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Metabolic changes concerning the effect of castration on some blood constituents in male rabbits

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Summary

This experiment was conducted to determine the effects of castration on some metabolic alterations concerning proteins, lipids and minerals metabolism in both immature and mature rabbits. Twenty male New Zealand White rabbits (10 immature and 10 mature) were used. Blood samples were collected from the immature and mature intact animals (control non castrated). Moreover, the castrated animal groups (immature and mature) were sampled at 2, 4, 6 and 8 weeks after castration. The obtained results revealed that, castration caused a significant decrease in serum total protein, albumin, α_1-globulins and α_2-globulins concentrations. Meanwhile, γ-globulins level was decreased temporarily at 2 weeks after castration in mature rabbits. β-globulins level revealed non significant decrease at 2 weeks after castration in immature rabbits followed by a non significant increase. In mature rabbits β-globulins level non significantly increased. A significant decrease in serum total nucleic acid concentrations was observed after castration throughout the experimental periods, whereas the value of serum uric acid level markedly increased after castration. Serum lipids concentrations (total lipids, total cholesterol, phospholipids and non esterified fatty acids) were increased after castration. The value of serum trace elements including copper, iron, zinc and manganese concentrations showed a significant decrease after castration. The decrease in serum copper and zinc levels were markedly observed in mature castrated rabbits. Also, serum sodium and potassium concentrations were decreased after castration. Testosterone propionate administration in mature castrated rabbits restored most of the investigated serum blood parameters to the levels of intact non castrated mature rabbit.

It could be concluded that castration (deficiency of testosterone) induced marked decrease in protein synthesis and increased protein degradation, but serum lipids markedly elevated after castration in both immature and mature animals. Also, castration caused a marked decrease in some serum minerals and trace elements.

HUSSEIN, S. A., AZAB, M. E., ABDEL-MAKSOUD, H. (1999): **Biochemische Serumuntersuchungen an männlichen Kaninchen über den Einfluß der Kastration auf den Eiweiß-, Fett- und Mineralstoffwechsel.**
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Zusammenfassung

Die Versuche hatten zum Ziel, die Auswirkung der Kastration männlicher Kaninchen der Rasse New Zealand White auf den Eiweiß-, Fett- und Mineralstoffwechsel zu untersuchen. Die Kastration wurde bei 12 Wochen alten, juvenilen und 20 Wochen alten, geschlechtsreifen Rammlern durchgeführt. Blutproben wurden 2, 4, 6 und 8 Wochen nach der Kastration bei jeweils 10 Tieren aus jeder Gruppe genommen. – Die Befunde ergaben eine während der ganzen Versuchszeit bestehende, deutliche Minderung des Gesamt-Serumeiweiß-Gehaltes, des Albumins und α_1-Globulins bei den juvenil und geschlechtsreif kastrierten Kaninchen. Die α_2-Globulin Fraktion war nur bei den geschlechtsreif kastrierten Rammlern vermindert. Der β-Globulin-Gehalt stieg bei den im Alter von 20 Wochen kastrierten Rammlern an, bei den juvenil kastrierten Kaninchen kam es innerhalb von 2 Wochen nach der Operation zunächst zu einem Abfall der Meßwerte, die danach aber anstiegen. Die γ-Globulin-Werte waren bei allen kastrierten Tieren 4 Wochen nach Kastration zurückgegangen, stiegen anschließend jedoch wieder auf die Werte der unbehandelter Tiere an. Die Kastration bewirkte einen deutlichen Abfall der Serum-Nukleinsäure, die Werte der Harnsäure waren während der ganzen Versuchsdauer deutlich erhöht. Die Serum-Lipide (Gesamtfett, Gesamtcholesterol, Phospholipide und nicht veresterte, freie Fettsäuren) nahmen bei allen kastrierten Kaninchen deutlich zu. Die Serumwerte für die Spurenelemente Kupfer, Eisen, Zink und Mangan sowie für die Elektrolyte Natrium und Kalium verminderten sich nach der Kastration. Nach Behandlung der geschlechtsreif kastrierten Rammler mit Testosteron-Proprionat stellten sich bei diesen mehrheitlich wieder die bei den nichtkastrierten Kaninchen ermittelten Serumwerte ein.

Aus den Untersuchungsergebnissen kann gefolgert werden, daß der mit der Kastration männlicher Kaninchen verbundene Mangel an Testosteron die Änderungen im Eiweiß-, Fett- und Mineralstoffwechsel mit Beeinträchtigung der Eiweißsynthese bei gleichzeitiger Erhöhung der Serumlipide herbeigeführt hat, die begleitet waren von einer Reduktion der im Serum vorhandenen, mineralen Spurenelemente und Elektrolyte.

