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Local Rabbit (*Oryctolagus cuniculus*) Population Growth Performance in Cote d'Ivoire as Affected by Rhythm of Reproduction

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Abstract

The present study compared the growth performance of rabbits from the local Ivorian population from females mated 11 days postpartum (semi-intensive rhythm R42) and those mated 25 days postpartum (extensive rhythm R56). 240 females bred on a private farm in Abidjan District were naturally mated. The bunnies from the different matings, weaned at 23 and 35 days, respectively in the R56 and R42 rhythms, were followed during the experiment. They were fed ad libitum with granulated feed after weaning. The following criteria were recorded: individual birth weight, average weaning weight, average weight at standard age, average daily feed intake (DFI), average daily gain (ADG), feed conversion index (FCI) and carcass yield. The results indicate that the reproduction rhythm had no significant effect (P>0.05) on Daily Food Intake, Consumption Index and carcass yield at all stages of growth. Rabbits weaned at 35 days (R56) grew between 35 and 60 days faster than those weaned early at 23 days (R42). Compensatory growth of these early weaned rabbits was observed after 55 days. In addition, the locally bred rabbits showed a good carcass yield (64-65%).

Keywords: growth performance, rabbits, reproduction rhythm, locally bred

1. Introduction

Raising rabbits is a relatively simple activity that requires very few inputs. Rabbit keeping can contribute to improving the income of rabbit keepers and the diets of urban and rural households (Kacou, 1987; Bodji, 1992; Kimse et al., 2017). The galloping demography of the city of Abidjan and its suburbs constitutes a potential market for the marketing of rabbit meat. Thus, since the 2000s, rabbit breeding has been increasingly evolving, with a predominance of semi-commercial breeding (Tano, 2002).

Unfortunately, rabbit farming is not yet fully developed in Côte d'Ivoire. Indeed, it remains traditional, unlike poultry and pig farming, which are also practiced in Abidjan and its suburbs. The most common mode of reproduction of rabbits in the different areas is extensive, with 4 births per year (Kimsé et al., 2017). Very little information is available on the zootechnical performance of the local breed. However, some recent studies (Kimsé et al., 2014; Soro et al., 2014; Kimsé et al., 2017; Samy et al., 2018) provide data on the growth performance of exotic rabbits and the breeding system.

Considered today as a developing breeding system, an improvement in the reproductive performance and longevity of breeding females through mastery of breeding management is a key element in overcoming the difficulties associated with this type of breeding (Feugier and Fortun-Lamothe, 2006). An optimal reproduction rhythm with short intervals between successive parturient females to reduce unproductive periods is of great interest. However, the search for optimum breeding behaviour to obtain highly productive females also involves improving the growth of the rabbits. The objective of this study is to evaluate the growth performance of local breed rabbits based on the reproduction rhythm (semi-intensive and extensive) and the age at weaning (early at 23 days old or late at 35 days old).

2. Material and Methods

2.1. Study Site

This study was carried out in a private farm located 5 km from the town of Bingerville, on the Bingerville-Abidjan axis in Ivory Coast. This region is characterised by abundant vegetation with a humid tropical climate, the annual rainfall is on average 1,600 mm, the temperature varies between 26°C and 32°C and the hygrometry rate exceeds 90% according to data collected from SODEXAM (Société d'Exploitation et de Développement Aéroportuaire, Aéronautique et Météorologique).

2.2. Livestock Buildings and Animal Monitoring

The farm covers an area of 5 ha. It has two barns, each covered with a tarpaulin and cemented floor. The first shed is 15 m long and 7 m wide. It houses the breeding stock and unweaned bunnies. This hutch has 70 cages. The second shed is 16 m long and 14 m wide. It is reserved for fattening bunnies and has 45 cages. Temperature and humidity are constantly monitored by means of a thermometer and a hygrometer inside each building. All the cages are protected by wire mesh on the outside. Each cage contains a metal trough and a metal drinking trough installed on two opposite sides in the width direction.

