Research Article

Selection Indexes for Efficient Meat Production Capacity from New Zealand White Rabbits

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Abstract | To enhance meat production capacity in New Zealand white (NZW) rabbits, six unrestricted, two single-restricted and one double-restricted selection indexes were constructed using phenotypic and genetic parameters estimated using multi-trait animal model on 458 growing rabbits, progeny of 25 bucks and 92 dams. The aggregate genotype involved post-weaning daily gain (DG), higher percentages of dressing (DP) and boneless meat (BMP). Sources of information were various combinations from weaning weight (WW), slaughter weight (SW), DG, body length (BL) and round girth (RG). The maximum accuracy of selection (R_{TI} = 0.71) was obtained from the selection based on the full index (I_1) containing the five sources of information. Dropping WW and RG from the full index simultaneously, to form the best reduced index (I_3), is expected to reduce the accuracy of selection to 0.70. Selection based on DG alone (I_5) seems to be the most efficient single trait index (R_{TI} = 0.57). Selection based on I_1 (Full index), I_3 (best reduced index) and I_5 (best single trait index) is expected to develop rabbits with faster DG (3.88 to 4.31 g/day), higher DP (0.01 to 0.10 unit) and BMP (0.03 to 0.06 unit). This improvement in the aggregate genotype traits is expected to be associated with unfavorable genetic changes in carcass weight distribution and in carcass composition. Restricting the full index to result in zero genetic change in Muscle:Fat ratio (M:F) and hind leg percentage (HLP), separately, ($I_{1(HLP)}$ and $I1_{(M:B)}$, respectively) is expected to reduce the RTI by 17% and 23%, respectively. Restricting the same index (I_1) to result in zero genetic changes in both of HLP and M:B ratio, simultaneously ($I_1(_{HLP, M:B})$), is expected to reduce the RTI by 20%. It could be recommended that in case of sub-optimal levels of HLP and M:F ratio, the use of the best reduced index (I_3) is expected to develop NZW rabbits with more efficient capacity in meat production, while the use of the double restricted form of the full index $I_{1(HLP, M:B)}$ is recommended to be apply in case of optimal levels of both of HLP and M:F ratio.

Keywords | New Zealand white rabbits, Selection indices, Meat production capacity, Carcass weight distribution, Carcass composition

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INTRODUCTION

Obtainment of high-quality animal protein with low cost is the main target of meat consumers over the world. Several authors recommended the rabbits to cover this demand due to its higher prolificacy (16 offspring/doe/year, Schlolaut, 1981), faster growth rate (22.3 g/kg metabolic weight, Lebas et al., 1986), higher carcass productivity (7.5 kg carcass/kg body weight of breeding doe/year, Schlolaut, 1981), and higher efficiency of conversion the diets protein into edible meat (20%, Dalle and Szendro, 2011). Add to the pervious advantages the other biological and economical facts like short generation interval, low initial capital outlet, its successfully raising on grain-free diets, and its smaller size (mean easier to sell to provide a regular source of income).

Commercial rabbit industries locking for faster gaining breeds with higher percentages of dressing and boneless meat (Sam et al., 2020). The NZW breed has gained wide popularity among rabbit producers due to their good adaptation with variable climate conditions, high mothering ability in terms of bigger litter size at birth and weaning. However, the NZW rabbits have been criticized for their relatively slower post-weaning daily gain vs Flemish Giant and Papilion breeds (Kariman et al., 2021), lighter carcass vs Flemish Giant (Lukefahr et al., 1982) and Californian (Lukefahr et al., 1982; Ozimba and Lukefahr, 1990).

Numerous studied (Shemeis and Abdallah, 1998, 2000; Shemeis, 1999; Gouda and Shemeis, 2022) recommended the body weight and size at slaughtering and post weaning daily gain as good indicators for selection to live performance and carcass meatiness indicating traits in rabbits. However, for the knowledge of the authors no information about combining both of post-weaning daily gain and percentages of dressing and boneless meat in one aggregate genotype and examining the side effects of this selection on carcass composition and carcass weight distribution traits.

The goal of this study is to construct selection indexes aiming to improve net income of the rabbit's breeder through selection for post-weaning daily gain and percentages of dressing and boneless meat and investigate its consequences on carcass weight distribution and carcass composition in New Zealand white rabbits.