Today rabbits industry is progressing rapidly in Egypt to overcome the excessive demand for animal proteins. The rabbit meat is highly digestible and rich in essential amino acids particulary lysine, valine, leucine, methionine and threonine (LEE and AHN 1977). Quality of rabbit meat is affected by some factors such as age and nutrition, whereas sex of rabbit had little or no significant effect (NIEDZWIADEK et al. 1993).

Castration has been performed on domestic animals for thousand years ago with the object of making the flesh more pleasant to eat or of making the animals more docile. These behaviours help the animal for meat production (IBRAHIM and EL-SAADANY 1967).

The biological effect of castration was studied by many authors. KUNG and BONG (1983) found that, plasma proteins were not affected by castration without or with testosterone treatment. On the other hand, MOGUILEVSKY and SCACCHI (1971) investigated DNA, RNA and protein content in the anterior, middle and posterior hypothalamus in normal and castrated rats. Their results indicated that, similar amounts of DNA and RNA were found in the different hypothalamic area. However, significant decrease in the protein contents of the anterior and middle hypothalamus was indicated.

BREUER and FLORINI (1965) reported that, the protein synthesis in ribosomes isolated from thigh muscles, was reduced after castration and was restored to normal level after androgen treatment. Meanwhile, CINIC et al. (1993) noticed that, the cholesterol level was increased in serum and liver of castrated rats and the androgen treatment restored the serum cholesterol only to the normal level.

According, the interest arises to study the biochemical alterations which may occur in the blood serum of immature and mature New Zealand White rabbits under the effect of castration with special reference to their effect on some metabolic changes concerning the proteins, lipids and minerals metabolism.

Material and methods

Twenty male New Zealand white rabbits (10 immature and 10 sexually mature), weighting between 1.600 and 1.700 kg were used in this experiment. The age of immature and sexually mature rabbits at the beginning of the experiment were 12 and 20 weeks, respectively. Rabbits were housed individually in stainless steel cages in a room with controlled temperature and a regular photoperiod (12 hr light and 12 hr dark). Rabbit pellets, green feed and fresh water were provided ad-libitum. The animals were kept at a constant environmental and nutritional condition through the period of investigation. The animals were divided into four equal groups each one consisting of 5 rabbits placed in individual cages and classified as follows:

Group I-control-:	Immature growing rabbits, noncastrated.
Group II-:	Immature growing rabbits, castrated.
Group III-control-:	Mature adult rabbits, non-castrated.
Group IV-:	Mature adult rabbits, castrated.

Castration procedure:

The castration procedure used was performed at 12 and 20 weeks of age for immature and mature rabbits, respectively. Briefly, two incisions were made with a disinfected scalpel on each side of the scrotum. A second incision on each side was made to free each testicle from the surrounding tissue. Each testicle pedicle was banded and then removed. A solution of 2 % iodine was applied to the open wound to prevent any infection and the rabbits were returned to their cages (MCGLONE and HELLMAN, 1988).

Blood samples:

Blood samples for serum separation were obtained from all animal groups (control and experimental groups) by vein puncture of the marginal ear vein after preening the rabbit, then allowed to coagulate at room temperature for 30 minutes, then centrifuged at 3000 r.p.m for 10 minutes. The clean serum was separated and kept in a deep freeze at -20 °C until used for subsequent biochemical analysis.

Blood samples were collected from immature and sexually mature castrated rabbits (castrated groups) four times and periodically every two weeks for a duration of two months from the onset of the castration procedure performed.

Eight weeks post-castration the sexually mature castrated rabbits (group IV) received once daily intramuscular injection of 4.66 mg/kg body weight testosterone propionate for 10 successive days according to PAGET and BARNES (1964). Moreover, blood samples were also collected once at 24 hours after last injection.

Biochemical analysis:

1. Total protein was determined as described by HENRY (1968).
2. Protein fractions were estimated by the microzone electrophoresis according to the method of KOH (1968).
3. Uric acid and total nucleic acid were determined in the serum by using the method of WILDING and HEATH (WOOTTON and FREEMANN, 1982) and SPIRN (1958) respectively.
4. Serum total lipids, total cholesterol, triglyceride, phospholipids and non esterified fatty acids (NEFA) were determined according the method described by FRINGS and DUNN (1970), MEIATTINI et al. (1978), BUCOLO and DAVID (1973), ZILVERSMIT and DAVIS (1950) and DUNCOMBE (1964) respectively.
5. Serum copper, iron, zinc and manganese were analysed using atomic absorption spectrophotometer according the method of WILLIS (1960).
6. Sodium and potassium serum concentrations were determined by using the method of TINDER (1951) and SUNDERMAN and SUNDERMAN (1968), respectively.

