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EFFECT OF SEX AND FEED FREQUENCY ON GROWING CALIFORNIA RABBITS, CARCASS CHARACTERISTICS AND MEAT QUALITY

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ABSTRACT: The current study aimed to investigate the effect of increasing feed frequency as a managerial method for both males and females' California rabbits on growth performance, carcass characteristics and meat quality. Thirty-six males and Thirty-six females of six-week-old were used. Both males and females were divided into three treatments. The first treatment (once) feed was offered once a day at 8 am second treatment (twice) feed was offered twice a day 8 am and 4 pm and third treatment (thrice) feed was offered three times a day at 6 am 12 pm and 6 pm. Growth performance measurements were recorded daily (Feed intake, body weight, daily gain and feed conversion ratio). At the end of experiment (8 weeks) all rabbits (males and females) were slaughtered after 8 hours of fasting. Carcass weight, carcass parts and individual muscles weight were recorded. The current study showed that, feed frequency significantly ($P<0.001$) improved feed intake in both males and females. Subsequently, increasing number of feeding increased ($P<0.01$) final weight, total gain and average daily gain, without any effect on feed conversion ratio in both males and females. Moreover, increased body weight of males and females fed more than one time a day resulted in an increase ($P<0.01$) in carcass weight and carcass parts. In addition, increased feed frequency decreased ($P<0.05$) carcass's fat. The current study showed that increasing feed frequency in both males and females improved rabbits' performance, carcass characteristics and meat quality.

Keywords: feed frequency, sex, carcass characteristics, performance, meat quality

INTRODUCTION.

Rabbits mainly are raised for their meat. Rabbits meat is a great source of high-quality protein and vitamins. Moreover, rabbits' meat is considering a low-calorie meat with low fat and cholesterol contents (Bieniek et al., 1993; Zajac, 1999; Skřivanová et al., 2000; Zajac, 2002; Danicke et al., 2004). Rabbits' carcass characteristics and meat quality vary according to many factors age, bodyweight, managerial factors (Barabasz and Bieniek, 2003; Frindt, 2004). Rabbit producers attempted to improve meat production efficiency to increase profitability. One of the most important factors that can dramatically affect profitability is the cost of feed. Feed cost accounts about 40% to 60% of the total costs, and can even reach up to 70% (Gidenne et al., 2017). One way to reduce feed cost is controlling feed waste and enhance rabbits for more growth. Feeding frequency (number of feeding meals) or feed distribution model is an important managerial factor can reduce feed loss and improve feed efficiency. Martignon et al. (2009) stated that increasing feed frequency for rabbits to 13 meals during 24h improved feed conversion ratio (FCR) without affecting growth. Moreover, many studies found that feed consumption increased with increasing feed frequency (Gibson, 1981; Beaty et al., 1994). In addition, increasing feed frequency causes higher body weight and daily gain (Verma et al., 1984; Chestnutt and Wylie, 1995). Therefore, the objective of this study was to compare three feeding patterns and to evaluate their impact on rabbit's nutrient utilization and whole-body tissue accretion, feed efficiency and carcass characteristics.

MATERIALS AND METHODS

The current study was carried out in poultry research farm, Poultry Production Department, Faculty of Agriculture, Assuit University, Asyut, Egypt. The current experiment lasted for 8 weeks from January 12th to March 10th, 2018.

Animals, housing, diet, and experimental design

The current study is designed in factorial arrangement to study the response of both males and females California growing rabbits to different feed frequency treatments. Thirty-six males and Thirty-six females of six-week-old weaned California rabbits were used. Both males and females were divided into three treatments. First treatment (once) feed was offered once a day at 8 am, second treatment (twice) feed was offered twice a day 8 am and 4 pm and third treatment (thrice) feed was offered three times a day 6 am, 12pm and 6pm. For twice and thrice groups, rabbits were left one hours without food before offering new fresh diet. Both males and females were rear in cage as doubles. The battery cage dimensions were 62 cm length × 64 cm width ×48 cm height. Both males and females are ascending blocked in six different categories according to their initial body weight. Each block category had six rabbits almost equal in their initial body weight. The six rabbits in each block were randomly divided two rabbits for each treatment. Both males and females were provided a concentrate meal in flat-bottomed earthen pots. The concentrate feed used in the current study is a registered commercial product (No. 1/8397 Egyptian Ministry of Agriculture). Body performance measurements were recorded daily (Feed intake), weakly (body weight) or even weekly calculated (daily gain and feed conversion ratio)

