Influence of Some Preweaning Factors on Traits of New Zealand White Rabbits

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Abstract

this work was carried out to evaluate the influence of early preweaning variables and cross-fostering on post-weaning and final market traits of rabbits. Two studies were carried out on purebred New Zealand White rabbits, the first was a retrospective analysis of data on 126 litters (1010 kits), and the second was a field–type cross-fostering experiment on 56 litters (476 kits). Traits investigated were litter weight (LW), litter size (LS), within litter coefficient of variation for body weight (LCV), and mean kit weight (KW) at marketing (70 days of age), litter gain (LG), mean kit daily gain (KDG) and mortality rate from weaning (28 days) to marketing. In the second study, LW28, LS28, LCV28, KW28, and preweaning mortality were also recorded. Results indicated that litter size born alive (LSB) affected ($P<0.05$ or $P<0.01$) all traits except LCV70. With the increase of LSB, KDG28–70 and KW70 decreased linearly, and LW70, LS70 and LG28–70 increased to limits then decline (negative curvilinear quadratic effect). Predicted maximum LW70 (15.688 kg) occurred at LSB = 9.4. Generally, summer and spring kindlings were associated with the least post-weaning and market growth performance. Post-weaning mortality, LS70 and LCV70 were not affected by kindling season. On the other side, doe body weight at kindling did not affect ($P>0.05$) any of the traits except LCV70 where more uniform litters at marketing were born to heavier dams at kindling. Likewise, none of the traits varied ($P>0.05$) with the kindling number. As a result of fostering, the size of the nursing litter was 7 to 9 in the fostered "F" group, while it ranged from 3 to 13 in the non–fostered "NF" litters. Preweaning mortality was greatly reduced (20.27 vs 8%, $P<0.001$) due to fostering. In turn, "F" litters were heavier (0.54 kg more, $P<0.05$), larger in size (one kit more, $P<0.05$) and tended ($P=0.08$) to be more uniform at weaning compared to "NF" litters. Superiority in growth and size of "F" litters continued post-weaning to marketing where they averaged 14.26, 13.53 and 14.59% higher LW70, LS70 and LG28–70, respectively than "NF" litters. It could be concluded that reducing the size of large litters to a maximum of nine per dam shortly after kindling through cross-fostering improved market traits primarily via reducing preweaning mortality. Management arrangements should be considered to reduce the adverse effects of hot seasons on growing litters.

Introduction

Effects of several factors on post-weaning and market traits of rabbits have been investigated. These include seasonal differences, nutritional regimens, doe characteristics, e.g. her kindling order, milk production and body weight, litter size and sex (30; 8; 29; 5; 25).

Determination of preweaning (early) factors influencing market (late) traits of rabbits may provide a potential for early modifications to make the best use of these effects in terms of profitability. Among these factors, litter size (LS) received the primary attention, and high LS was the main goal in breeding programs aiming at improving rabbit productivity (14; 23).

Unfortunately, studies have indicated that as litter size increases growth performance and kit survival decline. Consequently, the benefits of high litter size may be partially lost chiefly because of the high mortality, particularly during the preweaning period (9; 13; 10; 16).

On the other hand, commercial producers place greater emphasis on market traits for maximum profit. Their goal is, therefore, to maximize number of kilograms marketed per litter. In this respect, litter weight at market is a better composite indicator of profit and total performance of the litter than separate traits as it is the product of litter size, mortality and growth.

A classic recommendation in the literature to rabbit producers is to reduce the size of large litters through fostering as a means of increasing kit survival, and in turn improving litter performance up to marketing (18 ; 12), and even enhancing their breeding performance as adults (27). However, to our best knowledge, no reports published data on actual field–type cross-fostering rather than the experimental litter size standardization.

The aim of the present study was to evaluate the effect of preweaning factors (litter size, doe body weight, her kindling order and kindling season), and cross-fostering on market traits of meat rabbits.