MATERIALS AND METHODS

Source of data and animal management

This study was conducted in a private rabbit farm, located in Qalyobia governorate, during 2021-2022, where 458 rabbits of NZW rabbits (progeny of 25 bucks and 92 mature does) were chosen randomly at weaning on 28 days of age. After weighing at weaning (WW), rabbits were ear-tagged and separated in rearing cages for fattening under natural environmental circumstances. They fed *ad libitum* a commercial diet containing 2800 kcal of digestible energy/kg up to slaughter at 90 days of age.

Traits considered

At 90 days of age, the finished rabbits were weighted (SW), and transported to the Meat Laboratory in Faculty of Agriculture, Ain Shams University where they measured for body length (BL), and round girth (RG). The daily gain from weaning to slaughtering was calculated (DG). The rabbits were slaughtered and dressed out, then, the carcasses were splitted into two equal halves and the right side was jointed into hind leg, foreleg, loin, and thoracic cage according Blasco et al. (1993). Carcass weight distribution was assessed in terms of percentage of carcass side weight occurring in hind leg (HLP), for leg (FLP), loin (LOP) and thoracic cage (TCP) cut. Cuts were dissected into muscle (SM), fat (SF) and bones (SB). The sum of HL, FL, LO and TC gave the jointed side weight (JSD) and the sum of weights of SM, SF and SB gave the dissected side weight (DSW). Carcass composition was calculated as the percentage of DSW deposited as muscle, fat, and bones.

Statistical analysis

The genetic and phenotypic parameters of the traits describing live performance, carcass weight distribution and carcass composition were estimated using the VCE-6 software package of Kovač et al. (2002) according to the following Multitrait-animal model:

$$y = Xb + Za + e$$

Where; y is the vector of observations traits, b is the vector of fixed effects, a is the vector of random additive genetic direct effects, X and Z are known as incidence matrices relating observations to the respective fixed and random effects with Z augmented with columns of zeros for animals without records, and e is the vector of random residual effects.

Definition of net income

Net income was computed for each growing rabbit in terms of revenue of hot carcass weight (including the head) + giblets (heart + kidneys + liver) * 180 EGP/kg, the production costs being assumed constant. The contribution made to the variation of net income by several combination of biological measurements has been investigated separately. The highest coefficient of determination of the net income, 0.92, was obtained when daily gain (DG), dressing percentage (DP) and boneless meat percentage (BMP) were combined in the multiple regression equation.

Definition of aggregate genotype

The true breeding value (T) for net income is then defined as:

$$T = a_1 g_{DG} + a_2 g_{DP} + a_3 g_{BMP}$$

Where: g_{DG} is the additive genetic value for daily gain expressed as g/day. g_{DP} is the additive genetic value for dressing percentage expressed as 100*(hot carcass weight/farm pre-slaughter weight). g_{BMP} is the additive genetic value for boneless meat percentage expressed as

100*(boneless meat weight/carcass weight), a_1, a_2 and a_3 are the relative economic weights for DG, DP and BMP, respectively.

Estimation of economic values

To estimate the economic values for DG, DP and BMP, the net income was regressed on these three traits. The standard partial regression coefficients served as the estimates of economic values. The estimation was made according to the following general linear model of SAS (2011).

$$Y_{ij} = a + B_i + b_1X_1 + b_2X_2 + b_3X_3 + e_{ij}$$

Where: Yij is net income value of the jth rabbit in the ith year, A is intercept, Bi is fixed effect of i[th] year, X1 is daily gain, X2 is dressing percentage, X3 is boneless meat percentage, b1, b2 and b3 is partial regression coefficients of Y on DG, DP, and BMP, respectively, eij is error term.

Construction of selection indices

According to Hazel et al. (1994), Six unrestricted, two single-restricted and one double-restricted indexes including different combinations of WW, SW, DG, BL, and RG were constructed under the following three alternatives:

1. Selection based on a full index (involving the five sources of information).
2. Selection based on reduced indices (including the most valuable multiple traits combinations); and
3. Selection based on a single trait index (comprising one source of information).

Restraining change in hind leg meat percentage (HLP) and M:F ratio to zero was carried out in two indices separately (single-restriction) and in one index simultaneously (double-restriction), as improvement in the aggregate genotype traits is expected to decrease HLP and M:F ratio, which in turn would affect the biological state of the rabbit (jumping), which depends on the hind legs and the expected unfavorable genetic change in carcass fatness due to the reduction in M:F ratio.

