW and single litters were observed to be associated with higher survival and growth rates. Therefore, management practices which could increase BW seems a very tempting option for guinea pig productivity in the region.

Key words: Guinea pigs, birth weight, litter size, preweaning growth , survival, Cameroon.

RESUME

Les données relatives à la mise bas, à la croissance pré-sevrage et au taux de mortalité pré-sevrage enregistrées pendant deux mise-bas consécutives chez 121 jeunes cobayes nés de 39 mères ont été analysées dans le but de déterminer l'influence du poids à la naissance et de la taille de la portée sur le taux de survie et de croissance pré-sevrage. Les résultats ont montré une différence hautement significative (P<0,01) entre le poids des naissances simples (97,82±2,13 g) et celui des naissances doubles (78,69±2,40g) chez les mâles. La même tendance a été observée chez les femelles. Soit 86,17±4,0g pour les naissance simples et 73,72±1,80g pour les naissances doubles. Pour ce qui est du poids au sevrage, indépendamment du sexe , il a été très significativement plus élevée (P<0,001) chez les jeunes de naissance simple par apport a celui des naissances doubles. La gain moyens quotidiens, (GMQ) avant sevrage à été corrélée avec le poids a la naissance. Ainsi le tranche du poids a la naissance supérieur à 90g, à obtenu au terme du sevrage le GMQ le plus élevé (P<0,001) survie de celui des tranches de poids de 70-89,9 et 50-69,9 respectivement. En conséquence le poids au sevrage la plus élevé (P<0,001) à été obtenu avec les tranches de poids à la naissance les plus fortes. Pour ce qui est du taux de survie, il à été d'autant plus élevée que le poids a la naissance était faible. Soit 16,67 ; 64,52 ; 95,83 et 96,65 % respectivement pour les tranches de poids inférieur à 49,9; 50-69,9; 70-89,9 et supérieur à 90g. Le taux de survie dans les naissances simples à été de 6,10% supérieur comparé à celui des naissance doubles. Ainsi une corrélation à été trouvée entre le poids a la naissance élevée et le type de naissance simple d'une part et d'autre part le poids élevée a la naissance et le GMQ, le poids au sevrage et un taux de survie élevées. La recherche du poids a la naissance élevée chez le cobaye est susceptible d'accroître sa productivité.

Mots-clés : Cobayes, poids à la naissance, taille de la portée, taux de survie, croissance pré-sevrage.

INTRODUCTION

The challenges for research and development of the non – conventional small animal production in the western highlands of Cameroon is justified by the demographic pressure on land and a consequent growing resource poor farmer interest in small animal production. Due to this demographic problem, the development of small animal production in the region is squarely dependent on the increase in animal productivity rather than an increase associated with higher numbers of animals.

However, the major constraint to animal productivity is the poor reproductive performance of the females resulting from a combination of genetic, physiological, management and environmental factors (Agyemang et al; 1991). These together with the high preweaning mortality associated with production at the farm level which has been demonstrated in goats (Ndamunkong, 1985, Manjeli et al; 1996) and in guinea pigs (Fotso et al; 1995, Manjeli et al; 1998) are some of the key variables affecting small animal productivity.

Therefore a better understanding of the relationship between these variables and preweaning mortality for a particular species will often provide the basis for the design of an improved management system. An example has been demonstrated in selection against twins in sheep where survival rate tended to be low (Wilson et al; 1985). Similarly, birth weight has been shown to explain much of the variation in survival in pigs (Uko et al; 1994) and in sheep (Hinch et al; 1985). Although heavier kids at birth have a higher incidence of dystokia, lighter ones are more susceptible to mortality associated with starvation, mismothering and exposure (Fogarty et al; 1992).

The objective of this study is to quantify the influence of birth weight and litter size on preweaning growth performance and survival of guinea pigs. The availability of such information could facilitate the optimal exploitation of these small animals species at the farm level.