The animals have been fed with two types of granulated feed FACI and SIPRA/IVOGRAIN specially made for rabbits. The former is intended for lactating females and consists of 14.2% Crude Cellulose (CC) and 16.4% Crude Protein (CP). The second one for breeding males and fattening rabbits contains 14.7 % CB and 15.4 % CP. Fresh lemongrass leaves, stems, fresh or dry leaves (50 grams per breeding male every two days, 200 g for 5 weaned bunnies) of Moringa oleifera (Moringaceae) are added to the pellets as a feed supplement. Health monitoring was carried out by a veterinary technician from the Central Laboratory of Animal Pathology in Bingerville.

2.3. Experimental Design

A total of 240 locally bred primiparous rabbits aged 17 weeks with an individual body weight between 2 and 2.2 kg were subjected to staggered mating. Thirty 22-week-old breeding males of local breed with a body weight between 2.5 and 2.7 kg were used for mating: one male for every eight females. Two batches were formed. In each batch, 120 females and 15 males of local breed were mated with two breeding rhythms (semi-intensive and extensive) and weaning of the bunnies (early and late) at different ages:

- lot R42: the breeding rhythm is 42 days: mating takes place 11 days after farrowing (semi-intensive rhythm). The bunnies are weaned at 35 days of age (late weaning).
- R56 plot, breeding rate is 56 days, mating takes place 25 days after farrowing (extensive rhythm). The bunnies are weaned at 23 days of age (early weaning).

Immediately after the first parturition, the females are randomly assigned to one of the follow-up lots. The animals were followed over five breeding cycles for 10 months for lot R42 and 12 months for lot R56. Pregnancy of each rabbit was monitored from the 11th day after mating by abdominal palpation. When a female rabbit is pregnant, the palpation is qualified as positive.

After giving birth, the young rabbits are placed in the box under the skin. For the first 15 days after birth, the young rabbits feed exclusively on milk. From the third week they leave the nest but remain in their mother's cage until the day of weaning, so in addition to milk, granulated food and water is added.

2.4. Data Collection

The individual weights of the bunnies were recorded at birth, at 23, 35, 60 and 90 days of age. The amount of feed fed during the fattening period and the amount of feed withheld was also weighed for each animal. These data were used to calculate average weaning weight, average weight at standard age, average daily feed intake (DFI), average daily gain (ADG), consumption index and carcass yield for each individual.

The DFI is the difference between the total amount of feed fed and the amount of feed withheld divided by the duration of fattening and the average number of rabbits in the cage. The ADG corresponds to the difference between the average weight at standard age and the average weight at weaning, divided by the fattening time. The consumption index is calculated by dividing the DFI by the ADG. After the rabbit is slaughtered, the skin, head and viscera are removed. The weight of the commercial carcass is determined using a mechanical scale. Carcass yield is obtained by the ratio of the commercial carcass weight to the live weight before slaughter.

2.5. Statistical Analysis

The averages of average weaning weight, average age-standardized weight, average daily gain (ADG), average daily food intake (DFI) and consumption index were subjected to an analysis of variance using the GLM (General Linear Model) procedure of the STATISTICA 7.1 software. The effects in the order of parity were considered as fixed effects. The effects of the number of the mother, the month of farrowing and the father were considered as random variables. Not all the effects of the interactions were significant on the factors studied ($P > 0.05$) and, therefore, were not considered in the model. The comparison of means within the factors studied was carried out using the Student Duncan method. STATISTICA 7.1 software was used for the statistical processing of the data.

3. Results

3.1. Effect of the Parity Order on Growth Performance

The effect of parity order on the weight of bunnies at standard age was significant ($P<0.05$). For the R42 reproductive rate, the highest birth weight was 65g and the highest average weights at 35 days of age and 90 days of age were recorded at parity 2 and 5. In the case of reproductive rate R56, the highest birth weight was recorded at parity 1 (57.29g) (Table I).