Carcass characteristics

At the end of experiment (after 8 weeks), all rabbits (males and females) were slaughtered after 8 hours of fasting from food and free accessed to water. Rabbits were slaughtered by cutting the jugular veins and carotid arteries. Carcass dissection was proceeded according to Blasco and Ouhayoun (1996). After slaughter, all rabbits were deskinned, and the commercial skin weight was recorded. Then, the dissection was carried out by removing offal and recording their weight (Head, heart, liver, full gastrointestinal, lungs, and kidneys). Subsequently, during 30 minutes after slaughter the hot carcass weight (HCW) was recorded. thereafter, during the first hour from slaughter carcass was chilled (0-4°C) in refrigerator for 24 hours. Then, the chilled carcasses were weighed or commercial carcass weight (CCW) was recorded (Blasco and Ouhayoun, 1996). Moreover, Commercial Dressing Percentage (CDP) was calculated as CCW weight divided by liveweight and multiplied with 100. In Addition, the reference carcass weight (RCW) was calculated by subtraction the head weight and thoracic cage contents (heart, lunges, and the rest of respiratory system) from chilled carcass. Subsequently the carcass was divided to four parts, each part was weighted, as follow foreleg weight (FLW), thoracic cage weight (TW), lion weight (LW) and hind part weight (HPW). subsequently, six different muscles, longissimus dorsi, gastrocnemius, biceps femoris, gluteus medius, front triceps and vastus lateralis, were separated and weighted.

Statistical analysis

The experimental data were statistically analyzed as two-ways ANOVA in RCBD design with the model: $Y_{ijk} = \mu + S_i + F_j + SF_{ij} + B_k + E_{ijk}$ Where, Y_{ijk} is the observation, μ is the general mean, S_i is the effect of i^{th} level of sex, F_j is the effect of j^{th} level of feed frequency, SF_{ij} is the interaction between i^{th} level of sex and j^{th} level of feed frequency, B_k is the effect of k^{th} blook and E_{ijk} the error related to individual observation. In the current study the animals were blocked to six different initial body weight categories and the animal within each block randomly assigned to the experimental treatments. Moreover, the body weight and daily gain were analyzed as repeated measures. The data were analyzed using the GLM procedure of SAS (SAS, 2013) . Differences between means were tested using Duncan's multiple-range test (Duncan, EFSA,1955), $P < 0.05$ was set as the limit of significance. Differences between treatments (least square means of interactions) were tested using pairwise tests of values.

RESULTS

Feed intake

Feed intake (average daily intake during experimental period expressed as g/animal/day) of both males and females treated with different feeding time is represented in Table (1). The results showed that no difference in average daily feed intake during experimental period between males and females. On the other hand, rabbits fed thrice daily tended to have significant (P<0. 01) higher feed intake than those fed twice or once a day. No differences were found between rabbits fed once and twice daily. Although, both females and males fed thrice tended to consume more daily feed than the other groups, the interaction effect showed non-significant difference between the main factors.

Body weight, total gain and average daily gain

Both initial body weight and final body weight are showed in Table (2). Since rabbits were distributed on experimental treatments according to their initial body weight, no differences in initial body weight were found. In contrast, males showed a remarkable significant($P<0.01$) increase in their final body weight. Similarly, rabbits fed thrice time a day had significant ($P<0.01$) higher final body weight compare the twice and once fed a day rabbits. Besides, rabbits fed twice a day had higher final body weight compare with those fed once a day. On the other hand, no significant effect of interaction between sex and feed frequency was found on both initial and final body weight. The thrice fed females had higher final weight among the three females' group. Also, the same effect was found among the three males' groups. Moreover, males had higher final weight compared with females fed the same frequent feeding. Total gain is calculated by subtracting initial weight from final weight and the initial body weigh was almost equal in different sex and feed frequency groups rabbits. Subsequently, the differences in total gain among different sex and feed frequency groups are similar to final body weight. In addition, the average daily gain was like both final body weight and total gain trends, as well.

