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SOMATOTROPIN (rpST): ITS PHYSIOLOGICAL AND REPRODUCTIVE ROLE IN DOE RABBITS

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The study aimed to investigate effects of recombinant porcine somatotropin (rpST) on reproductive performance and some physiological parameters of two doe rabbit strains [Native cross strain Baladi and Spanish line V strain (V-Line)]. A total of thirty two females [16 Baladi and 16 Spanish (V-Line)] rabbits at 5 months of age were used in this study. Does of each strain were divided into four equal groups (4 females, each), 2nd, 3rd and 4th groups were injected subcutaneously every week with 0.5 ml rpST solution to provide 20, 40 and 80 mg rpST/ kg body weight/ week, respectively, for three parturitions, and the 1st group served as control. Somatotropin (rpST) hormone administration significantly increased total and alive litter size at birth, size at 21 days and at weaning, Litter weight at birth, at 7, 14 and 21 days at weaning as well as, litter weight gain at (0-28 days). Milk yields (g/ litter/ doe) from kindling up to weaning at 1st, 7th, 14th, 21st and 28th days of age significantly increased with hormone treatment in a dose dependent manner. Overall, V-Line does' reproductive performance was significantly higher than that of Baladi does. Doe serum total proteins and globulin concentration at kindling significantly increased with the increasing of rpST dose. Plasma total lipids concentration showed significant increase at 21 days of gestation period only. Results showed that, plasma total cholesterol, triglyceride, glucose, thyroxin (T_4), prolactin, progesterone and insulin like growth factors-I (IGF-I) concentrations were significantly increased in a dose dependent manner with rpST treatment, while serum triiodothyroxin (T_3) hormone decreased. It was concluded that weekly injection of doe rabbits with rpST (mainly by 40 or 80 mg/ kg bwt) can improve reproductive characteristics without harmfully affecting their physiological status. Treating the native cross 'Baladi" does with rpST can make them reach and sometimes surpass the untreated V-Line does, thus this hormonal treatment can improve the native cross performance.

Keywords: Doe, rabbit, reproduction, somatotropin hormone.

Somatotropin (growth hormone), a protein hormone produced by certain acidophilus (somatotrophs) of the pars distalis in the anterior pituitary gland, was first characterized when Evans and Simpson (1931) demonstrated growth promoting effects in rat treated with crude extract from pituitaries. In 1980, it became possible to produce large quantities of pure bovine growth hormone (bGH) by using recombinant DNA technology allowing its exogenous use as a biotechnology that increases food output (meet and milk) per unit of feed resource (Bauman *et al,* 1988 and Early *et a*l., 1990a & b). In 1993, food and drug administration (FDA) approved the recombinant bovine and porcine growth hormone (rbGH, rpGH), also known as recombinant bovine and porcine somatotropin (rbST, rpST) for use in dairy cattle (Oldenbroek *et al*., 1993) and pigs (Beerman *et al*., 1993). Such practice resulted in increased milk yield and reproductive function in dairy animals (Boutinaud *et al*., 2003; Tawfik, 2003 and Roginski *et al*., 2003).

Studies on using Somatotropin on rabbits are rare and dealt mainly with ovaries function (Yoshimura *et al.,* 1994; Hull and Harvey, 2001) and in vitro studies (Zebrowska *et al*., 1995). Therefore, and due to lack of information concerning the effect of recombinant porcine somatotropin (rpST) on productive and reproductive performance of rabbits with emphasis on their physiological states.

MATERIALS AND METHODS

The present study was carried out at the Poultry Research Center, Poultry Production department, Faculty of Agriculture, Alexandria University. A total of thirty two females, [16 Baladi and 16 Spanish (V-Line)] rabbits at 5 months of age with an average body weight of 2.8 kg for the native cross (N.C) Baladi females and 3.4 Kg for the V-Line females were used in this study. Recombinant porcine somatotropin (rpST) used, was in a white solution form (200 mg rpST/ ml), purchased from Monsanto Company.

Treatments

Does from each strain were divided into four equal groups (4 rabbits each), the 2nd, 3rd and 4th groups were injected subcutaneously every week by 0.5 ml rpST solution (rpST dissolved in sesame oil) to provide 20, 40 and 80 mg rpST hormone/ kg body weight, for three parturitions, respectively. Rabbits of the 1st group served as a control, treated in a like manner with 0.5 ml sesame oil injections every week.

Housing and management

Mating was carried out in the morning, each doe was transferred to buck's cage to be mated and returned to her cage after mating. Pregnancy

was diagnosed by abdominal palpation at the 14 days post mating. Does which failed to conceive were immediately returned after palpation to the buck for another service till conception occurred.

At four weeks of age, bunnies were weaned, sexed, individually weighted, ear-numbered and transferred to the progeny cages in groups of 3 rabbits per cage for the fattening period.

Feed and water were available *ad libitum* during the experimental period. Commercial pellet diet contained 17.85% crude protein, 11.89% crude fiber, 2.75% fat and 2556 kcal /kg diet and provided with all required vitamins and minerals as recommended by (N.R.C., 1977). Rabbits were kept under the same hygienic and environmental conditions during the experimental period.

Data collected

Reproductive traits

Data collected of does were total litter size at birth, alive litter size at birth, litter size at 21 days and litter size at weaning, litter weight at birth, at 7, 14 and 21 days and at weaning and litter weight gain from birth to weaning (0-28 days) for litters produced by all does.

Milk yield

Milk production (g/ litter/ doe) from kindling up to weaning at 1^{st}, 7^{th}, 14^{th}, 21^{st} and 28^{th} days of age, was determined by weighing the pups (to the nearest gram) before and after suckling, where the litter was deprived from suckling for 12 hours by separation from the mother and then pups was allowed to suckle, according to (McNitt and Lukefahr, 1990).