Statistical analysis:

The obtained data were statistically analyzed and the significant difference between groups was evaluated by t-test (SNEDECOR and COCHRAN, 1969).

Results

The obtained data in table 1 showed the effect of castration on the level of serum total protein and its components as well as total nucleic acid and uric acid concentration in immature and mature rabbits. The mean value of serum total protein concentration showed a highly significant decrease at 2 weeks after castration in immature and mature groups of rabbits, whereas, after 6 weeks of castration the mature castrated rabbits showed a significant decrease. A non significant decrease in serum total protein concentrations were observed throughout the experimental periods at 4,6,8 weeks and at 4 and 8-weeks post-castration in immature and mature rabbits respectively. The value of serum albumin level revealed a significant decrease after 2 weeks of castration in immature and mature groups followed by a non significant decrease throughout the rest of experimental periods. There was a non significant decrease in serum α_1-globulins level throughout the experimental period. This decrease became significant in mature castrated group after 6 weeks of castration. The concentration of α_2-globulin level showed a very highly significant decrease at 2 weeks post castration. This decrease became highly significant at 6 weeks after castration in mature group. Moreover, the value of serum α_2-globulin level revealed a non significant change in immature castrated rabbits when compared with intact immature control group.

The value of serum β-globulins level revealed a slight increase throughout the experimental period. Meanwhile, γ-globulins concentraion showed a highly significant decrease in mature castrated rabbit at 2 weeks after castration. A delayed decrease in γ-globulins level was reported throughout the experimental periods in immature and mature castrated rabbits.

The mean value of serum total nucleic acid concentrations showed a highly significant decrease in immature castrated rabbits at 6 and 8 weeks after castration. In mature castrated rabbit a significant decrease in serum total nucleic acid level was noticed at 4 weeks. This decrease became highly significant at 6 weeks and highly significant at 8 weeks after castration when compared with the intact control group. The value of serum uric acid concentration in immature and mature castrated rabbits were markedly increased throughout the experimental periods. Such increase became non significant at 2 weeks after castration in mature group.

The obtained data in table 2 revealed that, there was a significant increase in serum total lipids concentrations at 6 weeks after castration in immature rabbits. This increase became highly significant at 8 weeks. However, serum total lipids level displayed no significant changes in mature castrated group throughout the experimental periods. The value of serum total

cholesterol concentrations in immature castrated group displayed no significant alterations. Meanwhile, in mature castrated rabbits serum total cholesterol level showed a significant increase at 4 weeks followed by a highly significant increased at 6 weeks and 8 weeks after castration.

Serum triacylglycerols concentrations displayed no significant changes throughout the experimental periods and the value was non significantly increased when compared with non castrated groups.

Regarding serum phospholipids levels a significant increase was noticed at 2 weeks after castration. This increase became very highly significant at 6 weeks and 8 weeks after castration in immature rabbits, whereas, in mature castrated groups serum phospholipids level revealed a non significant increase.

A significant increase in serum non esterified fatty acids level was observed at 4 weeks, 6 weeks and 8 weeks after castration in immature rabbits, whereas, in mature castrated rabbits the value of NEFA revealed no significant increase.

The obtained results in table 3 revealed that in immature castrated rabbits a non significant decrease in the value of serum copper, iron, and zinc concentrations were observed throughout the experimental periods. Meanwhile, serum iron level showed a significant decrease at 8weeks after castration, whereas, a non significant increase in serum iron level was noticed in mature castrated rabbits. A highly significant decrease in serum manganese level was noticed at 2, 4 and 8 weeks after castration in immature castrated rabbits when compared with intact control group. A significant decrease in serum copper level was noticed at 4 weeks after castration. This decrease became highly significant at 6 weeks and 8 weeks after castration in mature group. A highly significant decrease in serum zinc and manganese concentrations were noticed at 4 weeks after castration in mature rabbits. This decrease became very highly significant at 8 weeks after castration. Also, a significant decrease in serum zinc level was reported at 6 weeks, while serum manganese concentration showed a significant decrease at 2 weeks and 6 weeks after castration in mature group of rabbit.

The value of serum sodium level revealed a non significant decrease at 2 weeks and 4 weeks after castration in immature rabbits. This decrease became significant at 6 weeks and highly significant at 8 weeks after castration when compared with intact control group. Also the value of serum sodium level revealed a non significant decrease at 2 weeks after castration. This decrease became highly significant at 4, 6 and 8 weeks after castration in mature castrated group.