MATERIALS AND METHODS

Study site

The study was conducted at the Teaching and Research farm of the University of Dschang. Dschang is situated in the Western Highlands of Cameroon which is in the Sudano – Guinean zone (latitude 5 - 7^0 N, longitude 8 - 12^0 E). The mean annual temperature and relative humidity are 16 - 17^0 C and 49 – 97% respectively. The mean annual rainfall is about 2000 mm, the wet season ranges from March to November and the dry season from late November to March.

Trial management

Forty-three (43) guinea pigs made-up of 39 females and 4 males of the same age range were randomly divided into four groups and placed in identical floor pens of 2.88 m. sq. Litter material was used in the pens and replaced to avoid accumulation of urine and faeces. At the beginning of the study, animals were identified using small metallic ear tags. Animals were allowed to mate naturally with a ratio of 9 – 10 females to one male per pen. The study lasted for six months (September 2001 to February 2002) with the females giving birth to a total of 121 kids in two parities (first and second).

Animal management

Animals were fed *ad libitum* with fresh forage mainly *Pennisetum purpureum, Trypsacum laxum, Pennisetum clandestinum, Bracharia spp*, plantain leaves and stems, *Desmodium spp* and kitchen wastes. An additional supplement of a mixture of palm kernel cake, wheat bran, vitamin-mineral premix and salt was also sometimes provided.

Animals kidded within a range of two weeks for each parity and the birth weights of kids were taken within 12 hours after kidding. The litter size and sex were recorded. Kids were weight weekly until the presumed weaning of 3 weeks when the weaning weights were obtained. The mortalities as reflected by birthweight and litter size were noted when they occurred.

Data analysis

Data on birth weight and weaning weight together with the effect of litter size on daily weight gain were analysed using the student's test. Analysis of variance was used to analyse data on daily weight gain as reflected by the different birth weight ranges and their corresponding weaning weights (Table 2). Significant means for the daily weight gain and weaning weights in table 2 were separated using the Duncan's multiple range test. All analysis were done according to the methods described by Steel and Torrie, (1980). Meanwhile data on mortality as reflected by these parameters are represented graphically.

RESULTS

Birth weight and weaning weights

The effect of litter size on the mean birth and weaning weights of guinea pigs is shown in table 1. The mean birth weights for males for the single and twin births were 97.82 ±2.13 and 78.69±2.40 respectively. Corresponding values for females were 86.17±4.0 and 73.72±1.80. Independent of sex, values for the overall mean birth weight for singles and twins were 92.85±2.25 and 73.83±1.68 respectively. Highly significant (P<0.01) differences between the single and twin birth were observed for all these values with the mean values of singles being higher.

Mean weaning weights also followed a similar trend with values for the single birth being significantly higher (P<0.01) than those for twin birth. These values were 196.29±6.65 and 162.36±6.12 for males of single and twin birth and 174.4±9.17 and 158.13±4.60 for females respectively. Overall mean values (independent of sex) were 188.63±5.76 and 158.14±3.72 respectively.

Preweaning growth performance

The effect of birth weight on mean daily weight gain is shown in table 2. The birth weight ranges which were those between 50 - 69.9, 70 - 89.9 and 90 g and above recorded over all mean daily weight gains (MDWG) of 3.14± 0.53, 3.95±0.25 and 4.65±0.30 respectively. Corresponding first week MDWG values were 3.22±0.22, 3.71±0.19 and 3.95±0.24. Second week mean values for these ranges were 2.60±0.26, 4.25±0.24 and 6.06±0.39 respectively while third week values were 3.61±1.11, 3.88±0.31 and 3.95 ±0.27. There was no significant difference (P>0.05) between these figures for the first and third week mean daily weight gains while there was a highly significant difference (P<0.001) between the mean values for the second week and the over all mean values.

The respective mean weaning weights for these birth weight ranges increased highly significantly (P<0.001) from 128.27 ±5.82 for the 50 – 69.9 range to 190.79±4.27 for the 90 and above range. Table 3 shows the effect of litter size on the preweaning mean daily weight gain of guinea pigs. Higher mean daily weight gains were recorded for the single birth for the first (4.30±0.25) and second week (5.80±0.45) than for the twin birth for the same period (3.42±0.14 and 3.78±0.23). The third week mean daily weight gains showed a different trend with twin births having a higher value (4.03±0.33) than single birth (3.75±0.22). There were highly significant (P<0.01) differences between single and twin birth for these values.