Materials and Methods

Study population and management:

Animals of the present study belong to El–Tamboli rabbit farm, a large commercial producer of meat rabbits raising about 1500 dams. The farm is located in El–Obour city, Cairo–Ismailia road. All rabbits used in this study were purebreds of the New Zealand White breed. First mating of females was done at 4–6 months of age. Following kindling, remitting occurred after 10 days, and females were palpated for pregnancy diagnosis about 12–14 days later. Feeding of newborn kits was limited to nursing for the first three weeks. Thereafter, they had a free access to a pelleted fryer rabbit ration formulated in the farm (in kg, hay 320, wheat bran 200, soybean meal 120, corn 120, barely 200, molasses 20, sodium chloride 5, limestone 8, sodium bicarbonate 5 and mineral mixture 2). Breeding bucks and non–lactating does were given about 150 g of the same ration daily, whereas weaned kits and lactating does were fed *ad libitum*. Weaning occurred at 28 days of age by transferring the kits to a separate cage. At this time, sexing, ear–tagging and individual weighing were done then individual kit weights were recorded biweekly thereafter to market age.

* First study: A retrospective analysis of data for the effect of preweaning variables on market traits:

A total of 126 litters (1010 kits) were used in this study. All newborn kits remained with their dams (no fostering). Data were collected throughout the year 2005 involving the four seasons. Traits under investigation in this study and their abbreviations are shown in Table (1). Within litter body weight coefficient of variation (LCV) was used as a measure of litter uniformity (12).

Statistical analysis:

Least squares analysis of covariance: It included the fixed effects of kindling season (four seasons, autumn, September to November; winter, December to February; spring, March to May; summer, June to August), body weight of the doe at kindling (< 4 kg, 4 – 5 kg, >5 kg) and kindling order (1^{st}, 2^{nd} or 3^{rd}), as main effects, and alive litter size at birth (LSB) as a linear and quadratic covariates. The interaction of doe weight by kindling order had significant effects on LW70 and LS70, so that included in their models, all other interactions were non–significant and thus removed from the final model (Model I).

$Y_{ijkl} = \mu + S_i + D_j + K_k + (DK)_{jk} + b_1(LSB) + b_2(LSB)^2 + e_{ijkl}$ (Model I),

Where:

Y_{ijkl} = observed value of a given dependent variable,

μ = overall mean,

S_i = fixed effect of i^{th} kindling season class,

D_j = fixed effect of j^{th} doe body weight class,

K_k = fixed effect of k^{th} kindling order,

$(DK)_{jk}$ = fixed effect due to interaction of doe body weight and kindling order, included only in the models of LW70 and LS70.

b_1 and b_2 = partial linear and quadratic regression coefficients of Y_{ijkl} =litter size at birth (LSB), and

e_{ijkl} = the random error.

According to the significance of the quadratic coefficient, linear or linear and quadratic regression equations were developed using LSB as an independent variable and performance traits as dependent variables (Model II).

$\hat{Y} = a + b_1(LSB) + b_2(LSB)^2$ [Model II], Where:

$\hat{Y}$ = a predicted value of a given dependent variable,

a = the intercept, and

b_1 and b_2 = the partial linear and quadratic regression coefficients of $\hat{Y}$ on LSB.

* Second study: Influence of fostering across litters on pre– and post-weaning performance.

A total of 56 litters (476 kits) were used in this experiment. The experiment was conducted from January to April of 2006. According to the regression of LW70 on LSB of the first study, fostering across litters was performed so that no dam in the fostering group nursing more than nine kits. Large litters available for the experiment had 10 to 13 kits. Transfer of kits occurred within two days of kindling by transferring the extra kits to the nest box while the recipient dam removed outside the box and masking the odor by smearing her nose with an oily perfume. Kits removed from large litters were the nearest in size to those of the recipient dam. Control non–fostered litters were selected to match, as exactly as possible, the original litter sizes of the fostering group, for example two litters of 12 and 5 kits remained unaltered in the control groups, meanwhile, rearranged to become 9 and 8 in the fostering group. Traits investigated in the second study and their abbreviations are given in Table (1).