A significant decrease in serum potassium level was noticed at 2 weeks in immature castrated rabbits and at 4 and 6 weeks in mature group. This decrease be-

Table 1: **Effect of castration on serum total proteins, protein fractions (g/dl), total nucleic acid (mg/dl) and uric acid (mg/dl) concentrations in immature and mature rabbits**

Animal groups	Group I	Group II Period after castration in week			
Parameters		2w	4w	6w	8w
Total proteins	6.21±.19	5.45±0.25**	5.35±0.68	5.79±0.53	5.50±0.43
Albumin	3.53±0.13	2.71±0.27*	2.92±0.55	3.12±0.49	2.90±0.71
α_1 globulin	0.55±0.18	0.55±0.21	0.24±0.09	0.26±0.05	0.42±0.13
α_2 globulin	0.76±0.20	0.82±0.03	0.69±0.09	0.74±0.03	0.85±0.06
β globulin	0.51±0.16	0.50±0.05	0.78±0.23	0.79±0.23	0.90±0.19
γ globulin	0.83±0.13	0.77±0.11	0.73±0.14	0.69±0.09	0.82±0.03
Total nucleic acid (mg/dl)	17.75±1.38	15.68±2.08	14.00±1.15	11.66±0.88**	10.33±0.88**
Uric acid (mg/dl)	2.19±0.15	3.60±0.34***	3.93±0.12***	4.53±0.20***	4.62±0.31***

Animal groups	Group III	Group IV Period after castration in week			
Parameters		2w	4w	6w	8w
Total proteins	6.24±0.18	5.06±0.06**	5.55±0.30	4.99±0.45*	5.36±0.38
Albumin	3.50±0.23	2.98±0.01*	3.32±0.19	2.63±0.34	3.13±0.43
a1 globulin	0.63±0.13	0.39±0.11	0.50±0.11	0.45±0.05	0.50±0.11
a2 globulin	0.76±0.01	0.51±0.01***	0.64±0.07	0.60±0.01**	0.69±0.05
b globulin	0.19±0.03	0.48±0.17	0.27±0.03	0.33±0.06	0.26±0.04
g globulin	0.82±0.11	0.49±0.03**	0.82±0.05	0.98±0.01	0.74±0.17
Total nucleic acid(mg/dl)	17.25±1.11	14.33±2.03	11.67±1.20*	10.33±1.45**	8.67±0.66**
Uric acid (mg/dl)	2.25±0.29	3.23±0.33	4.12±0.17**	4.29±0.99**	4.41±0.23**

Results are presented as mean ± SE. Values are significantly different at * P<0.05, **P<0.01 and *** P<0.0010 test)

Group I-control:- Immature growing rabbits, noncastrated ; Group II:- Immature growing rabbits, castrated; Group III-control:- Mature adult rabbits, noncastrated; Group IV:- Mature adult rabbits, castrated.

Table 2: **Effect of castration on serum lipids concentration in immature and mature rabbits (mg/dl)**

Animal groups	Group I	Group II Period after castration in week			
Parameters		2w	4w	6w	8w
Total lipid	317.00±20.31	376.00±40.72	354.00±42.31	438.66±44.43*	500.66±26.52**
Total cholesterol	79.73±7.60	82.67±9.22	91.07±8.45	99.11±8.16	105.21±11.10
Triglyceride	114.67±12.10	123.00±11.13	126.33±18.45	129.66±24.77	136.00±26.51
Phospho-lipids	114.75±0.59	151.00±14.43*	111.00±19.65	161.66±2.02***	205.00±3.77***
Free fatty acids	23.50±3.27	26.66±1.76	34.33±2.96*	41.00±4.93*	42.00±3.78*

Animal groups	Group III	Group IV Period after castration in week			
Parameters		2w	4w	6w	8w
Total lipid	320.25±35.54	357.33±78.70	394.00±34.15	404.00±21.97	415.66±30.00
Total cholesterol	74.20±4.93	89.11±6.98	101.80±6.55*	100.39±4.90**	101.15±3.80**
Triglyceride	130.25±12.25	131.67±15.43	131.33±14.88	137.67±12.19	147.33±18.11
Phospho-lipids	96.50±8.04	102.00±8.71	117.00±8.71	119.00±10.59	114.00±8.08
Free fatty acids	28.75±4.47	30.33±5.75	31.66±4.05	40.66±3.48	37.33±5.92

Table 3: **Effect of castration on serum copper, iron, zinc, manganese, sodium and potassium concentrations in immature and mature rabbits**