RESULTS AND DISCUSSION

Variability

Overall means, heritability estimates (h^2), phenotypic coefficient of variations (C.V%) and economic values (a) for sources of information, aggregate genotype, carcass weight distribution, and carcass composition traits are given in Table 1. It seems that the traits describing body weights (WW and SW) are more variable than that measuring the body size (BL and RC), carcass weight distribution and carcass composition traits, except the M:F ratio which was the most variable trait among the traits considered. Similar trend was reported by several authors (Gouda and Shemeis, 2022; Peiró et al., 2019, 2021; Ezzeroug et al., 2020; Sakthivel et al., 2017).

Table 1: Means, phenotypic coefficient of variability (C.V%) and heritability coefficients with its standard errors (SE) for sources of information, aggregate genotype and correlated traits.

Traits	Symbol	Mean	C.V%	h^2±SE	Economic value
i. Sources of information traits					
Weaning weight, gm	WW	407.6	25.27	0.40±0.04	
Slaughter weight, gm	SW	1767.3	16.95	0.33±0.03	
Daily gain, gm/day	DG	21.77	20.50	0.41±0.02	
Body length, cm	BL	31.74	6.49	0.39±0.05	
Round girth, cm	RG	18.38	11.43	0.20±0.04	
ii. Aggregate genotype traits					
Daily gain, gm/day	DG	21.77	20.50	0.41±0.02	6.5 EGP /g/day
Dressing percentage,	DP	51.61	5.43	0.51±0.06	2.0 EGP /unit
Boneless meat percentage	BMP	87.64	1.57	0.16±0.04	1.2 EGP /unit
Correlated traits					
a-Caracas weight distribution					
Hind leg, %	HLP	38.87	4.24	0.56±0.07	
Fore leg, %	FLP	17.62	10.15	0.72±0.14	
Loin, %	LOP	33.44	5.26	0.40±0.04	
Thoracic cage, %	TCP	10.07	13.66	0.38±0.06	
b-Carcass composition					
Muscle: bone, ratio	M:B	6.85	11.68	0.25±0.02	
Muscle: fat, ratio	M:F	24.34	47.10	0.43±0.07	

Heritabilities

Sources of information traits showed moderate trend of heritabilities (0.26 to 0.41). The h^2- values estimated for WW using the multi-trait animal mode (0.40, Table 1; 0.36, Iraqi, 2003; 0.42, Sakthival et al, 2017) were slightly lower than the values of 0.52 to 0.69 obtained on the same breed using the sire model (Shemeis and Abdallah, 1998; Abe et al, 2018; Dige et al, 2012) and greatly higher than the estimate of 0.13 obtained using the single trait animal model by Amira and Ibrahim (2017).

The h^2-value for SW of the New Zealand white rabbits reported in the present study and in those of Abe et al (2018) and Dige et al (2012) was 0.33. This value was slightly lower than the value of 0.40 obtained by Sakthival et al. (2017) and the value of 0.44 obtained by Gouda and Shemeis (2022) and higher than the values of 0.13, 0.20 and 0.23 obtained, respectively, by Amira and Ibrahim (2017) an Amira et al. (2021) and Iraqi (2003).

The h^2-value given for daily gain (0.41, Table 1; 0.54, Gouda and Shemeis, 2022) was much higher than the value of 0.06 obtained by Amira and Ibrahim (2017) and the value of 0.21 given by Skthival et al. (2017).

Body length in the present study was estimated to be 39% heritable. This value was much lower than the estimate of 85% obtained by Gouda (2008) and greatly higher the estimate of 21% reported by Shemeis and Abdallah (1998).

Dressing percentage in NZW was estimated to be high heritable trait using the multi-trait animal model (0.51, Table 1; 0.43, Gouda and Shemeis (2022). This estimate was much higher than the estimate of 0.19 obtained on the same breed using the sire model by Shemeis and Abdallah (2000). The h^2-value for BMP was low (0.16). This value was comparable to the value of 0.24 cited by Shemeis and Abdallah (1998) and much lower the value of 0.31 obtained by Gouda and Shemeis (2022).

The heritability estimates for the traits describing carcass weight distribution were moderate to high (0.38 to 0.72). The percentage of carcass weight occurring in limbs (HLP and FLP) were more heritable (h^2 = 0.56 and 0.72, respectively) than those occurring in the trunk (h^2 = 0.40 for LOP and 0.38 for TCP).

Carcass composition in terms of M:B and M:F ratios in the present study was estimated to be moderate heritable (0.25 and 43, respectively). These two estimates were much lower than the values of 0.89 and 0.75 found by Gouda and Shemeis (2022).