Blood biochemical parameters

Blood samples were collected from marginal ear vein under vacuum at 21 days of gestation period and at kindling allover the experimental period (three parturitions). Serum total proteins and albumin was measured by using special kits delivered from sentinel CH, Milano, Italy according to guidelines and recommendation of (Bogin and Keller 1987). Serum globulin level was calculated. Serum total lipids and serum triglyceride concentration were determined by using special kits delivered from CAL-TECH Diagnostics, INC, (CAL) Chino, California, U.S.A. according to recommendation of (Fringes *et al.,* 1972). Serum total cholesterol was determined on individual bases using the specific kits according to recommendation of (Bogin & Keller 1987). Plasma Glucose concentration was measured by the method of (Trinder, 1969). Direct Radioimmunoassay (RIA) technique was performed for the assessment of plasma Triiodothyroxin (T_3) and thyroxin (T_4) concentrations as (ng/ ml) by kits delivered from DSLABS Webster Texas USA. Plasma prolactin hormone was measured by radioimmunoassay (RIA) using the method described by (Lapierer *et al.,* 1990). Plasma progesterone

hormone was measured by radioimmunoassay (RIA) using special kits delivered from diagnostic, Webster, Texas, USA according to recommendation of (Guilbault *et al.,* 1988). Serum concentrations of insulin like growth factors-I IGF-I were measured by radioimmunoassay (RIA) according to (Gluckman and Breier, 1989).

Statistical analysis

The experiment was set in a completely randomized design. Data were analyzed by analysis of variance using the general liner model procedure (Proc GLM; SAS Institute, 1996). Differences among means were determined using Duncan's test (Duncan, 1955).

RESULTS AND DISCUSSION

Doe traits:

Litter size

Results concerned with the effect of weekly injections of Baladi and V-Line does with rpST on litter size (total and alive) at birth, at 21 days and at weaning are presented in (Table 1). Between strains statistical analysis indicates a significant ($P \leq 0.0001$) V-Line does superiority in total and alive litter size at birth, compared to Baladi does. As litter sizes at birth, both total and alive, of V-Line does were higher than those of Baladi does by 37.6 and 36.5%, respectively. This superiority was sustained till 21 days of age (35.2%) and till weaning (35.5%) with the same level of significance ($P \leq 0.0001$).

Regardless of strain effect, rpST injections significantly and in a dose dependent manner, increased total ($P \leq 0.05$) and alive ($P \leq 0.01$) litter size at birth (Table 1). Where alive litter size at birth reached 109, 114, and 122% of the untreated does' with the rpST 20, 40, and 80 mg/ kg /week doses, respectively. Similar trend was recorded until weaning (110, 115, and 122%, respectively $P \leq 0.001$).

Interaction between strains and hormone doses, were statistically significant ($P \leq 0.05$) at all periods studied (Table 1). The highest alive litter size was observed in the V-line does receiving 80 mg rpST/ kg/ week, and Baladi does treated with 80 mg rpST/ kg/ week, nearly reached the V-Line control values (7.08 *vs*. 7.83)

The present findings were in alignment with those of Yoshimura *et al.,* (1994) who reported that using 50 mg/ kg bwt/ week rpST increased number of large follicles, initiation of oocyte growth and number of birth in New Zealand white does. *In vivo* studies with immature mice, proved a stimulatory effect of growth hormone on prenatal follicle development and number at birth (Liu *et al.,* 1998).

Table 1. Effect of V-Line and Baladi does weekly injections with different doses of rpST on litter size (Total and Alive) at birth, at 21 days and at weaning, (Mean ± S.E).

Items		Litter size at birth		Litter size at 21 days	Litter size at weaning
		Total	Alive		
Strain					
V-Line		9.23±0.24[a]	8.56±0.21[a]	7.83±0.18[a]	7.40±0.16[a]
Baladi		6.71±0.22[b]	6.27±0.21[b]	5.79±0.18[b]	5.46±0.16[b]
P value		***0.0001***	***0.0001***	***0.0001***	***0.0001***
rpST doses:					
	Control	7.33±0.41[b]	6.67±0.34[c]	6.08±0.29[c]	5.75±0.28[c]
	20 mg/kg/wk	7.88±0.40[ab]	7.25±0.36[bc]	6.63±0.32[bc]	6.33±0.28[b]
	40 mg/kg/wk	8.08±0.44[ab]	7.63±0.40[b]	7.04±0.36[ab]	6.63±0.32[ab]
	80 mg/kg/wk	8.58±0.39[a]	8.13±0.36[a]	7.50±0.30[a]	7.00±0.28[a]
P value		***0.0500***	***0.0100***	***0.0010***	***0.0010***
Interactions (Strains x rpST doses)**:**					
	Control	8.67±0.45[ab]	7.83±0.34[bc]	7.00±0.30[bc]	6.67±0.33[bc]
	20 mg/kg/wk	9.25±0.46[a]	8.58±0.38[ab]	7.83±0.32[ab]	7.42±0.29[ab]
V-Line	40 mg/kg/wk	9.33±0.51[a]	8.67±0.50[ab]	8.08±0.42[a]	7.67±0.31[a]
	80 mg/kg/wk	9.67±0.51[a]	9.17±0.42[a]	8.42±0.31[a]	7.83±0.27[a]
	Control	6.00±0.41[d]	5.50±0.36[e]	5.17±0.32[e]	4.83±0.24[e]
	20 mg/kg/wk	6.50±0.34[d]	5.92±0.29[de]	5.42±0.26[e]	5.25±0.18[e]
Baladi	40 mg/kg/wk	6.83±0.50[cd]	6.58±0.47[de]	6.00±0.41[de]	5.58±0.38[d]
	80 mg/kg/wk	7.50±0.42[bc]	7.08±0.40[cd]	6.58±0.36[cd]	6.17±0.37[cd]
P value		***0.0100***	***0.0100***	***0.0500***	***0.0500***

[a, b, c, d, e] Means with different letters within a column are significantly different ($P \leq 0.05$).

Litter weight

Data presented in Table 2 indicates that overall the experiment period, V-Line's litter weight surpassed significantly that of Baladi's, starting by reaching 106% of it at birth ($P \leq 0.001$) continuing throughout the experiment to reach 103% of it at weaning ($P \leq 0.0001$). That trend was reflected on the total weight gain from birth to weaning, as litter weight was significantly higher by 3.2% in the V-Line compared with the Baladi's ($P \leq 0.0001$).

As expected with growth hormone treatment, a significant dose dependent increase in litter weight was observed with the different doses of rpST (Table 2). Starting at birth, litter weight was significantly ($P \leq 0.05$) higher by 2, 3 and 7% with the rpST 20, 40, and 80 mg/ kg/ week doses, respectively, when compared to the untreated group, and that increase reached 1.4, 2.5 and 2.9% at weaning with the same doses of rpST, respectively

Table 2. Effect of V-Line and Baladi does weekly injections with different doses of rpST on litter weight (g) at birth, 7 days, 14 days, 21 days and at weaning and bunny weight gain (g) from birth to weaning (0-28 days) (Mean ± S.E).