Statistical analysis:

The same model of the first experiment (Model I) was used except for the inclusion of the fixed effect of fostering (fostered "F" vs non-fostered "NF" litters) instead of the covariate LSB. No interactions were significant, thus all were not included in the final model.All analyses of the two studies were performed using the Statistical Analysis System (28). Means were separated using the least squares means of the same program. Mortality rates were compared using the chi–square test.

Table (1): Performance traits investigated and their abbreviations

Trait definition	Abbreviation
First study	
Litter body weight at marketing (day 70)	LW70
Litter body weight gain from weaning (day 28) to marketing	LG28–70
Mean kit body weight at marketing	KW70
Mean average daily gain from weaning to marketing	KDG28–70
Litter size at marketing	LS70
Within litter body weight coefficient of variation at marketing	LCV70
Second study*	
Litter body weight at weaning	LW28
Mean kit body weight at weaning	KW28
Litter size at weaning	LS28
Within litter body weight coefficient of variation at weaning	LCV28

* The second study included all traits in the first study.

Results and Discussion

* First study:

Results of the least squares analysis of covariance are presented in Table (2), regression analysis in Table (3) and least squares means for different effects are in Table (4).

Effect of litter size at birth:

The size of the litter nursed by the doe (born alive, LSB) affected all traits except LCV70. LW70 and LS70 varied ($P<0.01$) curvilinear with the variation of LSB (Tables 2, 3). It means that these two commercially important characters increase with the increase of LSB but to limits, beyond these limits, they will decline. Equation (1) in Table (3) and Fig. (1) indicated that maximum total litter weight at marketing (15.688 kg) was predicted to occur with LSB = 9.4. Consequently, keeping nine kits as a maximum number nursed by the doe would maximize income per litter in terms of kilograms of rabbits sold at marketing. Also, the presence of negative quadratic effect of LSB on LS70 indicates that in too large litters, kit survival is adversely affected up to market age. Although the analysis of covariance (Table 2) showed that LG28–70 regressed linearly on LSB, the relationship was a quadratic one in the separate regression analysis (Table 3, Equation 2). LG28–70 would, therefore, follow a similar trend (curvilinear) as that of LW70 and LS70. Similarly, (18) reported positive linear and negative quadratic effects of LSB on size and weight of the litter at marketing (56 days in their study). They predicted that litters of nine kits would have the heaviest weight at marketing; therefore they suggested adjusting the size of the litter at birth to a maximum of nine. It was concluded by (12) that LSB has a role in the determination of LS70 (a correlation coefficient of 0.80). In addition, it was reported by (5) that LSB significantly affected LW56 ($P<0.001$) with LW56 increased consistently from LSB = 2 to LSB = 7 (the maximum LSB tested in their study was 7).KW70 ($P<0.01$) and KDG28–70 ($P<0.05$) changed linearly (Table 2), but negatively (Table 3) with LSB. Their regression equations were significant in spite of the low R^2 of KDG28–70. These equations imply that the increase of LSB would reduce kit post-weaning daily gain and its market weight. Previous studies obviously support the negative association of LSB and post-weaning kit growth rate and body weight (3; 6; 15; 22; 5). It was reported by (12) that there is a negative correlation between LSB with KW70 ($r = -0.30$) and average daily gain ($r = -0.15$). It was explained by (4) that in small litters, milk per kit was higher, and this greater milk intake caused heavier kits till 70 days of age and a lower mortality rate. In contrary to the present and most other studies, (8) found that postweaning weight gain was not related to litter size.