Animal groups / Parameters	Group I	Group II Period after castration in week			
		2w	4w	6w	8w
Copper (µg/dl)	66.12±2.80	67.57±2.40	55.21±7.00	56.82±4.91	55.26±3.68
Iron (µg/dl)	124.75±3.12	126.33±1.76	129.66±3.29	120.66±4.40	111.66±2.33*
Zinc (µg/dl)	147.66±8.01	144.51±10.18	144.86±8.05	130.00±8.20	126.07±13.69
Manganese (µg/dl)	5.44±0.06	3.61±0.18**	3.13±0.09***	4.30±0.31	3.30±0.08**
Sodium (mEq/L)	100.80±4.04	86.01±8.49	84.15±8.38	72.73±7.07*	73.46±8.19**
Potassium (mEq/L)	3.72±0.16	2.63±0.31*	2.46±0.29**	2.53±0.29**	2.49±0.21**

Animal groups / Parameters	Group III	Group IV Period after castration in week			
		2w	4w	6w	8w
Copper (µg/dl)	66.41±2.33	58.80±4.17	52.21±3.82*	66.70±3.78**	117.66±3.79
Iron (µg/dl)	124.75±8.33	132.33±6.35	139.83±4.86	147.33±4.83	134.66±2.60
Zinc (µg/dl)	169.31±7.78	146.11±10.18	130.27±5.36**	125.83±13.09*	117.02±4.56**
Manganese (µg/dl)	7.49±0.32	5.37±0.12*	4.23±0.06**	4.87±0.34*	3.14±0.08**
Sodium (mEq/L)	100.64±4.04	82.38±6.26	73.37±1.94**	74.02±3.23**	74.07±4.53**
Potassium (mEq/L)	3.51±0.29	2.35±0.40	2.24±0.36*	2.35±0.29*	2.10±0.16**

Results are presented as mean ± SE
Values are significantly different at * P<0.05, **P<0.01 and ***P<0.0010 (t-test)
Group I-control:- Immature growing rabbits, noncastrate. Group II:- Immature growing rabbits, castrated. Group III-control:- Mature adult rabbits, noncastrated. Group IV:- Mature adult rabbits, castrated.

came highly significant at 4, 6 and 8 weeks after castration in immature rabbits and at 8 weeks after castration in mature group.

The obtained results concerning the effect of intramuscular injection of testosterone propionate on serum total proteins and its components, total nucleic acid, uric acid and serum lipids (total lipids, total cholesterol, triglyceride, phospholipids and free fatty acids) as well as serum minerals concentrations (copper, iron, zinc, manganese, sodium, and potassium) in mature castrated rabbits, were summarized in table 4. The values of serum total proteins, albumin, α_1-globulins, α_2-globulins, β-globulins and γ-globulins fractions were non significantly increased after treatment. A significant increase in serum total nucleic acid and highly significant decrease in serum uric acid concentrations were noticed after testosterone injection. Regarding serum lipids concentration a non significant increase in serum total lipids, triglyceride, phospholipids and NEFA with non significant decrease in serum total cholesterol levels were reported.

A significant increase in serum copper and iron concentration were observed after testosterone administrations.

Meanwhile a highly significant increase in serum zinc, manganese, sodium and potassium levels were observed in mature castrated rabbits after treatments with testosterone propionate.

Table 4: **Effect of intramuscular injection of 4.66 mg/kg body weight testosterone propionate once daily for 10 days on some biochemical blood parameters concentration in mature castrated rabbits.**

Statement / Parameters	Mature castrated rabbits (after 8 weeks)	
	TP non injected animals	TP injected animals
I Serum proteins (g/dl)		
Total proteins	5.38±0.38	6.02±0.16
Albumin	3.13±0.43	3.26±0.16
α_1 globulin	0.56±0.11	0.59±0.10
α_2 globulin	0.69±0.05	0.84±0.09
β globulin	0.26±0.04	0.41±0.05
γ globulin	0.74±0.17	0.93±0.01
Total nucleic acid (mg/dl)	8.07±0.88	16.00±2.52*
Uric acid (mg/dl)	4.41±0.28	2.50±0.27**
II Serum lipids		
Total lipid	415.66±30.00	444.66±29.41
Total cholesterol	101.15±3.60	87.16±6.62
Triglyceride	147.33±18.11	150.66±15.21
Phospholipids	114.00±8.08	155.33±18.02
Free fatty acid	37.33±5.02	38.33±3.92
III Serum minerals		
Copper (µg/dl)	47.66±3.79	63.38±3.66*
Iron (µg/dl)	124.66±2.60	144.00±4.35*
Zinc (µg/dl)	117.02±4.56	163.82±5.75**
Manganese (µg/dl)	3.14±0.08	8.58±1.61**
Sodium (mEq/L)	74.07±4.53	114.39±4.47**
Potassium (mEq/L)	2.10±0.16	3.46±0.26**