Items		Litter weight (g)					Weight gain (g) (0-28)
		At birth	7 days	14 days	21 days	Weaning	
Strains							
	V-Line	62.8±0.5^{a}	125.1±0.6^{a}	245.5±0.9^{a}	380.1±1.4^{a}	641.0±1.9^{a}	579.9±7.6^{a}
	Baladi	59.0±0.9^{b}	122.0±0.8^{b}	242.6±1.0^{b}	372.1±1.1^{b}	620.5±2.1^{b}	561.8±2.2^{b}
P value		***0.0010***	***0.0100***	***0.0500***	***0.0001***	***0.0001***	***0.0001***
rpST doses							
	Control	59.0±1.2^{b}	121.2±1.0^{b}	239.6±1.4^{c}	371.0±2.2^{b}	620.2±7.0^{b}	559.3±6.8^{b}
	20 mg/kg/wk	60.3±1.0^{ab}	123.5±1.0^{ab}	243.4±1.2^{b}	376.0±1.8^{a}	628.8±6.7^{a}	569.1±6.1^{a}
	40 mg/kg/wk	60.9±0.9^{ab}	124.2±1.1^{a}	245.9±1.4^{ab}	378.5±1.9^{a}	635.8±6.0^{a}	574.8±5.8^{a}
	80 mg/kg/wk	63.2±1.0^{a}	125.2±1.0^{a}	247.4±1.2^{a}	379.0±1.5^{a}	638.1±5.9^{a}	574.9±5.7^{a}
P value		***0.0500***	***0.0500***	***0.0010***	***0.0100***	***0.0100***	***0.0500***
Interactions (Strains x rpST doses)							
V-Line	Control	61.1±1.4^{bcd}	123.9±0.9^{ab}	242.2±1.8^{b}	375.6±3.0^{bcd}	634.7±5.7^{b}	569.9±7.6
	20 mg/kg/wk	62.7±0.6^{ab}	126.2±1.0^{a}	244.4±1.8^{ab}	380.0±2.9^{abc}	643.9±2.2^{a}	581.3±2.1
	40 mg/kg/wk	62.9±0.6^{ab}	125.4±1.5^{a}	247.2±2.0^{ab}	383.4±2.7^{a}	642.0±3.1^{a}	579.3±2.7
	80 mg/kg/wk	64.5±0.9^{a}	125.0±1.3^{a}	248.4±1.6^{a}	381.4±2.2^{ab}	643.3±3.3^{a}	578.8±3.6
Baladi	Control	57.0±1.9^{d}	118.5±1.4^{c}	237.0±2.0^{c}	366.4±2.5^{e}	605.7±3.4^{c}	548.6±4.2
	20 mg/kg/wk	58.5±1.7^{cd}	120.8±1.4^{bc}	242.3±1.6^{b}	375.2±1.7^{de}	613.6±4.0^{bc}	557.0±3.9
	40 mg/kg/wk	58.9±1.9^{bcd}	123.1±1.3^{ab}	244.6±1.8^{ab}	373.5±2.1^{cde}	629.6±3.8^{b}	570.0±4.7
	80 mg/kg/wk	61.9±1.6^{abc}	125.5±1.4^{a}	246.4±1.7^{ab}	376.6±1.7^{bcd}	632.9±4.2^{b}	571.0±4.1
P value		***0.0500***	***0.0500***	***0.0100***	***0.0500***	***0.0500***	***NS***

$^{a, b, c, d, e}$ Means with different letters within a column are significantly different ($P \leq 0.05$).

($P \leq 0.01$). Overall bunnies' weight gain was significantly ($P \leq 0.05$) affected by the hormone treatment and increased by 1.8, 2.8 and 2.8% with the three doses of rpST, respectively.

The interaction between strains and hormone doses, was statistically significant ($P \leq 0.05$) at all periods studied (Table 2). With the highest litter weight being observed with the V-Line does receiving 80 mg rpST/ kg/ week, and with the fact that treating Baladi does with 40 or 80 mg rpST/ kg/ week, made them statistically reach the V-Line control values.

Present findings are in a good agreement with that of Hull and Harvey (2001) and Lucy *et al*. (1994) who found that the stimulatory effect of growth hormone on follicle size has been also reflected on bunny weights at birth. And can be also due to the significant increase in milk yield acombining rpST treatments observed in this study (Table 3).

Milk yield

Results recorded in Table 3 shows antecedence of V-Line does in milk production starting from birth to 21 days in compare to Baladi does ($P \leq 0.05$), as milk production was higher for V-Line does by 9.9, 7.5, 12.7 and 9.6% at 1, 7, 14 and 21 days of age, respectively. Reaching weaning time, the difference between the two strains milk production, lost significance (NS).

There was a significant dose dependent ($P \leq 0.05$) increase in milk production with rpST treatments (Table 3). Percentages of that increase compared with control were (17.8 % and 19.9 %), (7.2 % and 5.6 %), (17.9 % and 19.5 %), (10.3 % and 8.7 %) and (10.8 % and 11.4 %) with the tow high doses of hormone (40 and 80 mg rpST/ kg bwt.) at 1, 7, 14, 21 and 28 days, respectively.

The interaction between strains and hormone doses was statistically significant ($P \leq 0.05$) at the different periods studied. Total values were significantly ($P \leq 0.05$) higher with the two high hormone doses compared with the control and the lower doses, in both strains. However, it can be observed that values with the two high hormone doses (40 and 80 mg rpST / kg bwt) in Baladi does were significantly higher ($P \leq 0.05$) than that of the V-Line control at 1, 14 and 28 days and were significantly similar at 7 and 21 days.

These findings are in parallel with the findings of Zebrowska *et al*. (1995) who, involving culturing explants of mammary gland tissue from 9 pregnant rabbits, reported that, porcine somatotropin (pST) hormone directly induced expression of milk production of doe rabbits, increasing milk production of treated rabbits compared to the control group. They also concluded that, rpST hormone directly regulates the expression of casein and protein genes. Moreover, Abd El-Hady (2007) reported an increase in milk

Table 3. Effect of V-Line and Baladi does weekly injections with different doses of rpST on milk yield (g/litter/doe) at 1day, 7 days, 14 days, 21 days and at weaning. (Mean ± S.E).