Effect of season of kindling:

Season of kindling affected significantly most of the growth parameters (LW70, $P<0.05$; KW70 and KDG28–70, $P<0.01$, Table 2). Results in Table (3) show that litters born during winter and autumn were 1.92 and 1.54 kg heavier at marketing than those born during summer, and 1.37 and 0.99 kg heavier than litters kindled during spring. LG28–70 followed a nearly similar trend but non–significantly ($P>0.05$). Moreover, winter and autumn were associated with the heaviest individual kits at marketing (2.18 ± 0.05 and 2.17 ± 0.03 kg, respectively compared to spring (1.93 ± 0.06 kg) and summer (2.03 ± 0.04 kg, $P<0.05$). Kits of spring born litter gained significantly ($P<0.05$) the least body weight daily (31.81 ± 0.82 g) during the post-weaning period relative to those born in other seasons (34.21 to 35.63 g/day). Since the ration used in the current study was the same allover the year, seasonal effects may be related to differences in climate and daylength. Rabbits are very susceptible to heat stress as found by (26 , 19 and 22) who reported that hot seasons were depressant to feed intake of rabbits. In addition, (21) found that daylength affected significantly postweaning gain of rabbits with the poorest performance was seen during summer.In contrast to the present findings, (2 and 5) reported that litter weight and average kit weight at marketing did not differ according to season. Different breeds and agro-climatic conditions of different countries may contribute to such disagreement. However, important seasonal effects on growth performance of rabbits appeared in several other reports especially the decline in performance during the hot periods (12 ; 3 ; 6 ; 15). In Egypt, our results disagree with those of (30) who found the best post-weaning growth of New Zealand White rabbits for those born in summer and autumn. However, they carried out their study in environmentally controlled houses, which might eliminate most of the outdoor seasonal effects. On the other hand, LS70, LCV70 and post-weaning mortality did not vary with the kindling season (Tables 2, 4). As well, (12) for LS70 and LCV70 and (2) for LS70, found no seasonal trends.

Effect of doe body weight at kindling and kindling order:

Data in Table (2) revealed that body weight of the dam at kindling was a non–significant (P>0.05) factor for all postweaning and market traits except LCV70 (P<0.05). Kits in litters from light weight does (<4 kg) had less uniform body weight at marketing (high LCV70, 9.75 ± 0.94 %) compared to litters born to heavier dams (7.89 ± 0.43 for does of 4.5 – 5 kg, and 7.23 ± 0.60 for those of >5 kg at kindling, (Table 4). Correspondingly, (18) found that the maternal effects of dam body weight at parturition never approached significance on litter weight, size and uniformity, or kit weight at marketing. But, (17) found that doe weight at kindling affected body weight of broiler rabbits, however, they used weekly individual weights rather than total final litter weight and mean kit weight used in the current study.All postweaning and market traits did not vary significantly (P>0.05) across the kindling order (Table 2). However, litters of the 3rd kindling tended to be heavier and more uniform at marketing, and showed faster postweaning growth, lower mortality rate and slightly larger litter size. In concurrence, lack of kindling order effects appeared in other studies, e.g. (12) for LS70, LCV70, kit body weight at 70 days of age and its postweaning daily gain; (24) for final body weight (87 days) and postweaning growth rate; (29)for 0 – 168 days mortality rate, and (5) for LS56, LW56, KW56.

* Second study:

In this experiment (Table 5), cross-fostering across litters was performed to reduce the size of large litter (10 or more) to a maximum of 9 kits as recommended in the first study. Table (6) indicates that the litter size nursed (LSN) by the doe averaged 8.5 kits in both groups. However it ranged from 7 to 9 per dam in the fostering "F" group as a result of redistribution of kits, meanwhile the range was 3 to 13 kits in the control non–fostering "NF" group.

Preweaning:

Cross-fostering did not affect KW28. However, "F" dams weaned litters of heavier weight (0.54 kg more, P<0.05), larger size (one kit more, P<0.05) and tended to wean more uniform kits (LCV28 11.14 vs 14.30, P = 0.08) compared to "NF" litters. The major preweaning effect of fostering appeared in kit survival (P<0.001) where reducing the size of large litters reduced preweaning mortality rate from 20.24 to 8%.