Feed conversion ratio

Feed conversion ratio are presented in Table (1) which calculated by dividing average feed intake through the experimental period by average daily gain. The only significant difference in feed conversion ratio was between males and females. Males tended to have significant ($P<0.05$) lower feed conversion ratio than females. On the other hand, the feed frequency groups had similar feed conversion ratio. Moreover, the interaction of sex and feed frequency effect had non-significant interaction for feed conversion ratio.

Organs weight

Organs weight (Skin, Head, Gastrointestinal, heart, lungs, liver, and kidneys) are represented in Table (2). Skin weight is significantly affected by sex, feed frequency, and their interaction. Subsequently, males had significant ($P<0.01$) higher skin weight than females. Besides, rabbits fed thrice and twice had significant higher skin weight than those fed once. In addition, both males fed thrice and twice had higher ($P<0.05$) skin weight than the other four interaction groups. Also, males fed thrice had higher ($P<0.05$) skin weight than males fed twice. Regarding to head weight the only significant difference ($P<0.01$) was among the feed frequency times. Both twice and thrice groups had higher head weight than once group. Gastrointestinal weight was varied due to sex and interaction while no significant difference was obtained among feed frequency times. In addition, males had higher ($P<0.01$) gastrointestinal weight than females. Moreover, the three groups of males treated with different feed frequency had significant ($P<0.01$) higher gastrointestinal weight than the three groups of females. Also, both males treated with one or thrice times a day had higher gastrointestinal weight than males fed twice a day. Both lungs and liver weights were similarly affected by the different sex groups ($P<0.01$), feed frequency treatments ($P<0.01$) and their interaction ($P<0.05$). Males had higher liver and lung weight than females. Moreover, rabbits fed three times a day had higher lungs and liver weights than those fed twice or once a day. For the

interaction, males fed thrice had very higher (P<0.05) lungs weight than other groups, while females fed twice had the lowest lung weight. The interaction effect was quite different in liver weight, males fed twice had lower liver weight than fed once. For kidneys weight, the only significant difference was between sex groups, males had higher kidney weight than females.

Carcass, dressing percentage and fat storages

Carcass weight was expressed in three different ways (hot, chilled and reference carcass) as shown in table (3). Hot, chilled and reference carcass weights were affected similarly by sex, feed frequency and their interaction. Besides, males had significantly higher (P<0.01) hot, chilled and reference carcass weight than females. Moreover, thrice fed rabbits had significant higher (P<0.01) hot, chilled and reference carcass weight than both twice and once fed rabbits. Also, twice fed rabbits had higher (P<0.01) hot, chilled and reference carcass weight than once fed rabbits. On the contrary, different carcass weight did not affect by the interaction between sex and feed frequency treatments. Dressing percentage as calculated by dividing hot carcass with respect to live body weight is shown in table (3). The only difference in dressing percentage was found between different feed frequency groups. Thrice and twice fed rabbits had significant (P<0.01) higher dressing percentage than once fed rabbits. Scapular, inguinal and perirenal fats were dissected and weighed as indicators of carcass's fat content. No differences were found in the three fat storages between males and females. On the other hand, rabbits fed thrice tended to have significant (P<0.01) lower fat in the three different storages than those fed once. Rabbits fed twice had intermediate fat content between the other feed frequency groups (once and thrice).