Economic values

The economic values were estimated to 6.5EGP per gram for post-weaning daily gain (DG), 2.0EGP per 0.01 dressing percentage (DP) and 1.2EGP per 0.01 boneless meat percent (BMP). The aggregate genotype (T) can then rewrite as:

$$T = 6.5g_{DG} + 2.0g_{DP} + 1.2g_{BMP}$$

Correlations

The Genetic (r_G) and phenotypic (r_P) correlations among sources of information, aggregate genotype traits, carcass weight distribution and composition traits are presented in Table 2. Phenotypically, sources of information traits (WW, SW, DG, BL and RG) are moderate to high (0.26 to 0.55) intercorrelated. These correlations embodiment the absence of collinearity when constructing the selection indexes using any combination from those five traits.

Genetically, rabbits with heavier WW are expected to grow faster to finish the fattening period with heavier SW (r_G= 0.72, Table 2; 0.81, Gouda and Shemeis, 2022) and larger body size in terms of longer BL (r_G = 0.32) and well-rounded thigh (r_G = 0.59).

The genetic correlations between sources of information traits and carcass attributes indicate that the faster gaining and the beefiest growing rabbits are expected to produce carcasses with higher percentages of dressing (r_G = 0.02 to 0.50) and boneless meat (r_G = 0.07 to 0.40) with slightly lighter hind leg (r_G = -0.03 to -0.14) and thoracic cage (r_G = -0.01 to -0.18), slightly higher M:B ratio (r_G = 0.09 to 0.44) and slightly lower M:F ratio (r_G = -0.08 to -0.45). These results agree with the finding of Michalik et al. (2009) whose concluded that the higher slaughter weight in French Lop rabbits would accompany by a decline in the proportion of hind part with an increase in the front part of the carcass with negligible effect on the proportion of the middle part.

Indices

Six unrestricted selection indexes were constructed in present study using the calculated estimates of genetic parameters and economic values (Tables 1 and 2). The weighing factors of each source of information, accuracy of selection, the standard deviation of indexes and the relative efficiency to the full index were presented in Table 3. The full index (I_1) including the five sources of information gives the highest accuracy of selection (r_{TI} = 0.71). Dropping WW (The lowest valuable source of information) from the full index to formulate the best 4-trait reduced index (I_2) has no effect on accuracy of selection (r_{TI} = 0.71). Omitting both WW and RG from the full index to construct the best reduced three-trait index (I_3) is expected to result in negligible reduction in accuracy of selection (r_{TI} = 0.70). Combining SW and DG into one index (I_4) is expected to

Table 2: Genetic (above the diagonal) and phenotypic (below the diagonal) correlation among sources of information, aggregate genotype, and correlated traits.

Traits	i. Sources of information traits					ii. Aggregate genotype traits		iii. Correlated traits					
								a- Carcass weight distribution				b- Carcass composition	
i. Sources of information traits	**WW**	**SW**	**DG**	**BL**	**RG**	**DP**	**BMP**	**HLP**	**FLP**	**LOP**	**TCP**	**M:B**	**M:F**
Weaning weight, WW	…	0.72	0.1	0.32	0.59	0.05	0.13	-0.14	0.09	0.15	0.01	0.09	-0.08
Slaughter weight, SW	0.64	…	-0.15	0.53	0.73	0.05	0.15	-0.09	0.05	0.12	-0.03	0.27	-0.35
Daily gain, DG	0.29	0.26	…	0.31	0.37	0.02	0.07	-0.03	0.03	0.04	-0.03	0.16	-0.22
Body length, BL	0.3	0.55	0.27	…	0.48	0.35	0.4	-0.14	0.21	0.12	-0.11	0.44	-0.45
Round girth, RG	0.47	0.52	0.28	0.44	….	0.13	0.19	-0.08	0.16	0.05	-0.18	0.21	-0.19
ii. Aggregate genotype traits													
Dressing percentage, DP	0.13	0.01	0.02	0.5	0.14	…	0.89	-0.18	0.41	0.17	-0.27	0.29	-0.23
Boneless meat percentage, BMP	0.23	0.15	0.09	0.58	0.22	0.84	…	-0.44	-0.04	0.44	-0.25	0.42	-0.33
Correlated traits													
a- Caracas weight distribution													
Hind leg, HLP	-0.16	-0.08	-0.05	-0.17	-0.06	-0.23	-0.47	…	-0.6	-0.89	-0.35	-0.17	0.24
Fore leg, FLP	0.04	0.04	0.03	-0.05	-0.01	-0.02	0.59	-0.54	….	0.25	-0.39	0.16	-0.38
Loin, LOP	0.18	0.04	0.05	0.2	0.0	0.25	0.46	-0.91	0.31	…	0.44	0.20	-0.11
Thoracic cage, TCP	-0.05	-0.11	-0.01	-0.13	-0.13	-0.22	-0.3	-0.31	-0.03	0.48	…	-0.09	0.17
b-Carcass composition:													
Muscle: bone ratio, M:B	0.13	0.21	0.15	0.43	0.19	0.34	0.52	-0.21	-0.01	0.23	-0.1	….	-0.58
Muscle: fat ratio, M:F	-0.01	-0.41	-0.25	-0.33	-0.3	-0.13	-0.22	0.22	-0.21	-0.06	0.09	-0.43	….