Table 1: Effect of litter size on the mean birth and weaning weights (grams± s.e) of guinea pigs.

	Males		Females		Males and Females	
LS	B W*	WW^z	B. W. *	WW^z	B. W^z	W.W. ^{z}
1	97.82±2.13^a	196.29±6.65^a	86.17±4.0^a	174.4±9.17^a	92.85±2.25^a	188.63±5.76^a
2	78.69±2.40^b	162.36±6.12^b	73.72±1.80^b	158.13±4.60^b	73.83±1.68^b	158.14±3.72^b

Means bearing different superscripts within the same column differ significantly (z = P< 0.001, * = P< 0.01).
LS = litter size *BW =birth weight* *WW = weaning weights*

Table 2: Effect of birth weight on mean daily weight gain (grams± s.e) of guinea pigs

Birth weight	Mean daily weight gain				Mean weaning
range(g)	1st week	2nd week	3rd week	0 –3 weeks	weight
50 - 69.9	3.22±0.22^a	2.60±0.26^a	3.61±1.11^a	3.14±0.53^a	128.27 ± 5.82^a
70 – 89.9	3.71±0.19^a	4.25±0.24^b	3.88±0.31^a	3.95±0.25^b	160.16±3.69^b
>90	3.95±0.24^a	6.06±0.39^c	3.95±0.27^a	4.65±0.30^c	190.79±4.27^c

Means (± Standard error) bearing different superscripts within the same column differ significantly (P<0.001).

Table 3: Effect of litter size on the preweaning mean daily weight gain (grams± s.e) of guinea pigs.

Litter size	Weeks		
	1st Week*	2nd Week^z	3rd Week*
1	4.30 ± 0.25^a	5.80 ± 0.45^a	3.75 ± 0.22^a
2	3.42 ± 0.14^b	3.78 ± 0.23^b	4.03 ± 0.33^b

Means bearing different superscripts within the same column differ significantly (z = P<0.001, * = P< 0.01).

Table 4 : Effect of litter size and sex on the preweaning mean daily weight gain (grams ± s.e) of guinea pigs.

Litter size	Mean daily weight gain					
	Males			Females		
	1st Week^{Z}	2nd Week^{Z}	3rd Week	1st Week^{Z}	2nd Week^{Z}	3rd Week^{R}
1	4.16±0.37^{a}	6.36±0.64^{a}	3.83±0.23^{a}	4.50±0.33^{a}	4.80±0.37^{a}	3.65±0.55^{a}
2	3.38±0.21^{b}	4.21±0.40^{b}	3.73±0.54^{a}	3.58±0.19^{b}	3.61±0.25^{b}	4.12±0.41^{b}

Means bearing different superscripts within the same column differ significantly ($_{Z}$ = P<0.001, $_{R}$ = P<0.05).

The effect of litter size as reflected by sex on the mean daily weight gain is shown in table 4. Males of the single birth recorded significantly higher (P<0.01) values for the first (4.16±0.37) and second week (6.36±0.64) than males for twin birth for the same period (3.38±0.21 and 4.21±0.40). Means for the third week followed the same numerical trend but for the fact that no significant differences (P>0.05) were observed.

Mean values for this parameter for females showed the same trend (P<0.01) for the first (4.50±0.35 vs. 3.58±0.19) and second week (4.80±0.37 vs. 3.61±0.25) while for the third week, significantly (P<0.05) higher values for the twin birth (4.12±0.41) than single birth (3.65±0.55) were obtained.

Preweaning mortality

Figure 1 shows the percentage preweaning mortality values for the four birth weight ranges; 49.9 and below, 50–69.9, 70– 89.9 and 90 and above. The figure shows that there was a 83.33% mortality for all the animals below 50 grams birth weight and this figure reduced considerably with increasing range in birth weight and these were 35.48, 04.17 and 3.45% in that order. These corresponded to survival percentages of 16.67, 64.52, 95.83 and 96.55 % respectively.