Items		Milk yield (g/ litter/ doe)				
		1- Day	7 days	14 days	21 days	Weaning
Strain						
	V-Line	60.56±0.56[a]	154.83±0.87[a]	222.92±2.29[a]	256.13±1.05[a]	195.21±1.76
	Baladi	55.10±0.97[b]	144.08±0.94[b]	197.79±2.78[b]	233.79±2.17[b]	194.96±2.26
P value		***0.0001***	***0.0001***	***0.0001***	***0.0001***	***NS***
rpST doses						
	Control	51.83±1.11[c]	143.29±1.49[c]	187.92±2.67[c]	230.79±3.87[d]	181.25±2.04[c]
	20 mg/kg/wk	56.29±1.09[b]	149.75±1.92[b]	207.25±3.54[b]	243.50±2.75[c]	196.33±2.24[b]
	40 mg/kg/wk	61.08±0.76[a]	153.54±1.34[a]	221.63±3.65[a]	254.67±2.40[a]	200.88±2.47[a]
	80 mg/kg/wk	62.13±0.75[a]	151.25±1.24[b]	224.63±3.29[a]	250.88±1.65[b]	201.88±2.55[a]
P value		***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***
Interactions (Strains x rpST doses)						
V-Line	Control	56.17±0.78[c]	149.42±1.04[c]	198.92±2.20[d]	248.42±1.37[c]	186.50±2.29[e]
	20 mg/kg/wk	59.67±0.67[b]	157.92±1.34[a]	223.42±1.92[b]	254.92±1.12[b]	199.50±3.39[bc]
	40 mg/kg/wk	63.08±0.72[a]	158.83±0.98[a]	234.08±1.65[a]	264.58±1.58[a]	197.92±3.83[cd]
	80 mg/kg/wk	63.33±0.87[a]	153.17±2.00[b]	235.25±1.09[a]	256.58±1.41[b]	196.92±3.49[cd]
Baladi	Control	47.50±1.06[e]	137.17±1.20[e]	176.92±1.73[f]	213.17±2.03[e]	176.00±2.66[f]
	20 mg/kg/wk	52.92±1.56[d]	141.58±1.19 [d]	191.08±1.09[e]	232.08±2.57[d]	193.17±2.78[d]
	40 mg/kg/wk	59.08±0.99[b]	148.25±1.18[c]	209.17±4.97[c]	244.75±1.92[c]	203.83±3.03[ab]
	80 mg/kg/wk	60.92±1.15[ab]	149.33±1.33[c]	214.00±4.86[c]	245.17±2.06[c]	206.83±2.34[a]
P value		***0.0100***	***0.0001***	***0.0500***	***0.0001***	***0.0001***

[a, b, c, d, e] Means with different letters within a column are significantly different ($P \leq 0.05$).

yield when doe rabbits were injected with rpST after matting. Also, Bauman *et al.* (1988) found that varying doses of rbST caused significant increases in milk yield of treated cows. Similar trend was observed with goats, as Disenhaus *et al*. (1992) found that, in lactating goats daily injections with rbST for 4 wks, significantly increased milk yield and exceeded the yield of untreated goats by nearly 26%.

These findings can be explained by the fact that Somatotropin is a homeorhetic controller that shifts the partitioning of nutrients so that more are used for milk synthesis (Peel and Bauman, 1987). In addition, Somatotropin appears to promote milk production by a partitioning effect on absorbed nutrients, as to supply more substances for mammary synthesis. Moreover, rbST was shown to increase mammary blood flow by 10%, providing critical precursors for milk synthesis, which is reflected by 21% increase in milk production (Wilkinson and Manor, 1989). According to McLaughlin *et al.* (1991) the performance responses due to bST treatment were reflected by changes in circulating glucose, blood nitrogen, and insulin-like growth factor-I (IGF-I) concentrations. Which were also found in the present study (Table 5). Also, results obtained by Faulkner (1999) indicated that there were increases in the availability of glucose within the mammary epithelial cell in response to growth hormone treatment that would result in increase of the rate of lactose synthesis and hence stimulation of milk production. In addition, Bauman and Eppard, (1985) concluded that the increase in milk synthesis with ST treatment most likely involves changes in the activity of key regulatory enzymes resulting in an increased synthesis rate per epithelial cell. However, the possibility of an increase in mammary cell numbers cannot be excluded. In either case, somatotropin affects the maintenance of lactation as evidenced by the changes observed in the shape of the lactation curve. This role can presumably involve an altered turnover of epithelial cells and cellular components so that normal loss of cells or the normal decline in biochemical activity per cell was reduced with ST treatment (Bauman and Eppard 1985).

Blood biochemical characteristics

Table 4 summarizes the effect of weekly rpST administration on does' serum total proteins, albumin, globulin, total lipids, total cholesterol, triglyceride and glucose concentrations at 21 days of gestation period and at kindling.

Results illustrates that serum total protein concentration didn't differ between the two strains, but it significantly ($P \leq 0.05$) increased in a dose dependent manner with rpST treatment at kindling. The percentage of that increase compared with the control was (1.3% and 2.1%) with the high doses of rpST (40 and 80 mg rpST/ kg bwt).

Table 4. Effect of V-Line and Baladi does weekly injections with different doses of rpST on serum total protein(g/dl), albumin(g/dl), globulin(g/dl), total lipids(g/l), triglycerides(mg/dl), total cholesterol, and plasma glucose(mg/dl) at 21 days of gestation period and at kindling (Mean ± S.E).