Weaning to marketing:

Advantages of fostering remained clear on litter weight and size at market age. Litters from the "F" group averaged 1.91 kg (14.28%) heavier and 0.89 kit (13.53%) larger in size compared to the "NF" litters. KW70, LCV70, KDG28–70 and mortality rate were similar in both groups (P>0.05). LG28–70 was higher (1.37 kg or 14.59%) in the "F" group relative to the control, but the effect only approached statistical significance (P = 0.07).Results of second study indicate that the positive effect of cross-fostering is principally through reducing preweaning mortality, as a result maintaining higher litter size at weaning and marketing, and in turn, heavier total litter weights at both ages. In accordance, (10) recorded a positive correlation (r = 0.64, P<0.01) between LSB and preweaning mortality in litters of 10 to 14 kits. Also, (32, 27 and 22)concluded that performance got worse with the increase of litter size.One half of the "NF" litters had a size of 10 – 13 kits. In these large litters, because of the competition for teats and low amount of milk available per kit, some kits would suffer starvation and are more likely to die. Literature findings support this explanation as the number of teats in the rabbit doe is mostly 8 – 10 (31) and milk yield of the doe is stimulated as the number of suckling kits increases up to nine (20). Moreover, milk available to individual kits decreases with the increase of litter size (1 ; 7 ; 33). Also, (11) observed that preweaning mortality was significantly higher in non–suckled (starved) kits (36.9%) than in suckled ones (13.5%).The main conclusions are: (1) The size of the nursing litter appears to be the main factor affecting overall performance of rabbit litters post-weaning to marketing. (2) Because of the clear seasonal effects, management decisions should be considered to reduce the adverse effects of hot seasons on growing litters. (3) Reducing the size of large litters to a maximum of nine per dam shortly after kindling through cross-fostering improved total litter performance pre– and post-weaning mainly via improving kit survival before weaning.

Table (2): Analysis of covariance for market traits of New Zealand White rabbits

Effect	LW70 (kg)		LG28–70 (kg)		KW70 (kg)	
	DF	MS	DF	MS	DF	MS
Kindling season	3	15.77*	3	3.05	3	0.30**
Doe weight (DW)	2	0.55	2	5.29	2	0.04
Kindling order (KO)	2	0.26	2	2.91	2	0.06
DW x KO	4	14.93*	—	—	—	—
Regression on LSB†						
- Linear	1	493.12**	1	262.92**	1	1.65**
- Quadratic	1	316.69**	—	—	—	—
Residual	112	5.78	116	3.79	117	0.41
R^2	0.63		0.57		0.43	
	KDG28–70 (g)		LS70		LCV70 (%)	
	DF	MS	DF	MS	DF	MS
Kindling season	3	58.08**	3	1.22	3	35.17@
Doe weight (DW)	2	16.73	2	0.27	2	41.71*
Kindling order (KO)	2	11.06	2	0.10	2	9.34
DW x KO	—	—	4	3.04*	—	—
Regression on LSB†						
- Linear	1	48.47*	1	117.20**	1	28.29
- Quadratic	—	—	1	63.42**	1	38.48@
Residual	117	12.61	112	1.12	114	13.55
R^2	0.22		0.72		0.16	

†LSB = Litter size born alive, other trait abbreviations: Refer to Table 1.
DF = Degrees of freedom; MS = Mean square;
R^2 = Coefficient of determination.
@ P <0.10; * P<0.05; ** P<0.01.