Figure 2 shows the influence of litter size on the preweaning mortality. The lowest mortality was observed for animals in the single birth category (11.76) while the animals in twin birth had 17.86% and a single litter of triple birth which was observed during the study had a 100% mortality. The corresponding difference in survival rate between single and twin birth was observed to be 6.10%.

DISCUSSION

The values for the mean birth weight of males and the overall mean values for the single birth reported in table 1 are within range of values reported by Hardouin et al, (1991) and Cicogna, (2000). Values for these parameters in females and for twin birth are slightly lower than those of Hardouin et al, (1991) but is consistent with the range observed by Cicogna, (2000) and slightly higher than single and twin birth values reported by Manjeli et al, (1998). Corresponding mean weaning weight values for this study (at 3

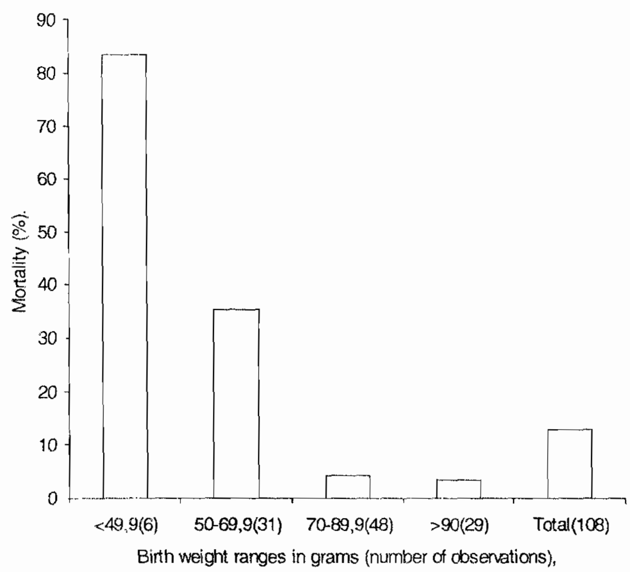

Figure 1: Influence of birth weight on preweaning mortality

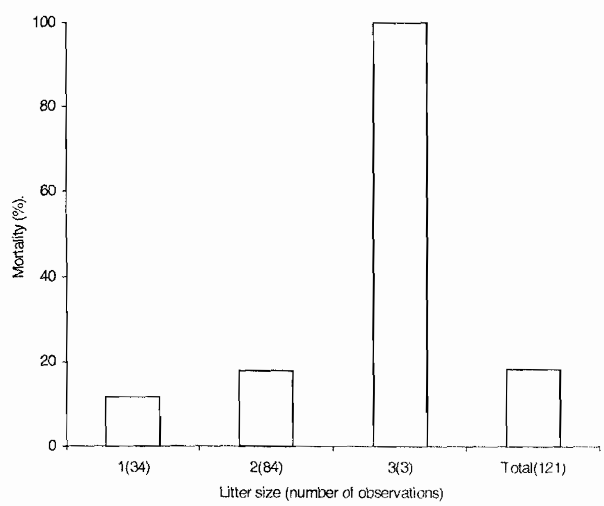

Figure 2: Influence of litter size on preweaning mortality

weeks of age) were more than double the values for their equivalent birth weights. The doubling is indicative of the rapid growth rate associated to preweaning growth of guinea pigs. A similar observation has been made by Cicogna, (2000) who observed that the live weight of guinea pigs is more than doubled at normal weaning of 3 weeks and will again be doubled the following 6 weeks. The doubling of these weights was independent of the litter size and the initial birth weight.

These mean weaning weights were higher than the values observed by Manjeli et al, (1998) for animals under traditional management. However values for this study are similar to the observations of Tchoumboue et al, (2001) for guinea pigs under improved management in the Western Highlands of Cameroon. The mean daily weight gain values as reflected by the birth weight ranges (Table 2), litter size (Table 4) are in conformity with the observations of Tchoumboue et al, (2001).