Table 3: Weighing factor (b-value), value of each trait as a source of information (in parentheses), standard deviation (σ_I) and accuracy of selection for various alternative indexes.

	Index	b-value and value of each trait (between brackets) for each source of information[a]						
Alternative	number	WW	SW	DG	BL	RG	σ_I	r_{TI}
Full index	I_1	13.30 (0.13)	42.39 (8.40)	2.69 (42.61)	3.60 (2.16)	2.48 (0.90)	28.47	0.71
Reduced indexes	I_2	…	40.45 (8.85)	2.70 (44.26)	3.55 (2.11)	2.64 (1.05)	28.43	0.71
	I_3	…	31.11 (9.42)	2.83 (58.09)	3.62 (2.25)	…	28.13	0.70
	I_4	….	23.39 (7.34)	2.92 (88.04)	….	…	27.50	0.68
Single trait indexes	I_5	…	…	2.67	…	…	25.48	0.63
	I_6	…	7.18	…	…	…	3.29	0.08

a: WW, weaning weight; SW, slaughter weight; DG, daily gain; BL, body length; RG, round girth.

give the best two-trait reduced index (r_{TI} = 0.68). Due to its presence in the aggregate genotype, DG seems to be the most valuable source of information among the five traits. Selection based on DG alone as a single trait index (I_5) is expected to be 89% as efficient as the full index.

Expected genetic response

Table 4 show the results of the expected genetic response per generation in individual traits for the considered indices.

Aggregate genotype traits

Selection based on all indexes is expected to improve DG by 3.88 to 4.31 g/day, DP by 0.01 to 0.11 unit and BMP by 0.01 to 0.04 unit. The highest increase in the three basic traits is expected from the selection based on the full index (I_1).

Carcass weight distribution traits and carcass composition traits

The improvement in the aggregate genotype traits is expected to be associated with unfavorable economic and biological changes in carcass weight distribution between carcass joints and in carcass composition. The proportion of carcass weight occurring in the hind leg and M:F ratio are expected to decrease. This expected decrease must be taken in the consideration due to its adverse effects on the consumer acceptability of rabbit carcass (low yield of high-priced cuts) and meat (high level of fatness).

Table 4: Expected genetic changes in individual traits when using the most accurate indexes (r_{TI} = 0.68 to 0.70).

Expected genetic change in	I_1 WW, SW, DG, BL, RG	I_2 SW, DG, BL, RG	I_3 SW, DG, BL	I_4 SW, DG	I_5 DG
Aggregate genotype traits					
DG	4.31	4.30	4.26	4.20	3.88
DP	0.11	0.10	0.09	0.01	0.02
BMP	0.04	0.03	0.03	0.01	0.02
Carcass weight distribution traits					
HLP	-0.02	-0.01	-0.02	0.00	-0.02
FLP	0.02	0.02	0.02	0.00	0.01
LOP	0.00	0.00	0.01	-0.01	0.03
TCP	-0.03	-0.03	-0.02	-0.01	-0.02
Carcass composition traits					
M:B	0.06	0.06	0.07	0.03	0.08
M:F	-0.42	-0.45	-0.55	-0.34	-0.75
Sources of information traits					
WW	-10.0	-20.0	-10.0	-10.0	10.0
SW	80.0	90.0	80.0	90.0	30.0
DG	4.31	4.30	4.26	4.20	3.88
BL	0.19	0.19	0.21	0.07	0.22
RG	0.15	0.15	0.10	0.07	0.19

a: WW, weaning weight; SW, slaughter weight; DG, daily gain; BL, body length; RG, round girth.