TP: Testosterone propionate
Results are presented as mean ± SE
Values are significantly different at * P<0.05, **P<0.01 (t-test)

Discussion

The obtained results revealed a highly significant decrease in serum total protein level at two weeks after castration in immature and mature rabbits. This decrease became significant at 6 weeks after castration in mature rabbits only. This decrease in serum total protein concentrations was generally, referred to the significant decrease of protein components, mainly albumin and α_2-globulins level observed after castration. These results were in agreement with Ibrahim and EL-SAADANY (1987). Also, BREUER and FLORINI (1960) reported that the protein synthesis in ribosomes isolated from thigh muscles was reduced after castration and was restored to normal level after androgen treatment. Similarly, MCDOWELL et al. (1995) reported that, both total protein and the protein concentration in seminal plasma were decreased at 32 days after castration in geldings, but treatment with testosterone propionate maintained both values at levels similar to those of the stallions. Meanwhile, KATTESH et al (1994) found that, plasma concentrations of albumin and total proteins were unaffected by castration in the piglets from 3 to 42 days of age.

The results of electrophoretic separation of the serum protein revealed that, serum albumin level was significantly decreased after castration. Similar results was reported by CASTRO et al. (1977) in goats and IBRAHIM and EL-SAADANY (1987) in rabbits. This would indicate that the steroid sex hormones involved in the stimulation of synthesis of albumin in liver. This result is also supported by VIZZOTTO et al. (1996) who reported that, testosterone deficiency and administration exerts specific effect on the liver (castration produces hepato cellular distress).

The obtained data revealed a slight increase in β-globulin level throughout the experimental period. This, may be explained as testosterone in blood is bound to β-globulin called gonadal steroid-binding globulin (GBG) and albumin (GANONG, 1989). The secretion of GBG is inhibited by androgens, whereas estrogens stimulate its synthesis (RUCKEBUSCH et al., 1991), thereby castration (testosterone deficiency) could be increase β-globulins. On the other hand, the observed decrease in α_1-globulins and α_2-globulins could be compensatory result of a higher β-globulins fraction. There was also a decrease in the γ-globulin level. This decrease was temporarly and delayed. The same result is also recorded by IBRAHIM and EL-SAADANY (1987).

The obtained data revealed that, serum total nucleic acid level was highly significantly decreased in immature and mature rabbits after castration. The obtained re-

sults were nearly similar to those recorded by PIZZICHINI et al (1995) who observed that, after castration there was purine nucleotide catabolism, and RNA synthesis decreased with less formation of GMP than that of AMP. Also VIZZOTTO et al (1996) reported that, acid soluble nucleotides, RNA and DNA were lower after castration. Furthermore, STEFANO et al. (1990) found that, castration accelerate the turnover of purine nucleotide in adult rats and reduced it in prepubertal castrated rat. Moreover, castration did not modify the RNA content in the different hypothalamic areas of rats, but significantly decreased the protein content of the posterior hypothalamic area (MOGUILEVSKY and SCACCHI, 1971).

The obtained results revealed that, there was a highly significant increase in catabolic products of the nucleoprotein, particularly uric acid in immature and mature castrated rabbits throughout the experimental periods. The obtained data agreed well with the results of Ibrahim and EL-SAADANY (1987) who recorded that, a significant increase in the catabolic product compounds, particularly uric acid after castration in rabbits. Uric acid often reflects the increase of nucleic acids synthesis and breakdown. In this respect, testosterone exerts potent anabolic effects for protein by increases protein synthesis and decreases the breakdown of protein, leading to an increase in the rate of growth (GANONG 1989), subsequently, castration induces an increase in the protein catabolism. This hypothesis concurrent with the present results involving uric acid in which a marked increase was indicated.

The obtained data revealed that, in immature castrated rabbits a significant increase of serum total lipids concentrations was observed after castration. However, in mature castrated rabbits there was a significant increase in serum total cholesterol level after castration. It is evident from the present study that, in immature castrated rabbits serum phospholipids level showed a significant increase at 2 weeks followed by highly significant increase at 6 and 8 weeks after castration. Moreover, serum non esterified fatty acids revealed a significant increase at 4, 6 and 8 weeks after castration. The obtained data agreed well with the results of CINIC et al. (1993) who recorded that, the cholesterol level increased in serum and liver of castrated rats and androgen administration restore the serum level only.