Carcass parts and carcass parts percent

The carcass was separated to four different parts (Fore legs, Thoracic cage, Lion and Hind limbs weight) according to Blasco and Ouhayoun (1996). In addition, the percent of each part was calculated by dividing its weight by the chilled carcass weight to tract any changes in carcass composition. All carcass parts weight and their percent are shown in table (4). The different four parts weights were significantly (P<0.01) affected by both sex and feed frequency. However, only Lion weight was affected by the interaction between sex and feed frequency treatments. In details, males had significant (P<0.01) higher fore legs, Thoracic cage, Lion and Hind limbs weight than females. In contrast there were no difference between males and females in four parts percent which mean sex affects carcass weight without any change in its composition. The four carcass's parts responded to feed frequency treatments into two different patterns. In the first pattern, both Thoracic cage and Lion weight were significantly higher in rabbits fed thrice than those fed twice or once a day. Besides, rabbits fed twice had significant higher Thoracic cage and Lion weight than those fed once. In the second pattern, both rabbits fed thrice and twice had higher Fore legs and Hind limbs weight than those fed once a day. No differences were found between rabbits fed twice and thrice in Fore legs and Hind limbs weight. Similar to sex, feed frequency did not affect carcass's parts percent. The only significant difference in carcass's parts affected by the interaction between sex and feed frequency times was lion weight. As shown in table (4) females

rabbit fed thrice a day had dramatic increase in lion weight compared with the other two females' treatments. Females fed trice attended to have 35% and 7.4% lion weight increase compare with females fed once and twice, respectively. Carcass's parts percent did not affect by the interaction of sex and feed frequency treatments.

Individual muscle weight.

Six different muscles (longissimus dorsi, gastrocnemius, biceps femoris, gluteus medius, front triceps and vastus lateralis) were dissected and weighted. The individual muscles weights were shown in table (5). Four muscles out of sex (longissimus dorsi, gastrocnemius, biceps femoris, and front triceps) were significantly ($P<0.01$) higher in males than females. Similarly, four muscles out of sex (longissimus dorsi, gluteus medius, biceps femoris, and front triceps) were significantly ($P<0.01$) higher in rabbits fed thrice than those fed twice or once. Moreover, rabbits fed twice had significant higher weight of the four muscles than those fed once. A significant effect of interaction had been noticed in five different muscle (longissimus dorsi, gastrocnemius, biceps femoris, front triceps and vastus lateralis).

DISCUSSION

In the current study, sex had no effect on daily feed intake of rabbits, the current results are agreed with Ortiz Hernández et al. (2001) . In contrast, the increased feed intake associated with increasing feed frequency may be due to simply by altering the pattern of feed consumption (Chestnutt and Wylie, 1995). Authors noticed that feed consumption was increased directly after offering fresh feed, subsequently, offering fresh feed more than one time stimulates total feed intake. Moreover, offering feed for 24 hrs. in once feeding rabbitsو makes it susceptible to urine and feces contamination which in turn affect feed odor and palatability. As a result, rabbits refuse to consume feed and their total intake decrease. Similar to the current results, Gidenne et al. (2017) stated that feed intake increased with increasing feeding number in rabbits. Final body weight (at week 14), total gain and average daily gain showed that males grew faster than females. Since, the feed intake of males was similar than females and males had higher body weight, subsequently, males' feed conversion was improved. During the growing period (from weaning to week 16) results showed different responses in body weight to sex of rabbits. Many authors found no sex effect on body weight (Carrilho et al., 2009; Abouelezz and Hussein, 2017), while others found males had heavier weight than females (Szendrő et al., 2010). In the current experiment, the response of males to feed frequency treatment was higher than females' response and this is in turn is reflected on males' body weight and total gain. Moreover, increasing feed frequency increased body weight, total gain and average daily gain. The resulted may be due to the effect of feed frequency on feed intake. Rabbits fed more frequent consumed more feed and had higher final body weight without any change in feed conversion. Faichney (1968) suggested that increased body weight by increasing feed frequency may be due to decrease in heat increment with increasing feed frequency which saves food energy for growth. In addition, Sutton et al. (1986) found a higher concentration of plasma insulin in lactation cows fed more frequent feeding. insulin had stimulatory effect on growth of rabbits (Herrler et al., 1998).