The average daily gain from birth to 23 days of age was significantly influenced ($P<0.001$) by parity in the case of reproductive rate R42. The highest ADG was recorded at the second parity (13.21 g/d). However, there is a regularity of the ADG at all five parities up to day 35. From the 35th day to the second month of age of the bunnies, the 2nd, 4th and 5th parities recorded the best ADGs, which were almost identical (Tables I and II). From the second month onwards, the average daily gain drops to 22.47, 21.74, 21.75, 20.49 and 21.70 g/d for the five respective parities despite the increase in the DFI (Table I). Contrary to the R42 rhythm, the average daily gain from birth to 23 days of age was not significantly influenced by the order of parity in the R56 reproduction rhythm ($P=0.810$). The same was true for the period 60-90 days of age of the bunnies ($P=0.216$). Between GMQ23-35 and GMQ35-60, the mean daily gain was significantly influenced by the order of parity ($P<0.05$). The ADG was highest during this period (4.56 g/d) and was recorded at parity 1. The average daily gain dropped after weaning despite the increasing evolution of the DFI (Table I).

Table I: Live body weight (LBW) and Average Daily Gain (ADG) of growing rabbit as affected by order of parity

Rhythms	Variables	Parity 1	Parity 2	Parity 3	Parity 4	Parity 5	p
R42	**Live body weight, g**						
	at birth	53.54^{b}	52.43^{b}	53.55^{b}	53.61^{b}	65.00^{a}	0.051^{*}
	at 23 days	323.63^{b}	355.50^{a}	319.01^{b}	339.26^{ab}	359.25^{a}	0.002^{*}
	at 35 days (weaning)	415.4^{b}	458.50^{a}	$407{,}09^{b}$	$431{,}85^{ab}$	$447{,}75^{ab}$	0.019^{*}
	at 60 days	1463.33^{bc}	1682.86	$1429{,}65^{b}$	$1613{,}90^{ab}$	$1761{,}25^{a}$	0.028^{*}
	at 90 days	1950.83^{b}	2242.86^{a}	$1963{,}37^{b}$	$2140{,}37^{ab}$	$2241{,}25^{a}$	0.017^{*}
	Average daily gain, g/d						
	0-23 days	11.83^{bc}	13.21^{a}	$11{,}74^{c}$	$12{,}40^{abc}$	$12{,}80^{ab}$	$<0.001^{***}$
	23-35 days	7.62	8.58	7.68	8.76	8,9	0.114^{ns}
	35-60 days	41.93^{a}	48.97^{a}	40.90^{b}	47.28^{a}	52.54^{a}	0.032^{*}
	60-90 days	16.25^{b}	16.67^{b}	17.79^{ab}	17.55^{ab}	16.00^{b}	0.029^{*}
	Live body weight, g						
	at birth	57.29^{a}	43.66^{c}	55.59^{ab}	53.93^{ab}	52.47^{b}	$<0.001^{***}$
	at 23 days	358.17	339.44	349.61	346.58	347.47	0.602^{ns}

Rhythms	Variables	Parity 1	Parity 2	Parity 3	Parity 4	Parity 5	p
R56	at 35 days (weaning)	412.92	390.88	401.52	394.03	400.45	0.491^{ns}
	at 60 days	1417.92	1338.90	1471.08	1387.76	1415.73	0.081^{ns}
	at 90 days	2092.00	2041.20	2123.53	2002.55	2066.65	0.126^{ns}
	Average daily gain, g/d						
	0-23 days	13.08	12.88	12.78	12.82	12.82	0.810^{ns}
	23-35 days	4.56^{a}	4.29^{a}	4.33^{a}	3.95^{b}	4.33^{a}	0.012*
	35-60 days	40.20^{a}	39.92^{a}	42.78^{b}	39.75^{a}	40.68^{a}	0.029*
	60-90 days	22.47	21.74	21.75	20.49	21.70	0.216^{ns}

a, b, c: means within each row affected with different letters are significantly different (P<0.05)

All bunny DFIs were significantly influenced by the order of parity for the two breeding rates studied. In the R56 rhythm, the DFIs were significantly influenced by parity at all stages of bunny growth. DFI_{0-23}; DFI_{23-35}; DFI_{35-60} and DFI_{60-90}, the lowest were recorded at the second parity (53.60 g/d; 67.00 g/d; 100.50 g/d; 175.87 g/d respectively). For the R42 rhythm, the largest DFIs were recorded at parity 5 with values of 74.74 g/d; 93.30 g/d; 140.14 g/d; 245.25 g/d for DFI_{0-23}; DFI_{23-35}; DFI_{35-60} and DFI_{60-90}, respectively (Table II).