Table (3): Regression of postweaning and market traits on litter size born alive (LSB)

Eq. No.	Variable‡	Prediction equations	R^2	Prob.†	F value
1	LW70	− 4.599 + 4.307 (LSB) − 0.2286 $(LSB)^2$ SE (± 0.518) (± 0.0325)	0.47	**	53.54**
2	LG28–70	− 4.241 + 3.137 (LSB) − 0.1618 $(LSB)^2$ SE (± 0.401) (± 0.0252)	0.47	**	53.72**
3	KW70	2.514 − 0.0531 (LSB) — SE (± 0.0083)	0.25	**	40.85**
4	KDG28–70	36.67 − 0.282 (LSB) — SE (± 0.143)	0.03	*	3.89**
5	LS70 (%)	− 3.139 +2.161 (LSB)− 0.1059 $(LSB)^2$ SE(± 0.220) (± 0.0138)	0.64	**	105.46**

Trait abbreviations‡: Refer to Table 1.
R^2 = Coefficient of determination.
† Probability of highest order regression Coefficient ;
* P<0.05; ** P<0.01
LCV70 equation was not significant, thus not presented.

Fig. (1): Predicting litter weight at marketing from litter size at birth (equation 1, table 3)

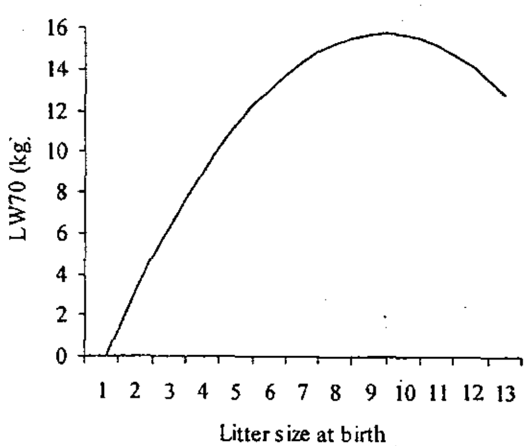

Table (4): Least squares means (± standard errors) and mortality rate for the effects of preweaning factors on postweaning and market traits of New Zealand White rabbits

Item	N	LW70 (kg)‡	LG28–70 kg	KW70 (kg)	
Overall mean	126	13.86 ± 0.33	9.58 ± 0.25	2.08 ± 0.02	
Kindling season		*	NS	*	
- Autumn	46	14.40 ± 0.65 ^{a}	9.94 ± 0.50	2.17 ± 0.03 ^{a}	
- Winter	38	14.78 ± 0.76 ^{a}	9.86 ± 0.54	2.18 ± 0.05 ^{a}	
- Spring	22	13.41 ± 0.59 ^{ab}	9.36 ± 0.51	1.93 ± 0.06 ^{b}	
- Summer	20	12.86 ± 0.56 ^{b}	9.16 ± 0.43	2.03 ± 0.04 ^{b}	
Doe body weight		NS	NS	NS	
- < 4 kg	27	13.68 ± 0.41	9.22 ± 0.37	2.04 ± 0.04	
- 4 – 5 kg	74	13.92 ± 0.48	9.41 ± 0.35	2.10 ± 0.03	
- > 5 kg	25	13.97 ± 0.74	10.11 ± 0.59	2.09 ± 0.05	
Kindling order		NS	NS	NS	
- 1st	60	13.74 ± 0.53	9.64 ± 0.42	2.04 ± 0.03	
- 2nd	34	13.88 ± 0.58	9.23 ± 0.39	2.12 ± 0.04	
- 3rd	32	13.95 ± 0.59	9.87 ± 0.46	2.07 ± 0.05	
Item	**N**	**KDG28–70 (g)**	**LS70**	**LCV70 (%)**	**P.M.%**
Overall mean	126	33.99 ± 0.35	6.83 ± 0.17	8.29 ± 0.35	2.86
Kindling season		*	NS	NS	NS
- Autumn	46	35.63 ± 0.54 ^{a}	6.74 ± 0.31	9.03 ± 0.61	3.28
- Winter	38	34.21 ± 0.75 ^{a}	6.93 ± 0.34	8.65 ± 0.77	1.45
- Spring	22	31.81 ± 0.82 ^{b}	7.10 ± 0.35	7.54 ± 1.07	3.61
- Summer	20	34.32 ± 0.57 ^{a}	6.52 ± 0.31	7.94 ± 0.42	2.65
Doe body weight		NS	NS	*	NS
- < 4 kg	27	33.08 ± 0.58	6.84 ± 0.24	9.75 ± 0.94 ^{a}	2.49
- 4 – 5 kg	74	34.15 ± 0.46	6.72 ± 0.25	7.89 ± 0.43 ^{b}	3.24
- > 5 kg	25	34.74 ± 0.77	6.90 ± 0.38	7.23 ± 0.60 ^{b}	2.25
Kindling order		NS	NS	NS	NS
- 1st	60	34.38 ± 0.49	6.82 ± 0.27	8.56 ± 0.59	3.84
- 2nd	34	34.40 ± 0.67	6.76 ± 0.28	8.73 ± 0.61	2.13
- 3rd	32	33.20 ± 0.68	6.90 ± 0.33	7.56 ± 0.41	1.81