Items		Total protein		Albumin		Total lipids		Total cholesterol		Triglyceride		Glucose	
		21 days	kindling	21 days	Kindling	21 days	kindling	21 days	kindling	21 days	kindling	21 days	kindling
Strains													
	V-Line	6.21±0.08	7.54±0.01	3.77±0.06	5.11±0.01^{a}	4.39±0.02^{b}	4.35±0.09	80.78±0.34^{a}	89.60±0.26^{a}	87.09±0.10^{b}	113.62±0.13^{a}	101.32±0.42^{b}	90.27±0.60^{a}
	Baladi	6.23±0.03	7.53±0.03	3.76±0.01	5.05±0.02^{b}	4.47±0.08^{a}	4.39±0.07	75.37±0.43^{b}	85.57±0.33^{b}	90.05±0.41^{a}	110.50±0.57^{b}	102.73±0.12^{a}	88.55±0.64^{b}
P value		*NS*	*NS*	*NS*	*0.0500*	*0.0010*	*NS*	*0.0001*	*0.0500*	*0.0500*	*0.0001*	*0.0001*	*0.0001*
rpST dose													
	Control	6.19±0.05	7.46±0.02^{c}	3.78±0.12	5.05±0.02	4.35±0.07^{c}	4.30±0.06	75.63±0.48^{d}	85.63±0.47^{c}	85.33±0.47^{b}	107.48±0.53^{b}	99.20±0.21^{c}	85.18±0.31^{d}
	20mg/kg/wk	6.19±0.02	7.51±0.02^{bc}	3.76±0.01	5.08±0.03	4.37±0.07^{c}	4.33±0.08	77.28±0.40^{c}	87.19±0.51^{bc}	87.49±0.34^{a}	111.38±0.55^{b}	101.02±0.18^{b}	88.64±0.21^{c}
	40mg/kg/wk	6.24±0.02	7.56±0.02^{ab}	3.75±0.02	5.05±0.02	4.50±0.08^{b}	4.42±0.08	79.05±0.62^{b}	88.10±0.55^{b}	90.63±0.39^{a}	114.31±0.76^{a}	103.07±0.63^{a}	90.51±0.30^{b}
	80 mg/kg/wk	6.26±0.05	7.62±0.03^{ab}	3.79±0.08	5.15±0.04	4.56±0.09^{a}	4.42±0.06	80.52±0.65^{a}	89.40±0.56^{a}	90.83±0.36^{a}	115.09±0.96^{a}	104.81±0.76^{a}	93.29±0.21^{a}
P value		*NS*	*0.0010*	*NS*	*NS*	*0.0500*	*NS*	*0.0001*	*0.0500*	*0.0100*	*0.0100*	*0.0001*	*0.0001*
Interactions (Strain x rpST dose)													
	Control	6.19±0.02	7.49±0.03^{c}	3.78±0.23	5.09±0.01	4.37±0.01^{c}	4.30±0.01	78.28±0.02^{d}	87.92±0.05	84.48±0.17^{bc}	108.52±0.19	98.44±0.03^{d}	86.22±0.02^{g}
	20 mg	6.21±0.04	7.54±0.02^{b}	3.78±0.01	5.12±0.02	4.38±0.02^{c}	4.34±0.02	80.49±0.04^{c}	89.04±0.02	86.83±0.14^{bc}	112.85±0.22	100.47±0.04^{c}	89.35±0.03^{e}
V-Line	40 mg	6.20±0.02	7.56±0.09^{ab}	3.74±0.03	5.11±0.07	4.42±0.02^{c}	4.36±0.02	81.67±0.02^{b}	90.17±0.02	88.03±0.23^{bc}	115.52±0.25	102.98±0.25^{b}	91.52±0.04^{c}
	80 mg	6.24±0.02	7.58±0.07^{ab}	3.79±0.02	5.13±0.06	4.41±0.04^{c}	4.39±0.07	82.66±0.03^{a}	91.26±0.03	89.03±0.16^{b}	117.60±0.18	103.40±0.05^{a}	93.97±0.03^{a}
	Control	6.19±0.11	7.42±0.04^{c}	3.78±0.03	5.01±0.05	4.32±0.11^{d}	4.30±0.12	72.99±0.05^{g}	83.35±0.05	86.17±0.81^{c}	106.43±0.88	99.79±0.06^{d}	84.15±0.04^{h}
Baladi	20 mg	6.18±0.03	7.48±0.04^{bc}	3.73±0.02	5.04±0.06	4.35±0.15^{cd}	4.32±0.15	74.03±0.04^{f}	85.35±0.03	88.15±0.56^{ab}	109.90±0.96	101.58±0.06^{b}	87.93±0.02^{f}
	40 mg	6.28±0.03	7.56±0.04^{ab}	3.76±0.02	4.99±0.04	4.58±0.16^{b}	4.47±0.17	76.04±0.03^{e}	86.02±0.02	93.23±0.69^{a}	113.10±0.72	103.15±0.06^{a}	89.50±0.04^{d}
	80 mg	6.28±0.04	7.65±0.05^{a}	3.79±0.03	5.17±0.04	4.70±0.18^{a}	4.46±0.14	78.37±0.02^{d}	87.54±0.03	92.63±0.75^{ab}	112.58±1.24	106.22±0.06^{a}	92.62±0.04^{b}
P value		***NS***	***0.0500***	***NS***	***NS***	***0.0500***	***NS***	***0.0001***	***NS***	***0.0500***	***NS***	***0.0001***	***0.0001***

$^{a, b, c, d, e}$ Means with different letters within a column are significantly different ($P \leq 0.05$).

Serum albumin concentration was significantly ($P \leq 0.05$) higher in V-Line does compared to Baladi does, at kindling. On the other hand it was not significantly (NS) affected by the somatotropin treatment. Interaction between strains and hormone doses did not show statistical deference at the studied periods.

Serum total lipids level was significantly ($P \leq 0.001$)) higher in Baladi does compared to V-Line does, (by 2.3%) at 21 days of gestation period. In respect of the rpST doses effect on total lipids level, results reveal a significant ($P \leq 0.05$) dose dependent increase at 21 days of gestation period, compared to the control being 3.4% and 4.8% with the two doses of 40 and 80 mg rpST/ kg bwt/ wk. Interaction between strains and the hormonal doses was statistically significant ($P \leq 0.05$) at 21 days of gestation period only. Values of Baladi does with the two high hormone doses were statistically higher than those of the V-Line strain with the same hormone doses.

Total serum cholesterol concentration of the V-Line strain was significantly ($P \leq 0.05$) higher than that of Baladi strain by (6.7% and 4.7%) at both 21 days of gestation period and kindling, respectively. In regard of rpST doses effect on serum total cholesterol concentration, results indicate a significant dose dependent increase at both periods studied. The percentages of that increase compared with the controls were (4.5% and 6.4%) and (2.9% and 4.4%) with (40 and 80 mg rpST / kg bwt/ wk) at 21 days of gestation period and at kindling, respectively. Interaction between strains and the hormonal doses was statistically significant ($P \leq 0.0001$) at 21 days of gestation period only, with the highest values observed in the V-Line strain with the two high hormone doses.