Although sex and feed frequency acted differently, they had similar effects on

carcass weight. Sex tended to improve final body weight without any effect on feed intake, this leads to an improvement in feed conversion ratio. While feed frequency improved feed intake and final body weight without any change in feed conversion ratio. Both sex and feed frequency significantly improved carcass weight in its three different forms (hot, chilled and reference carcass). The increased carcass weight is mainly due to the higher final body weight. Michalik et al. (2009) stated a strong relationship between body weight and carcass weight. Many authors (Bernardini et al., 1995; Piles et al., 2000) found results agree with the current study, that males had higher carcass weight than females. In addition, sex had no effect on dressing percentage many authors ((Bernardini et al., 1995; Piles et al., 2000) agreed with the current result. Sex increased males' final body weight which produced higher carcass weight without any effect on dressing percentage. On the other hand, increase feed frequency improved both final body weight and dressing percentage which leaded to increase in carcass weight. Carcass's fat content as measured by dissected scapular, inguinal and perirenal fats did not affected by sex while, feed frequency treatments decreased fat weight in different fat storages.

Carcass was separated to four commercial parts according to Blasco and Ouhayoun (1996), all the four parts were higher in males and in rabbits fed more than once a day. This increase in their weight is a normal result of increasing the carcass weight. The four parts' percent did not affect by sex, feed frequency or the interaction between them. Moreover, individual muscles weight responded in the same manner of carcass and parts weight, they increased in males than females. Also, they were higher in more frequent fed rabbits, without change in their percent.

CONCLUSIONS

The current study proved that, both male and female rabbits responded to increase feed frequency by improving their intake, growth, carcass characteristics and meat quality. Although, feed frequency not common in rabbits' production as managerial method of improving performance. According to the current study, using more feeding times is an effective way to enhance feed intake and subsequently, increase growth and improve carcass characteristics and meet quality. Moreover, we strongly recommend more work on feed frequency treatments and its relation with rabbits performance since there are view researches covered this poi

Table (1): rabbits' performance as affected by sex, feed frequency treatments and their interaction

Factors	Feed intake	Initial body	Final body	Total gain	Average daily	Feed conversion
Sex effect						
Significant	P = 0.5351	P = 0.6277	P <0.0001	P <0.0001	P <0.0001	P = 0.0231
Females	167.89±3.83	845.33±39.20	2116.67 ^{B} ±61.53	1271.33 ^{B} ±51.44	22.70 ^{B} ±0.92	7.40^{A}±1.04
Males	174.33±10.22	883.00±59.22	2537.67 ^{A} ±55.44	1654.67 ^{A} ±62.25	29.55 ^{A} ±1.11	5.90^{B}±0.47
Feed frequency effect						
Significant	P <0.0001	P = 0.9952	P <0.0001	P <0.0001	P <0.0001	P = 0.8169
Once	142.11 ^{B} ±3.57	861.50±67.26	2118.50 ^{C} ±81.79	1257.00 ^{C} ±83.82	22.45 ^{C} ±1.50	6.33±1.60
Twice	167.04 ^{A} ±3.34	869.50±64.34	2338.50 ^{B} ±85.67	1469.00 ^{B} ±80.47	26.23 ^{B} ±1.44	6.37±0.70
Thrice	204.19 ^{A} ±15.20	861.50±56.73	2524.50 ^{A} ±87.00	1663.00 ^{A} ±69.26	29.70 ^{A} ±1.24	6.87±0.57
Interaction effect						
Significant	P = 0.2401	P = 0.9968	P = 0.9814	P = 0.9592	P = 0.9592	P =0.6285
Females × once	143.47±5.64	841.00±78.70	1904.00±44.34	1063.00±53.49	18.98±0.96	7.56±3.04
Females × Twice	171.52±5.24	855.00±77.70	2124.00±94.11	1269.00±22.66	22.66±0.40	7.57±0.77
Females × Thrice	188.68±7.69	840.00±62.19	2322.00±84.06	1482.00±49.59	26.46±0.89	7.13±0.93
Males × once	140.75±4.43	882.00±118.14	2333.00±71.62	1451.00±99.69	25.91±1.78	5.43±0.73
Males × Twice	162.56±4.12	884.00±111.73	2553.00±34.12	1669.00±92.88	29.80±1.66	5.46±1.11
Males × Thrice	219.69±29.41	883.00±101.90	2727.00±80.55	1844.00±52.40	32.93±0.94	6.67±0.70

Means within the sex, feed frequency treatments or sex × feed frequency column with different letters are significantly different.