Trait abbreviations‡: Refer to Table 1. ;
P.M.: Post-weaning mortality ;
* Means in a column with no common letter differ significantly (P <0.05).
NS = Not significant, P > 0.05.

Table (5): Least squares means (± standard errors) and mortality rates for the effect of crossfostering on preweaning and weaning to market traits of New Zealand White rabbits

	Non–fostered litters	Fostered litters	Probability
Size of the nursing litter (LSN)	8.5 ± 2.95* (range 3 – 13)	8.5 ± 0.58* (range 7 – 9)	
<u>Pre-weaning traits</u>			
LW28 (kg)[‡]	4.00 ± 0.16	4.54 ± 0.17	0.03
KW28 (kg)	0.59 ± 0.02	0.58 ± 0.02	0.44
LS28	6.78 ± 0.37	7.82 ± 0.14	0.03
LCV28 (%)	14.30 ± 1.41	11.14 ± 1.17	0.08
Birth to weaning mortality(%)	20.24	8.00	0.0002
<u>Post-weaning & market traits</u>			
LW70 (kg)	13.39 ± 0.70	15.30 ± 0.50	0.04
LG28–70 (kg)	9.39 ± 0.57	10.76 ± 0.43	0.07
KW70 (kg)	2.05 ± 0.05	2.05 ± 0.04	0.93
KDG28–70M (g)	34.46 ± 0.87	34.90 ± 0.85	0.71
LS70	6.58 ± 0.33	7.47 ± 0.18	0.03
LCV70 (%)	8.93 ± 0.81	9.06 ± 0.95	0.92
Weaning to marketing mort.(%)	2.95	4.48	0.63

Number of litters per group = 28. ; * Mean ± standard deviation
Trait abbreviations[‡]: Refer to Table 1.

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تأثير بعض العوامل قبل الفطام و التبنى التبادلى على صفات التسويق لأرانب النيوزيلاندى الأبيض