The increase in serum total cholesterol level after castration may be due to the reduced catabolic rate of serum cholesterol or reduced activity of cholesterol 7α-hydroxylase, the rate limiting enzyme in bile acid synthesis from cholesterol (SZYMANSKI et al., 1981). Moreover, in the mammal it seems well established that, the plasma FFA are precursors of the plasma triglycerides (HAVEL 1961). Such a relationship would permit a ready explanation of the increase in plasma lipids simultaneously with an increase in plasma FFA. Furthermore, HEALD and ROOKLEDGE (1964) reported that, testosterone decreased the level of plasma lipids and of lipophosphoprotein in the laying fowl. So, the increase in lipids concentration reported in the obtained results may be due to the direct effect of testosterone deficiency in immature and mature castrated rabbits. However, KUNG and BONG (1983) found that, plasma creatinine decreased in castrated animals. Meanwhile, cholesterol concentration was varied inversely to creatinine levels.

On the other hand, higher lipids concentration in immature and mature castrated rabbits may be attributed to the decrease of the manganese level observed after castration as confirmed by AMDUR et al. (1948) who found that, higher liver lipid concentration in manganese deficient rat livers. Also, CURRAN (1954) reported that, manganese is associated with steroid biosynthesis. Manganese act as a cofactor of mevalonate kinase and farnesyl pyrophosphate synthase (AMDUR et al. 1957 and BENEDICT et al. 1965). These enzymes lead to squalene (direct cholesterol precursor) formation. Also CURRAN (1954) observed that in vitro studies, small amount of manganese lead to increased cholesterol biosynthesis. In contrary, DOISEY (1972) reported that, manganese deficiency in a human subject was accompanied by decrease in the concentration of serum cholesterol, triglycerides and phospholipids.

The obtained results revealed that, there was a significant decrease in serum copper concentration in mature castrated rabbits at 4 weeks and this decrease became highly significant at 6 and 8 weeks after castration. The decrease in serum copper concentrations in mature castrated rabbits may result from the influence of increased cortisol response of adrenal gland which is directly associated with the short-term behavioural changes observed after castration in lambs, kids and to a lesser extent calves (ROBERTSON et al. 1994 and Meller 1991). Such explanation was confirmed by EVANS et al. (1967) who reported that, the ceruloplasmin and plasma copper increase accompanying adrenalectomy can be inhibited by continuous corticosterone therapy. The high ceruloplasmin and plasma copper concentrations found in the adrenalectomized animals, together with the inhibitory effect of corticosterone, suggest that, the adrenal gland influence plasma copper and ceruloplasmin (EVANS and WIEDERANDERS, 1968). Moreover, EVANS and WIEDERANDERS (1967a) found that, ACTH inhibited the ceruloplasmin oxidase activity and plasma copper concentration in the developing neonatal rats as confirmed by EVANS and WIEDERANDERS (1967b) who showed that, a decrease in ceruloplasmin concentrations following ACTH administration.

Regarding serum iron concentrations a significant decrease in serum iron was noticed in immature castrated rabbits at 6 weeks after castration. The decrease in serum iron concentrations may be attributed to the decrease in serum copper level reported in the present study, which might be emphasize the role of copper containing enzyme (ceruloplasmin) in the absorption of iron and transfer of iron from reticuloendothelial system to the plasma as confirmed by BAUER (1962) who reported that, the enzyme ceruloplasmin oxidises Fe^{++} to Fe^{+++} helping to transport iron across the intestinal wall and helps to mobilize iron from its storage site. The decrease in serum iron concentrations may be attributed to the high cortisol level as confirmed by SWENSON and REECE (1993) who reported that, the iron level is decreased when the adrenal cortex secrete more cortisol. Moreover, transferrin, ceruloplasmin, testicular plasminogen activators and growth factors are synthesized and released from the Sertoli's cells of the testis (RUCKEBUSCH et al., 1991).

Zinc is present in relatively large quantities in the testes and the prostate gland and is essential for the growth of germinal and somatic cells (Ruckebusch et al., 1991). The obtained results revealed that, there was a highly significant decrease in serum zinc concentration in mature castrated rabbits at 4 weeks after castration. This decrease became significant at 6weeks and very highly significant at 8 weeks after castration. The decrease in serum zinc level in mature castrated rabbits was nearly similar to the results reported by HIDIROGLOU et al. (1979) who observed that, castration depressed the amount of ^{65}Zn uptake by prostate gland, the administration of testosterone propionate restored the amount of ^{65}Zn uptake to that maintained in intact male sheep. Moreover, it was postulated by MILLOFI et al. (1957) that, under normal physiological conditions, testosterone is the major responsible for the accumulation and maintenance of high zinc concentrations in the dorsolateral prostate gland of the ram. The decrease in serum zinc level may be attributed to high cortisol level and the results were confirmed by the statement of KUTASKY (1981) who reported that, the high cortisol level decrease the serum zinc concentration.