Table (2): Organs weight as affected by sex, feed frequency treatments and their interaction

Factors	Skin (g)	Head (g)	Gastrointestinal (g)	Heart (g)	Lungs (g)	Liver (g)	Kidneys (g)
Sex effect							
Significant	P < 0.0001	P = 0.2095	P < 0.0001	P = 0.0058	P <.0001	P <.0001	P = 0.0002
Females	$405.72^{B} \pm 9.87$	128.98 ± 4.35	$346.70^{B} \pm 7.72$	$6.95^{B} \pm 0.18$	$14.52^{B} \pm 0.81$	$75.08^{B} \pm 3.90$	$17.02^{B} \pm 0.45$
Males	$474.09^{A} \pm 16.44$	134.09 ± 2.16	$419.77^{A} \pm 10.42$	$7.50^{A} \pm 0.16$	$19.63^{A} \pm 0.70$	$111.49^{A} \pm 5.96$	$20.43^{A} \pm 0.68$
Feed frequency							
Significant	P < 0.0001	P = 0.0024	P =0.1282	P = 0.0007	P <.0001	P <.0001	P = 0.0610
Once	$391.93^{B} \pm 8.71$	$120.44^{B} \pm 3.52$	392.13 ± 24.13	$7.32^{A} \pm 0.15$	$15.53^{B} \pm 0.69$	$87.23^{B} \pm 7.22$	18.19 ± 0.94
Twice	$448.13^{A} \pm 16.80$	$136.66^{A} \pm 3.33$	368.89 ± 11.52	$6.68^{B} \pm 0.22$	$15.05^{B} \pm 1.19$	$77.24^{B} \pm 4.04$	17.89 ± 0.73
Thrice	$479.66^{A} \pm 21.22$	$137.50^{A} \pm 3.62$	388.68 ± 9.34	$7.67^{A} \pm 0.20$	$20.64^{A} \pm 0.90$	$115.39^{A} \pm 8.58$	20.09 ± 0.88
Interaction effect							
Significant	P = 0.0348	P = 0.3252	P =0.0004	P = 0.0784	P 0.0130	P = 0.0188	P =0.7627
Females × once	$380.80^{C} \pm 9.04$	113.76 ± 4.17	$323.80^{C} \pm 7.87$	7.34 ± 0.21	$13.67^{C} \pm 0.34$	$68.0^{E} \pm 4.80$	16.51 ± 0.91
Females × Twice	$410.24^{C} \pm 23.00$	135.15 ± 6.88	$345.45^{C} \pm 13.16$	6.20 ± 0.23	$11.56^{D} \pm 0.42$	$65.80^{E} \pm 2.54$	16.52 ± 0.73
Females × Thrice	$426.13^{C} \pm 12.12$	138.03 ± 6.76	$370.84^{B\,C} \pm$	7.30 ± 0.20	$18.33^{B} \pm 0.73$	$91.43^{C} \pm 5.46$	18.02 ± 0.63
Males × once	$403.05^{C} \pm 14.06$	127.12 ± 3.99	$460.46^{A} \pm 14.99$	7.29 ± 0.23	$17.39^{B} \pm 0.54$	$106.45^{B} \pm 5.18$	19.87 ± 1.33
Males × Twice	$486.01^{B} \pm 4.78$	138.16 ± 1.12	$392.33^{B} \pm 12.21$	7.17 ± 0.20	$18.55^{B} \pm 0.32$	$88.67^{D} \pm 1.28$	19.26 ± 0.95
Males × Thrice	$533.19^{A} \pm 21.11$	136.97 ± 3.65	$406.52^{B} \pm 10.97$	8.05 ± 0.27	$22.94^{A} \pm$	$139.36^{A} \pm 3.77$	22.15 ± 0.97

Means within the sex, feed frequency treatments or sex × feed frequency column with different letters are significantly different.