Consumption index was not significantly influenced (P>0.05) by the order of parity regardless of the growth stage of the animals in the R42 rhythm. In contrast, in the R56 rhythm, this index had a significant effect depending on parity. Furthermore, the consumption index remained low between 35 and 60 days of age compared to the post-weaning stage (60-90 days) for each of the R42 and R56 rhythms. As for carcass yields, they differed significantly at all stages of evolution of the two reproduction rates studied. The highest yield was recorded at the second parity of the R42 rhythm. In the case of R56, the highest values were recorded at parities 1, 2 and 5 (Table II).

Tableau II: Daily Food Intake (DFI), Consumption Index (CI) and Carcass Yield affected by order of parity

Rhythms	Variables	Parity 1	Parity 2	Parity 3	Parity 4	Parity 5	P
R42	**Daily Food Intake , g/d**						
	0-23 days	63.78^{a}	62.39^{a}	63.48^{a}	63.61^{a}	74.74^{b}	0.041*
	23-35 days	79.73^{a}	77.99^{a}	79.35^{a}	79.51^{a}	93.30^{b}	0.041*
	35-60 days	119.59^{a}	116.98^{a}	119.03^{a}	119.27^{a}	140.14^{b}	0.041*
	60-90 days	209.29^{b}	204.72^{b}	208.30^{b}	208.72^{b}	245.25^{a}	0.041*
	Consumption index, g/d						
	0-23 days	5.03	4.68	4.99	5.15	5.73	0.076^{ns}
	23-35 days	10.17	9.17	9.59	8.89	9.80	0.398^{ns}
	35-60 days	2.69	2.40	2.74	2.53	2.50	0.121^{ns}
	60-90 days	12.20	11.22	10.95	11.86	14.60	0.082^{ns}
	Carcass Yield	63.22^{b}	64.44^{a}	63.63^{b}	63.83^{ab}	63.40^{c}	0.031*
R56	**Daily Food Intake , g/d**						
	0-23 days	67.29^{c}	53.60^{d}	65.59^{bc}	63.80^{ab}	62.73^{a}	<0.001***
	23-35 days	84.16^{c}	67.00^{d}	81.99^{bc}	79.75^{ab}	78.41^{a}	<0.001***
	35-60 days	126.17^{c}	100.50^{d}	122.98^{bc}	119.63^{ab}	117.61^{a}	<0.001***
	60-90 days	220.80^{c}	175.87^{d}	215.21^{bc}	209.35^{ab}	205.82^{a}	<0.001***
	Consumption index, g/d						
	0-23 days	5.17^{b}	4.17^{c}	5.18^{b}	4.93^{a}	4.87^{a}	<0.001***
	23-35 days	18.91^{a}	16.00^{c}	19.88^{ab}	20.58^{b}	19.02^{a}	<0.001***
	35-60 days	3.17^{c}	2.54^{b}	2.91^{a}	3.02^{a}	2.89^{a}	<0.001***
	60-90 days	10.12^{a}	7.97^{c}	10.08^{a}	10.21^{a}	9.53^{b}	<0.001***
	Carcass Yield	65.47^{ab}	65.23^{ab}	65.64^{b}	65.10^{a}	65.48^{ab}	0.015*

a, b, c: means within each row affected with different letters are significantly different (P<0.05)

3.2. Growth Performance as a Function of the Rate of Reproduction

Evaluation of average daily weights shows that average individual birth weights at 23 and 90 days of age show no significant difference regardless of reproduction rate (P >0.05). At 35 and 60 days of age, the rhythm had a significant effect on this parameter. Indeed, rabbits in the R42 rhythm had higher average weights than individuals of the same age in the R56 rhythm (Table III).