Data presented in Table 4 proves a significant ($P \leq 0.05$) difference in serum triglyceride concentration of the two strains studied. As Baladi does had significantly ($P \leq 0.05$) higher serum triglycerides compared to that of V-Line strain (by 3.4%) at 21 days of gestation period. But that was reversed at kindling, with serum triglyceride concentration of V-Line strain being significantly ($P \leq 0.0001$) higher than that of Baladi strain (by 2.8%). Triglyceride concentration was significantly ($P \leq 0.05$) increased with increasing the hormone dose at the two studied periods. The percentages of those increases compared with the controls were (6.2% and 6.4%) and (6.4% and 7.1%) with the doses of (40 and 80 mg rpST / kg bwt/wk) at 21 days of gestation period and at kindling, respectively. It can also be observed that the interaction between strains and hormone doses showed significance ($P \leq 0.05$) at 21 days of gestation period only.

Plasma glucose concentration was significantly ($P \leq 0.0001$) higher in Baladi does compared to V-Line does at 21 days of gestation period. Which was reversed at kindling, with the value of the V-Line does being significantly ($P \leq 0.0001$) higher than that of Baladi does. Somatotropin treatments increased plasma glucose in a dose dependent manner at the two

periods studied. Compared with the controls, the increases were (3.9% and 5.7%) and (6.3% and 9.5%) with the two high doses of hormone at 21 days of gestation period and at kindling, respectively. Interaction between strains and hormone doses reveals that treating Baladi does with rpST significantly ($P \leq 0.05$) raised their plasma glucose compared to the control of V-Line does.

Present findings are generally in the same trend of those reported by several workers. McLaughlin *et al*. (1991) reported that plasma total protein significantly increased in finishing lams treated with 2 and 4mg pST/ day for 6 weeks. Also, Abd El-Hady (2007), observed an increase in serum total protein when growing rabbits were treated with rpST. This can be due to the observation that Somatotropin stimulates amino acid uptake by cells. Which is not a secondary effect to increased protein synthesis (Boisclair *et al*., 1994). Some information suggests that Insulin like growth factors-I (IGF-I) may mediate the effects of pST on protein accretion. This indicated that there is a reasonably good relationship between the changes in circulating IGF-I level and protein accretion rate in pST-treated animals (Eisemann *et al.,* 1986) which was also reported in this study (Table 5). Also, somatotropin administration to animals showed a dramatic improvement in the efficiency of amino acid utilization for protein accretion (Boyd et al., 1991) which is frequently referred to as the biological efficiency of amino acid utilization, with a ratio of 25-50% being reported for pST treated animals (Caperna *et al*., 1990).

Moreover, Tawfik, (2003) indicated that Friesian cows injected with 500 mg bST/ 14 days from 42 pre partum to 182 days postpartum had higher plasma total lipids. Also, Abd El-Hady (2007) reported an increase in plasma total lipids of doe rabbits treated with rpST after mating.

The elevation of plasma glucose concentration in the rpST treated doe rabbits in the present study could be explained on the basis of the diabitogenic effect of somatotropin that was previously described by (Chillard, 1989). This effect is vital to shift nutrient partitioning and also, because the mammary glands possess an insulin independent mechanism for glucose uptake and can enhance lactose synthesis and the osmotic regulator of milk volume (Gallo and Block, 1990). The fact that administration of ST produces an elevation in blood glucose maybe via decreasing the utilization of carbohydrates, where the hormone appears to block the phosphorylation of glucose after carbohydrates have penetrated cells. Somatotropin also reduces sensitivity of peripheral tissues (muscle and adipose tissues) to insulin and inhibits the glucose uptake by peripheral tissues (Hadly, 1992). Additionally, somatotropin stimulates lipolysis, which provides substrates of glucose formation and this has sparing effect on direct glucose utilization. The elevated glucose levels produced by somatotropin could act as a substrate for the metabolic actions of the IGFs on their many target tissues, including mammary gland (Griffin and Ojeda, 1996).

Table 5. Effect of V-Line and Baladi does weekly injections with different doses of rpST on Plasma triiodothyronine (T_3) (ng/dl), Thyroxin (T_4) (ug/dl), Prolactin (ng/dl), Progesterone (ng/dl), and Insulin like growth factor-I (IGF-I) (ng/ml) at 21 days of gestation period and at kindling (Mean ± S.E).