Table (3): Carcass weight, dressing percentage and fat storages as affected by sex, feed frequency treatments and their interaction.

Factors	Hot carcass (g)	Chilled carcass (g)	Reference carcass (g)	Dressing percentage (%)	Scapular fat (g)	Inguinal fat (g)	Perirenal fat (g)
Sex effect							
Significant	P <0.0001	P <.0001	P <.0001	P = 0.5694	P = 0.3516	P = 0.5746	P 0.0949
Females	1272.70 ^{B} ±41.56	1189.30 ^{B}±41.17	956.91 ^{B} ±33.68	60.06±0.48	6.54 ± 0.56	3.82 ± 1.05	14.25 ± 2.88
Males	1534.29 ^{A}±43.58	1438.70 ^{A} ±41.35	1155.90 ^{A} ±35.84	60.34±0.48	5.83 ± 0.68	3.34 ± 0.35	18.77 ± 3.55
Feed frequency effect							
Significant	P <.0001	P <.0001	P <.0001	P = 0.0002	P = 0.0037	P = 0.0304	P <.0001
Once	1239.77 ^{C} ±44.74	1152.46 ^{C} ±42.89	913.34 ^{C} ±32.45	58.59 ^{B} ±0.60	7.55^{A} ± 0.53	5.24^{A} ± 1.38	22.27^{A} ± 3.70
Twice	1415.12 ^{B} ±54.20	1325.34 ^{B} ±53.29	1083.73 ^{B} ±46.72	60.49 ^{A} ±0.23	6.78^{A} ± 0.92	2.46^{B} ± 0.24	20.79^{A} ± 4.38
Thrice	1555.58 ^{A} ±60.51	1464.19 ^{A} ±55.04	1172.15 ^{A} ±43.15	61.53 ^{A} ±0.42	4.23^{B} ± 0.26	3.04^{B} ± 0.66	6.46^{B} ± 0.79
Interaction effect							
Significant	P=0.7820	P= 0.7135	P = 0.3648	P = 0.0900	P = 0.7685	P = 0.0020	P <.0001
Females × once	1127.75±31.77	1042.75±27.13	833.28±23.38	59.24±1.19	7.75 ± 1.06	7.69^{A} ± 2.34	26.32^{AB}± 5.53
Females × Twice	1274.34±52.70	1181.03±45.90	955.31±37.10	60.04±0.35	7.52 ± 0.58	2.39^{B} ± 0.50	8.15^{C} ± 0.78
Females × Thrice	1416.00±62.96	1344.11±59.84	1082.14±47.39	60.91±0.75	4.36 ± 0.21	1.38^{B} ± 0.13	8.28^{C} ± 1.03
Males × once	1351.80±41.50	1262.17±39.04	993.39±31.43	57.94±0.05	7.35 ± 0.35	2.78^{B} ± 0.15	18.23^{B} ± 4.78
Males × Twice	1555.91±23.03	1469.65±16.08	1212.14±14.18	60.94±0.10	6.03 ± 1.79	2.54^{B} ± 0.03	33.44^{A} ± 2.36
Males × Thrice	1695.15±52.68	1584.28±53.32	1262.17±45.62	62.15±0.16	4.10 ± 0.50	4.70^{B} ±0.76	4.63^{C} ± 0.33

Means within the sex, feed frequency treatments or sex × feed frequency column with different letters are significantly different.

Table (4): Carcass's parts and carcass's parts percent as affected by sex, feed frequency treatments and their interaction