Table III: Growth rate of young rabbits according to rhythm of reproduction

Variables	Reproduction rhythm		P
	R42	R56	
Live body weight, g			
at birth	55.63±5.26[a] (n=2340)	52.59±5.31[a] (n=3392)	NS
at 23 days	339.33±18.5[b] (n=2209)	348.25±6.73 (n=3291)	NS
at 35 days	432.05±21.56[a] (n=2209)	399.97±8.49[b] (n=3079)	<0.05
at 60 days	1590.20±141.67[a] (n=1941)	1416.28±33.80[b] (n=3079)	<0.05
at 90 days	2107.74±143.71 (n=1941)	2065.23±46.43 (n=3079)	NS
Average daily gain, g/d			
0-23 days	12.39±0.63 (n=2209)	12.87±0.12 (n=2209)	NS
23-35 days	8.31±0.61[a] (n=2209)	4.29±0.22[b] (n=2209)	<0.001
35-60 days	46.32±4.88[a] (n=2209)	40.67±1.23[b] (n=2209)	<0.001
60-90 days	17.25±1.11[b] (n=2209)	21.63±0.71[a] (n=2209)	<0.001

a, b, c: means within each row affected with different letters are significantly different (P<0.05)

Table IV presents the average daily gain of rabbits according to the breeding rhythm. From birth to 23 days of age, the reproductive rate of females had no significant effect on average daily rabbit gains (p>0.05). After 23 days of fattening, there was a variation in the ADG. Indeed, the best growth rates were recorded in the R42 rhythm except for the 60-90-day period, where 21.60 g/d was recorded for the R56 rhythm compared to 17.25 g/d for R42.

Reproduction rate had no significant effect (P<0.001) on bunnies' DFIs at all stages of growth (Table IV). The Feed Consumption Index was only significantly influenced by the reproduction rate after 23 days of age (P<0.001). Up to two months of age, the consumption index in rabbits in the R56 rhythm was higher than that of rabbits in the R42 rhythm. However, from three months of age, the consumption index in individuals in the R42 rhythm was significantly higher with 12.17 versus 9.58 in the R56 rhythm (Table IV). As for the yields, they do not differ significantly (P>0.001) for the two breeding behaviours Table IV).

Tableau IV: Daily Food Intake (DFI), consumption index and carcass yield affected by rhythm of reproduction

Variables	Reproduction rhythm		P
	R42	R56	
Daily Food Intake , g/d			
0-23 days	65.59±5.14	62.60±5.32	NS
23-35 days	81.99±6.42	78.25±6.66	NS
35-60 days	122.98±9.63	117.38±9.98	NS
60-90 days	215.22±16.86	205.42±17.47	NS
Consumption index,			
0-23 days	5.17±0.38	4.86±0.42	NS
23-35 days	9.52±0.51[b]	18.82±1.87[a]	<0.001
35-60 days	2.57±0.14[b]	2.91±0.23[a]	<0.01
60-90 days	12.17±1.45[a]	9.58±0.94[b]	<0.01
Carcass Yield	64.10±0.84	65.39±0.22	NS

a, b, c: means within each row affected with different letters are significantly different (P<0.05)

4. Discussion

The results obtained in this study show significant effects of scope number on ADGs and DFIs. These results are consistent with the work of Xiccato et al (2004); Fortun-Lamothe (2006); Ouyed et al (2007) which found that scope number has significant effects on ADGs and DFIs. However, in our study, the effect of litter number is smaller on average daily earnings because equal values were observed for several farrowing rows. As for individual weight, it does not seem to vary significantly as a function of this factor for the R56 rate. The results of the work of Ozimba and Lukefahr (1991) in New Zealand and Abdelli-Larbi et al. (2014) in Algeria also reported the absence of a significant effect of litter size on some growth performance in local breeds.