Source of information traits

Selection for efficient meat production capacity using any combination from the five sources of information is expected to result in heavier body weight at slaughtering (30 to 90gm), longer body length (0.07 to 0.22Cm) and rounder circumference (0.07 – 0.19Cm).

Restricted selection indexes

Table 5 gives effects of single and double restrictions applied to the full index on weighing factors, index standard deviation, accuracy of selection and expected genetic changes in individual traits.

Restricting the full index to produce zero genetic changes in HLP alone or in M:F alone or in both of HLP and M:B ratio, simultaneously, are expected to result in a reduction of R_{TI} by 0.01, 0.02 and 0.03, respectively and reduce the rate of improvement in DG (1.16%, 2.55%, 2.55%, respectively), DP (54.55%, 45.45%, 54.55%, respectively) and BMP (75%, 50% and 75%, respectively). These reduction in accuracy of selection and in aggregate genotype traits are expected to cause a reduction of 0.48, 0.84 and 0.87 EGP, respectively in total economic superiority of the selected group (sum of expected genetic changes * economic weight) in each round of selection with selection intensity =1.0.

Table 5: Effect of restriction of genetic changes in hind leg percentage and muscle to fat ratio on weighing factors, accuracy of selection and expected genetic changes in individual traits[a].

Effect of restriction on	No restriction	Restriction to zero genetic change in HLP only	M:F ratio only	Both of HLP and M:F
Weighing factors of				
WW	13.30	-13.43	28.08	18.39
SW	-42.39	-39.53	-53.54	-51.37
DG	2.69	2.75	2.48	2.52
BL	3.60	1.52	1.17	0.84
RG	2.48	3.05	4.01	4.00
Index standard deviation	28.47	28.0	27.45	27.447
Accuracy of selection	0.71	0.70	0.69	0.68
Expected genetic changes in				
Aggregate genotype traits				
DG	4.31	4.26	4.20	4.20
DP	0.11	0.05	0.06	0.05
BMP	0.04	0.01	0.02	0.01
Carcass weight distribution traits				
HLP	-0.02	0.00	0.00	0.00
FLP	0.02	0.01	0.01	0.01
LOP	0.00	-0.03	-0.03	-0.03
TCP	-0.03	-0.03	-0.03	-0.03
Carcass composition traits				
M:B	0.06	0.03	0.01	0.00
M:F	-0.42	-0.26	0.00	0.00

a: WW, weaning weight; SW, slaughter weight; DG, daily gain; BL, body length; RG, round girth; HLP, hind leg percentage; M:F, muscle to fat ratio.

CONCLUSIONS AND RECOMMENATIONS

It could be recommended that in case of sub-optimal levels of HLP and M:F ratio, the use of the best reduced index:

$$I_3 = 31.11\ SW + 2.83\ DG + 3.62\ BL\ (R_{TI} = 0.70)$$

Is expected to develop NZW rabbits with more efficient in meat production capacity, while the use of the double restricted form of the full index:

$$I_{1(HLP,\ M:B)} = 18.39\ WW - 51.37\ SW + 2.52\ DG + 0.84\ BL + 4.00\ RG\ (R_{TI} = 0.68)$$

Is recommended to be appley in case of optimal level of both of HLP and M:F ratio.

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NOVELTY STATEMENT

The main target of rabbit meat producer over the time is to achieve highly efficient meat production capacity accompanied with high-quality animal protein with low cost. This work aim to construct selection indexes to improve net income of the rabbit's breeder through selection for fast post-weaning daily gain and percentages of dressing and boneless meat and investigate its consequences on carcass weight distribution and carcass composition in New Zealand White rabbits. It is concluded that applying the restricted index: $I_{1(HLP, M:B)}$ = 18.39 WW – 51.37 SW + 2.52 DG + 0.84 BL + 4.00 RG is recommended to develop NZW rabbits with more efficient meat production capacity, keeping the present levels of hind leg and Meat to Fat ratio without change.

AUTHOR'S CONTRIBUTION

SAR, RMA and GGF suggested the research concept and plan. EGE collected and analyzed the experimental data and prepared the first draft. All authors participated in editing, critical reviewing, and approving the present version of the manuscript.

Ethical statement

The handling, rearing, management and slaughter of the rabbits were achieved takin into consideration the protocols recommended by the scientific research ethical commission of Ain Shams University in Egypt.

Conflict of interest

The authors have declared no conflict of interest.

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