The differences are making clearer the fact that the main constraint to productivity at the farm level is improved breeding and management (principally nutrition). The poor growth associated to production at the farm level which may be responsible for low birth and weaning weights is most probably associated with the sub-optimal protein levels given to the animals at the farm level.

Feeding at the farm level has often depended on animals scavenging on the floor of kitchens for their daily needs with most food provided coming from harvest wastes, house hold scraps and vegetables and forages which are sometimes provided (Manjeli et al; 1998). The wide variation in growth rate in the present study as reflected by the birth weight ranges (Table 2) is indicative of the initial advantage which birth weight confers on the animal. Selection for improved birth weight is therefore important for these species since the main product in this enterprise is meat. The corresponding weaning weights as shown in the same table (2) still further points to the fact that birth weight and growth rates determine overall productivity in guinea pigs. Faster growing kids attain higher weights at a given age and reach puberty or table size earlier than slower growing ones. This advantage of birth weight with regards to growth has been demonstrated for other species (Adu et al; 1985; Chiboka et al; 1988, Ikwuegbu et al; 1996). The influence of litter size as recorded in this study are still indicative of the strong initial advantage which birth weight confers on the offspring amongst other factors such as more maternal care for singles. Higher preweaning growth rates associated to the single births in all cases as opposed to twin births is understandable. However, the variation in this trend for third week growth figures in table 3 is probably owing to the increasing feed efficiency for twin kids at this age due to their increasing weights and probably compensatory growth.

The preweaning mortalities represented in figures 1 and 2 for the birth weight ranges and litter size respectively were lower than the values reported by Manjeli et al, (1998) (38.93%) and slightly higher than those of Hardouin et al, (1991) (15.60%). These differences are attributable to the differences in litter sizes and birth weights of animals used in the respective studies. Manjeli et al, (1998) had up to 4 litters in their studies, which are taught to have considerably reduced birth weight, viability at birth and survival while Hardouin et al, (1991) reported a birth weight range of 95- 145grams which is very high and could improve survival. Manjeli et al, (1998) further stated that high prolificacy did not seem desirable because mortality of young increased with increasing prolificacy. The percentage preweaning mortality values for the different birth weight ranges shown in figure 1 are consistent with the above observations.

Several studies in other species have also demonstrated the fact that animals with low birth weight are more prone to die than heavier ones (Bathau and Kennedy, 1990; Otesile and Oduye, 1991; Uko et al; 1994). The influence of litter size on preweaning mortality which may still be another mild reflection of birth weight has also been reported for sheep (Otesile, 1993) and pigs (Uko et al; 1994).

These factors taken together suggest that despite the fact that considerable improvements in productivity can be achieved with higher prolificacies, it is the attainment of a satisfactory individual birth weight which determines largely whether a kid will survive or not especially at the farm level. It would therefore be of no practical use to increase prolificacy especially at the farm level if improved management practices such as improved health, nutrition and housing are not adopted to maintain the production level. In the mean time the selection for increased birth weight or management practices geared towards improved birth weight seems a very tempting option for guinea pig productivity in the region. This is so because higher birth weights have been shown to be associated with higher growth rates, weaning weights and indeed the growth rate of guinea pigs is rapid within the first 4

– 6 weeks (NRC, 1991). The weight at maturity is therefore strongly dependent on the preweaning phase of growth which represents about half of the active growth cycle of guinea pigs. The above suggestion will be quite useful if the production objectives are geared towards raising animals as a source of meat as is the case in the Western Highlands of Cameroon.

While these remain true, further research is required to study the role of specific factors as causes of preweaning mortality as well as their incidence and interaction.

ACKNOWLEDGEMENTS

We acknowledge the assistance of the staff of the Teaching and Research farm, brooding unit, of the University of Dschang. Special thanks goes to Mr Tsafack Prosper who participated actively in the feeding of the animals under the study. Sincere thanks also goes to Mrs. M. L. Niba for typing the manuscript.

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Received: 15/11/2002
Accepted: 14/01/2004