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أستهدفت هذه الدراسة تقييم تأثير بعض العوامل المبكرة قبل الفطام و تنظيم عدد المواليد مع الأم بعد الولادة بالتبنى على الآداء بعد الفطام و صفات التسويق فى الأرانب. أجريت لذلك دراستين على قطيع من سلالة أرانب النيوزيلاندى الأبيض النقية؛ الأولى إعتمدت على تحليل بيانات سابقة (١٢٦ خلفة تشتمل على ١٠١٠ أرنب) و الثانية تجريبية لدراسة التبنى التبادلى بشكله الحقلى (٥٦ خلفة شاملة ٤٧٦ أرنب). الصفات التى تم دراستها عند التسويق (عمر ٧٠ يوم) كانت وزن الخلفة، حجم الخلفة، معامل تباين وزن الجسم داخل الخلفة و متوسط وزن الأرنب بالإضافة إلى نمو الخلفة، معدل النمو اليومى للأرنب و معدل النفوق من الفطام (عمر ٢٨ يوم) إلى التسويق. فى الدراسة الثانية بالإضافة إلى الصفات السابقة تم تحديد وزن الخلفة و حجمها و معامل تباين وزن الجسم و متوسط وزن الأرنب عند الفطام و معدل النفوق قبل الفطام. دلت النتائج على أن حجم الخلفة الحى عند الولادة أثر معنويا (إحتمال أقل من ٠,٠٥ أو ٠,٠١) على كل الصفات ما عدا معامل تباين وزن الجسم عند التسويق. زيادة حجم الخلفة الحى عند الولادة يقلل معدل نمو الأرنب ما بين الفطام و التسويق و متوسط وزنه عند التسويق (علاقة خطية سالبة). بينما مع زيادة حجم الخلفة الحى عند الولادة يزداد وزن الخلفة و حجمها عند التسويق و نموها بين الفطام و التسويق إلى حد معين ثم تبدأ هذه الصفات فى التناقص بزيادة حجم الخلفة عن هذا الحد (علاقة منحنى تربيعية سالبة). أقصى وزن كلى للخلفة متوقع عند التسويق (١٥,٦٨٨ كجم) حدث عند حجم خلفة يساوى ٩,٤. بشكل عام كانت ولادات الصيف و الربيع يتبعها أقل أداء بعد الفطام و عند التسويق. معدل النفوق بعد الفطام، حجم الخلفة عند التسويق و معامل تباين وزن الجسم عند التسويق لم تتأثر بموسم الولادة. من جهة أخرى، وزن الأم عند الولادة لم يؤثر معنوياً على أى من الصفات التى تم دراستها فيما عدا معامل تباين وزن الجسم عند التسويق حيث كانت أفراد الخلفة الناتجة من الأمهات الأثقل وزناً أكثر تناسقاً فى وزن الجسم عند التسويق. أيضاً لم تتأثر أى صفة معنوياً بإختلاف ترتيب الولادة. فى الدراسة الثانية، نتيجة لتنظيم عدد الأرانب مع الأم فى مجموعة التبنى تراوح حجم الخلفة المرضع للأم ما بين ٧ إلى ٩ أرانب بينما تراوح العدد من ٣ إلى ١٣ فى المجموعة الضابطة (حجم الخلفة الطبيعى بدون إجراء تبنى تبادلى للمواليد). قل معدل النفوق قبل الفطام بشكل واضح (من ٢٠,٢٧% إلى ٨%– إحتمال المعنوية أقل من ٠,٠٠١) نتيجة للتبنى. تبعاً لذلك كانت الخلفة فى مجموعة التبنى أكبر وزناً (بزيادة ٠,٥٤ كيلوجرام – إحتمال أقل من ٠,٠٥)، أكبر حجماً (بزيادة أرنب واحد – إحتمال أقل من ٠,٠٥) و تميل إلى أن تكون أكثر تناسقاً فى وزن الجسم عند الفطام عن خلفة الأرانب فى المجموعة الضابطة. استمر تفوق آداء مجموعة التبنى فى الوزن و الحجم إلى التسويق حيث تفوقت بنسبة ١٤,٢٦ و ١٣,٥٣ و ١٤,٥٩% فى وزن الخلفة عند التسويق، حجمها عند التسويق و نموها بين الفطام و التسويق على التوالى مقارنة بالمجموعة الضابطة. أستنتج من الدراستين أن تقليل حجم الخلفة الكبير بعد الولادة بالتبنى إلى عدد ٩ كحد أقصى يحسن آداء الأرانب النامية إلى التسويق و السبب الرئيسى هو الحد من النفوق قبل الفطام. يجب إتخاذ التدابير الرعوية الملائمة للحد من التأثير السلبى للمواسم الحارة على الخلفة النامية.