Evaluation of average daily weights shows that average individual birth weights show no significant difference at any breeding rate. These values are similar to those obtained by Goudjo (2010) and Cherfaoui (2015) who reported 52.20 g and 54 g, respectively, in local populations in Benin and Algeria. In contrast, Jaouzi et al. (2004) obtained 75 g in bunnies from a local population in Morocco, while Lebas et al. (2010) in the local Algerian population and the white population (from Hyplus) obtained 62 g and 61 g at birth, respectively. These different results could be explained by maternal genetic effects such as uterine capacity on weight (Moce et al., 2004). Indeed, according to the latter authors, foetuses are heavier when carried by females with high uterine capacity.

The growth rate during the period 23 to 60 days of age was lower in early weaned bunnies. This observation has also been reported by Gidenne and Fortun-Lamothe, (2004); Gallois et al. (2005) and Feugier et al. (2006). Xiccato et al. (2000) and Welsh et al. (2005) suggest that early weaned rabbits should be fed more solid food than rabbits of the same age still being nursed to compensate for the lack of milk. In the present study, this compensatory growth was observed at 90 days of fattening age in contrast to the work of Welsh et al. (2005) who observed it at 42 days and Feugier (2006) at 50 days of age. Indeed, the weight at 90 days of early weaned bunnies is close to that of late weaned bunnies (2065.23 g compared to 2107.74; P = 0.956). Fortun-Lamothe et al (2001) hypothesised that animals showing early adaptation to solid feed intake have a higher total feed intake than those subjected to late weaning during the growing period. This hypothesis is not tested in this study. In fact, the solid feed intake of early-weaned bunnies was not higher at all the different growth stages studied. On the other hand, Feugier et al (2006) reported a lower feed intake in early-weaned rabbits. These different observations could be explained by the high mortality observed in early-weaned rabbits at 23 days compared to those weaned at 35 days in the R42 rhythm (Soro et al., 2020), the composition of the feed or the disturbances caused by the early weaning of the young rabbits. According to Swallow et al (2005), diet change is a constraint that affects physiological functioning and growth of the animals. These results confirm the difficulty for bunnies to rapidly increase their feed intake, or to compensate for milk consumption by sufficient solid feed intake reported by Di Meo et al. (2003). Indeed, youngsters have a low capacity to digest starch (Debray et al., 2003).

Between 60 and 90 days of age, the average weight gain observed in bunnies weaned early is much higher than that of bunnies weaned at 35 days of age. This translates into a better feed conversion (9.58 compared to 12.17 in rabbits weaned at 35 days). A better adaptation of these early weaned subjects to solid food following a change in their diet could explain this result. After 60 days of fattening, the feed conversion rate increases sharply whatever the reproduction rate. Gidenne et al. (2003) justified this variation by the increase in tissue deposition allometry, which becomes strong for adipose tissue and has a high energy cost for synthesis. According to these authors, between 11 and 15 weeks of age, the growth rate is strongly reduced while food intake remains stable at around 180 g/d, but the Conversion Index increases strongly. Carcass yield is not affected by the reproduction rate. The values obtained in our experiments are in line with those reported by the results of work carried out on rabbits. Different studies point out that the local rabbit gives higher carcass yields (62-65 %) than the marketed breeds 57 % for the New Zealand breed Ouhayoun (1985) and 55-60 % Dalle-Zotte (2000).

5. Conclusion

The study of females subjected to a semi-intensive reproductive rhythm associated with weaning at 35 days showed that the growth of the bunnies is higher between 35 and 60 days of age than that of bunnies weaned at 23 days. Despite the superposition of gestation and lactation, the growth of the rabbits in the semi-intensive rhythm is improved during the post-weaning period. The period of adaptation to solid food during early weaning (23 days) of the rabbits is 55 days and corresponds to the period of compensatory growth under our experimental conditions. The extensification of the reproduction rate coupled with early weaning is not accompanied by an increase in the solid food intake of the rabbits fed ad libidum. Subsequent tests in several farms with higher numbers of females and rabbits in a more favourable sanitary context are necessary to confirm these results.

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