Items		T_3		T_4		Prolactin		Progesterone		IGF-I	
		21 days	Kindling	21 days	Kindling	21 days	Kindling	21 days	Kindling	21 days	Kindling
Strains											
V-Line		155.06±1.45^{a}	148.19±1.29	1.96±0.03	2.34±0.03^{a}	27.03±0.20^{a}	29.78±0.19^{a}	8.72±0.13^{b}	4.31±012	695.1±44.8^{a}	847.1±46.3^{a}
Baladi		150.23±1.45^{b}	145.88±1.43	2.09±0.03	2.25±0.04^{b}	24.48±0.44^{b}	27.98±0.35^{b}	10.75±0.05^{a}	4.40±0.06	679.5±50.3^{b}	835.8±55.8^{b}
P value		***0.0100***	***NS***	***NS***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***NS***	*0.0500*	*0.0001*
rpST doses											
Control		157.09±1.78^{a}	152.09±1.45^{a}	1.91±0.06^{d}	2.10±0.03^{c}	23.38±0.56^{c}	26.06±0.36^{b}	8.92±0.17^{b}	3.15±0.11^{c}	650.8±42.1^{c}	807.8±48.1^{d}
20mg/kg/wk		156.62±1.65^{a}	150.22±1.36^{a}	2.06±0.09^{c}	2.30±0.12^{b}	24.71±0.54^{b}	28.73±0.42^{b}	9.33±0.15^{a}	4.41±0.13^{b}	678.8±56.7^{b}	832.9±44.3^{c}
40mg/kg/wk		150.59±1.27^{b}	144.98±1.53^{b}	2.18±0.02^{b}	2.40±0.04^{a}	27.16±0.25^{a}	30.76±0.31^{a}	10.00±0.15^{a}	4.70±0.16^{a}	699.8±50.8^{ab}	852.8±58.8^{b}
80 mg/kg/wk		145.48±1.82^{c}	140.87±1.61^{b}	2.27±0.04^{a}	2.39±0.04^{a}	27.56±0.32^{a}	29.95±0.44^{a}	10.09±0.17^{a}	4.80±0.15^{a}	719.9±49.3^{a}	872.4±60.3^{a}
P value		***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.0010***	***0.0001***	*0.0500*	*0.0500*
Interactions (Strain x rpST dose)											
V-Line	Control	160.75±2.99	152.98±2.29	1.93±0.03^{d}	2.13±0.04^{d}	24.92±0.40^{b}	27.07±0.35	9.02±0.34^{d}	3.65±0.20^{d}	660.2±66.1^{c}	812.1±77.3^{d}
	20 mg	157.30±2.09	150.13±1.62	2.08±0.02^{c}	2.35±0.03^{b}	26.17±0.29^{ab}	29.85±0.28	8.91±0.06^{c}	4.31±0.06^{c}	689.0±62.1^{b}	842.8±91.1^{c}
	40 mg	154.10±1.77	146.78±2.32	2.20±0.01^{b}	2.45±0.05^{a}	28.55±0.30^{a}	31.63±0.09	8.93±0.16^{bc}	4.64±0.18^{b}	703.3±51.1^{ab}	854.9±95.1^{b}
	80 mg	148.10±2.23	142.87±2.42	2.27±0.08^{a}	2.44±0.03^{a}	28.47±0.29^{a}	30.55±0.37	9.00±0.04^{b}	4.64±0.21^{b}	727.7±49.8^{a}	878.7±70.8^{a}
Baladi	Control	155.07±1.49	151.20±1.55	1.89±0.02^{d}	2.07±0.05^{e}	21.83±0.50^{d}	25.05±0.23	9.82±0.04^{b}	3.36±0.05^{d}	641.4±70.1^{d}	803.4±84.6^{e}
	20 mg	155.93±1.62	150.30±2.04	2.06±0.09^{cd}	2.24±0.06^{c}	23.25±0.60^{c}	27.62±0.45	10.95±0.05^{a}	4.50±0.08^{bc}	668.5±65.5^{c}	822.9±89.1^{d}
	40 mg	147.08±1.93	143.17±2.23	2.18±0.02^{bc}	2.35±0.05^{b}	25.77±0.35^{ab}	29.88±0.61	11.07±0.07^{a}	4.76±0.07^{ab}	696.2±69.9^{b}	850.6±73.3^{b}
	80 mg	142.85±1.15	138.87±2.27	2.26±0.01^{a}	2.39±0.03^{b}	27.05±0.58^{ab}	29.35±0.75	^{b} 11.18±0.08^{a}	4.96±0.08^{a}	712.0±73.3^{a}	866.1±96.2^{b}
P value		***NS***	***NS***	***0.0100***	***0.0010***	***0.0100***	***NS***	***0.0100***	***0.0100***	***0.0100***	***0.0500***

$^{a, b, c, d, e}$ Means with different letters within a column are significantly different ($P \leq 0.05$).

Hormones and IGF-I

Table 5 summarizes the effect of weekly rpST injection on does' some plasma hormones concentration at 21 days of gestation period and at kindling.

Plasma T_3 concentration of V-Line does was significantly ($P \leq 0.01$) higher than value of Baladi strain at 21 days of gestation period, this deference between strains disappeared by reaching the kindling period. Increasing the rpST dose at the two studied periods significantly decreased plasma T_3 ($P \leq 0.05$). Thus, those decreases compared to the control were (4.9% and 8.5%) and (4.9% and 8.0%) with the two high hormone doses at 21 days of gestation period and at kindling, respectively. Interaction between strains and hormone doses was not statistically significant.

Plasma T_4 concentration didn't differ between the two strains at 21 days of gestation period (NS), but by reaching kindling period, the value of V-Line does was significantly ($P \leq 0.0001$) higher than that of the Baladi does' (by 4.0%). Somatotropin treatments significantly ($P \leq 0.05$) increased plasma T_4 at both periods studied. Compared with the control, those increases were (14.1% and 18.8%) and (14.3% and 13.8%) with the two high levels of rpST at 21 days of gestation period and at kindling, respectively. That was reflected on the interaction between strains and hormone doses, which showed significance at both periods studied.

V-Line does demonstrated higher plasma prolactin concentration ($P \leq 0.0001$) compared to Baladi at both 21 days of gestation and at kindling (by 10.4% and 6.4%), respectively. Plasma prolactin concentration was significantly dose dependent in response to the rpST treatments ($P \leq 0.05$) at the two studied periods. It increases compared to the control by (16.2% and 17.8%) and (18.0% and 14.9%) with the two high doses of hormone at 21 days of gestation period and at kindling, respectively. Interaction between strains and hormone doses was statistically significant ($P \leq 0.05$) at 21 days of gestation period only.

Data in Table 5 states that plasma progesterone (P_4) concentration was significantly ($P \leq 0.0001$) higher in Baladi does compared to V-Line does at 21 days of gestation period (by 23.3%). Plasma P_4 concentration significantly and in a dose dependent manner ($P \leq 0.05$) increased with increasing the hormone dose at the two studied periods. Percentages which of such increase compared with the control were (12.1% and 13.1%) and (49.2% and 52.4%) with the two high hormone levels at 21 days of gestation period and at kindling, respectively. Interaction between strains and hormone doses was statistically significant ($P \leq 0.05$) at both, 21 days of gestation period and at kindling. It was evident, that plasma P_4 hormone concentration was affected by progeny status, where the lowest value was at kindling, while the highest value was at 21 days of gestation period.

Insulin like growth factor-I was comparatively higher in V-Line does compared to Baladi does at the two studied periods (by 2.2% and 1.3% at 21 days of gestation period and at kindling, respectively). Moreover, serum IGF-I concentration was significantly dose dependently ($P \leq 0.05$) and increased in response to rpST treatments at the two studied periods. Percentages of that increase compared with control were (7.5 % and 10.6%) and (5.6 % and 8.0 %) with the doses of (40 and 80 mg rpST/ kg bwt/wk) at 21 days of gestation period and at kindling, respectively. Interaction between strains and hormone doses was statistically significant ($P \leq 0.05$) at both studied periods, with the values of the high hormone doses (40 and 80 mg rpST/ kg bwt/ wk) with Baladi strain being significantly ($P \leq 0.05$) higher than those of the V-Line control at the two studied periods.