The obtained results showed that, serum sodium and potassium concentrations decrease after castration in both immature and mature animals. This result may be explained as testosterone causes moderate sodium, potassium, water, sulfate and phosphate retention (GANONG, 1989). However, there is no explanation to the observed decrease in manganese levels after castration because the available literatures seem to be deficient to discuss our results.

The present study revealed that testosterone administration in mature castrated rabbits restored most of the investigated

parameters nearly to the recorded levels in the intact male. This could be attributed to the anabolic effect of testosterone by interfering with the catabolic response of glucocorticoids (MAYER and ROSEN, 1975) in addition to testosterone suppress of hepatic synthesis of cortisol-binding proteins. Moreover, testosterone increases protein synthesis (MARTINEZ et al. 1984; TUCKER and MERKEL 1987).

Reffering to the effect of testosterone administration on trace elements levels, testosterone restored the levels of copper, iron, manganese and zinc to normal. This result is confirmed by DVORAK et al. (1980) who found that, the concentration of serum iron rose after testosterone treatment. Moreover, the levels of iron and copper increased towards maturity in buffalo calves (DEVARAJ et al. 1985). He attributed such increase in the levels of serum iron and copper to sex hormones. The observed increase in the serum zinc level may be attributed to increase zinc uptake as reported by HIDIROGLOU et al. (1979).

It could be concluded that, castration (deficiency of testosterone) induced marked decrease in protein synthesis and increased protein degradation, but serum lipid markedly elevated after castration in both immature and mature animals. Also, castration caused a marked decrease in some serum minerals and trace elements. So the subsequently possible increase in the body weight of castrated animals not due to excessive meat production but mainly due to fat deposition. Therefore castration must not be done in early age of animal to allow optimal growth.

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الملخص العربى

تغيرات الأيض التى تخص تاثير الخصى على مكونات الدم فى الأرانب

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تم إجراء البحث لتوضيح التغيرات فى أيض البروتينات والدهون وبعض العناصر الموجودة فى الدم بعد الخصى فى الأرانب البالغة والغير بالغة. وقد استخدم فى هذا البحث عدد ٢٠ من الأرانب النيوزلاندى البيضاء (١٠أرانب بالغة و١٠ أرانب غير بالغة). تم أخذ عينات الدم من الحيوانات الغير مخصية البالغة والغير بالغة لتكون مجموعات ضابطة للمجموعات المخصية البالغة والغير بالغة. ثم تم تجميع عينات الدم من الحيوانات المخصية بعد أسبوعين و ٤ أسابيع و ٦ أسابيع و ٨ أسابيع بعد الخصى، بعد ذلك تم حقن المجموعة المخصية البالغة بهرمون التستوستيرون لمدة عشرة أيام متوالية، ثم تم أخذ عينات الدم بعد ٢٤ ساعة من آخر جرعة تم حقنها. وقد أظهرت النتائج التالية:-

- انخفاض فى مستوى البروتين الكلى فى الدم والألبيومين والألفا-١ والألفا-٢ جلوبيولين، بينما انخفض مستوى الجاما جلوبيولين بعد أسبوعين فقط من الخصى فى الحيوانات البالغة.
- انخفاض فى مستوى الأحماض النووية الكلية طوال التجربة بينما زاد مستوى حمض اليوريك.
- ارتفاع مستوى الدهون فى الدم بعد الخصى (الدهون الكلية والكلوستيرول الكلى والدهون الفسفورية والأحماض الدهنية الحرة).
- انخفاض تركيز النحاس والزنك والحديد فى الدم بعد الخصى وكان هذا واضحا فى الحيوانات البالغة حيث انخفض الزنك والنحاس بصورة عالية. كما لوحظ انخفاض تركيز الصوديوم والبوتاسيوم فى الدم بعد الخصى فى الحيوانات البالغة والغير بالغة.
- وقد أدى حقن هرمون التستوستيرون فى الحيوانات المخصية البالغة إلى إرجاع مستوى معظم القياسات إلى مستوى الحيوانات الغير مخصية البالغة.

ومن هذه النتائج يمكن استخلاص أن الخصى (نقص التستوستيرون) يؤدى إلى تقليل تخليق البروتين وزيادة تكسيره. أما بالنسبة إلى الدهون فقد ارتفعت بعد الخصى فى الحيوانات البالغة والغير بالغة. كما أدى الخصى إلى انخفاض ملحوظ فى تركيز الزنك والنحاس والحديد بالإضافة إلى الصوديوم والبوتاسيوم، ومن هذا يمكن أن نوصى بعدم إجراء عملية الخصى فى سن مبكرة وذلك للإستفادة من التأثير البنائى لهرمون التستوستيرون لإعطاء فرصة لنمو الحيوان قبل إجراء عملية الخصى.