Results of the current study concerning the thyroid function (Table 5) are in agreement with the findings of Binelli *et al.* (1995) who observed that dairy cows treated with rpST had 10% lower plasma T_3 concentration compare to untreated animals. These decreases in T_3 concentration were attributed to the decrease of thyroidal deiodination of T_4 to T_3 (Kahl *et al.*, 1995). Results concerning the increase of doe rabbits T_4 values with rpST hormone treatment are in a good agreement with the findings of Holzer *et al.* (1999) who found that male claves treated with rbST 500 mg/ 14 days had increased plasma T_4 concentration. Also, Capuco *et al.* (2001) who found that short-term treatment of Holstein cows with rbST (40 mg /day) elevated serum T_4 by about 12% compared to the control. In addition, Kahl *et al.* (1995) showed that cows treated with rbST tend to have higher plasma T_4 concentration than controls. They attributed this increase to the decreased of extra-thyroidal deiodination of T_4 to T_3.

The present study indicated that administration of rpST increased does' plasma prolactin concentration. Which agrees with the findings of Hodate *et al*. (1991) who reported that rbST hormone administration increased plasma prolactin of cows. They also observed a highly positive correlation between the mean daily milk yield and the mean of prolactin concentration. El-Maghawry *et al*. (1994) results indicated that in the pregnant does, the level of progesterone hormone progressively increased with the progress of gestation period reaching the highest level at the 3rd and 4th weeks of pregnancy. They add that the respective variability in the P_4 level could be explained on the basis that, in non- pregnant does, no active corpora lutea or placenta exist, so that the P_4 concentration in response to rpST hormone administration are in a good agreement with that finding. Moreover, Hsu and Hammond, (1987) found that treatment with 50 mg rpST hormone/ kg bwt/ day increased P_4 synthesis in rat granulose cells and increased serum P_4 level. Also, Schemm *et al*. (1990) found positive correlation between ST treatment and plasma progesterone concentration during bovine estrous cycles.

Bauman and Vernon (1993) stated that the increase in circulating concentration of IGF-I after bST hormone treatment suggested of a role of IGF in bST hormone stimulated increased milk production. However, the exact mechanism is not fully understood, although treatment with exogenous somatotropin stimulate milk production. Moreover, IGF-I is a potent mitogen for mammary epithelial cells and stimulated the synthesis of milk components in some studies (Akers, 1985). Close arterial infusion of IGF-I into mammary gland increases both milk production and mammary blood flow in lactating goats (Prosser *et al.,* 1990 and 1994). Addition of IGF-I to bovine cell culture systems increase casein synthesis (Collier *et al.,* 1993). Which led to the assumption that IGF-I mediates the rbST stimulatory effect of the secretor cells in the udder to produce more milk. IGF-I acts also by promoting local production of vasodilators of the mammary gland blood vesicles (Bachman *et al.*, 1992).

Conclusively, it can be concluded that weekly injections of doe rabbits with rpST (mainly 40 or 80 mg/ kg bwt) can improve reproductive characteristics without harmful affects on the physiological aspects under consideration. Also, treating the native cross 'Baladi" does with rpST can make them reach and sometimes surpass the untreated V-Line does, thus this hormonal treatment can improve the native cross performance.

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هرمون النمو (السوماتوتروبين) :- الدور الفسيولوجى والتناسلى فى اناث الارانب

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يهدف البحث لدراسة تأثر معاملة اناث الارانب (سلالة الاسبانىV وسلالة البلدي الخليط المحلية) بهرمون السوماتوتروبين المخلق وراثيا على بعض الصفات الفسيولوجية والتناسلية. استخدم عدد 32 انثى بالغة عمر 5 اشهر (16 انثى من كل سلالة) قسمت حيوانات كل سلالة الى 4 مجاميع متساوية. حقنت ارانب المجموعة 2،3،4 اسبوعيا تحت جلد الرقبة بـ 20،40،80 ملجم هرمون/ كجم وزن جسم لمدة 3 بطون بينما المجموعة الاولى استخدمت للمقارنة.

هرمون السوماتوتروبين ادى الى زيادة جوهرية فى حجم البطن عند الولادة وعند 21 يوم وعند الفطام وايضا وزن الخلفة عند الولادة وعند عمر 7،14،21 يوم وايضا عندالفطام وكذلك الربح فى الوزن عند الاعمار ذاتها. متوسط محصول اللبن من الولادة حتى الفطام لكل ام اذداد معنويا وكذلك عند الاسابيع 1،2،3،4 من العمر وكانت الزيادة مرتبطة بزيادة جرعة الهرمون. عموما الخواص التناسلية لسلالة V الاسبانية كانت اعلى جوهريا بالمقارنة بالسلالة البلدى الخليط المحلية.

نسبة البروتين الكلى والجلوبيولين فى سيرم الدم اذدادت معنويا مع زيادة جرعة الهرمون حتى الفطام. نسبة دهون البلازما ارتفعت معنويا مع الهرمون بعد 21 يوم فقط من فترة الرضاعة. اظهرت النتائج ان كل من نسبة الكلوستيرول والجليسريدات الثلاثية والجلوكوز وكذلك هرمونات البرولاكتين والبروجستيرون و T_4 وكذلك تركيز هرمون الانسولين المنظم لعامل النمو اذدادت معنويا بالدم وكانت الزيادة مع زيادة جرعة الهرمون. بينما تركيز هرمون T_3 انخفض بزيادة جرعة الهرمون.

نستنتج من هذة الدراسة ان المعاملة بهرمون النمو(السوماتوتروبين) اسبوعيا لامهات الارانبخاصة بجرعات (40،80 ملجم/ كجم) يحدث تحسن ملحوظ فى الصفات التناسلية لاناث الارانب بدون اى تأثير ضار على الصفات الفسيولوجية لهذة الامهات. كذلك معاملة امهات سلالة البدى الخليط المحلية بهذا الهرمون ادت الى تحسين واضح فى هذة الصفات واعطت نتائج مشابهة الى قيم السلالة الاسبانية V (الغير معاملة).

ومن هذة النتائج يمكن استخدام هذا الهرمون فى تحسين صفات السلالة المحلية.