Factors	Fore legs (g)	Thoracic cage(g)	Lion (g)	Hind limbs (g)	Fore legs%	Thoracic cage%	Lion%	Hind limbs%
Sex effect								
Significant	P <0.0001	P = 0.0003	P <0.0001	P <0.0001	P = 0. 0820	P = 0.2573	P = 0.0956	P = 0.0927
Females	261.56 ^{B} ±10.50	80.87 ^{B} ±4.17	232.73 ^{B} ±8.63	381.75 ^{B} ±11.90	27.28±0.30	8.41±0.20	24.34±0.37	39.98±0.25
Males	327.19 ^{A} ±9.95	103.53 ^{A} ±5.82	273.25 ^{A} ±12.23	451.93 ^{A} ±11.77	28.33±0.26	8.96±0.43	23.51±0.41	39.20±0.28
Feed frequency effect								
Significant	P <0.0001	P = 0.0003	P <0.0001	P <0.0001	P = 0.4771	P = 0.2232	P = 0.0517	P = 0.0986
Once	254.61 ^{B} ±12.91	76.93 ^{C} ±2.67	209.65 ^{C} ±4.97	372.16 ^{B} ±12.98	27.75±0.52	8.43±0.12	23.06±0.43	40.76±0.05
Twice	304.72 ^{A} ±14.13	90.91 ^{B} ±6.81	262.52 ^{B} ±12.56	425.58 ^{A} ±16.31	28.11±0.36	8.34±0.41	24.20±0.39	39.35±0.33
Thrice	323.81 ^{A} ±14.03	108.76 ^{A} ±7.23	286.80 ^{A} ±11.45	452.78 ^{A} ±16.00	27.56±0.23	9.28±0.56	24.50±0.54	38.65±0.14
Interaction effect								
Significant	P = 0.9123	P = 0.3578	P = 0.0441	P = 0.7084	P = 0.0299	P = 0.5999	P = 0.0717	P = 0.0814
Females × once	221.58±10.49	70.66±1.82	200.64 ^{C} ±4.67	340.40±9.27	26.55±0.68	8.50±0.23	24.10±0.39	40.85±0.06
Females × Twice	269.37±11.16	75.05±3.89	227.30 ^{C} ±8.82	383.59±16.79	28.19±0.17	7.84±0.19	23.85±0.79	40.12±0.43
Females × Thrice	293.74±15.76	96.88±8.07	270.26 ^{B} ±8.06	421.25±17.35	27.09±0.36	8.89±0.44	25.07±0.65	38.95±0.15
Males × once	287.63±9.76	83.19±3.05	218.66 ^{C} ±6.98	403.92±12.94	28.95±0.20	8.37±0.11	22.02±0.37	40.66±0.06
Males × Twice	340.06±12.20	106.77±8.24	297.75 ^{A} ±3.40	467.56±5.78	28.03±0.74	8.84±0.76	24.56±0.01	38.57±0.03
Males × Thrice	353.88±13.60	120.64±9.97	303.34 ^{A} ±19.71	484.31±18.80	28.03±0.09	9.68±1.08	23.94±0.85	38.36±0.14

Means within the sex, feed frequency treatments or sex × feed frequency column with different letters are significantly different.

Table (5): individual muscles weight as affected by sex, feed frequency treatments and their interaction

Factors	Longissimus Dorsi(g)	Biceps Femoris(g)	Gastrocnemius(g)	Front Triceps(g)	Gluteus Medius(g)	Vastus Lateralis(g)
Sex effect						
Significant	P = 0.0002	P = 0.0006	P = 0.0023	P <0.0001	P = 0.1396	P = 0.1691
Females	43.71 ^{B} ±1.99	19.51 ^{A} ±1.55	10.86 ^{B} ±0.38	2.67 ^{B} ±0.15	10.31±0.72	10.90±0.54
Males	50.61 ^{A} ±2.18	16.89 ^{B} ±0.30	12.59 ^{A} ±0.48	3.17 ^{A} ±0.24	9.30±0.58	11.85±0.67
Feed frequency effect						
Significant	P <0.0001	P <0.0001	P = 0.4071	P <0.0001	P <0.0001	P = 0.0738
Once	40.93 ^{C} ±0.84	14.92 ^{C} ±0.93	11.30±0.30	2.25 ^{C} ±0.13	7.74 ^{C} ±0.95	10.29 ±0.65
Twice	45.01 ^{B} ±2.85	18.58 ^{B} ±0.82	11.73±0.81	2.71 ^{B} ±0.06	9.69 ^{B} ±0.28	12.24 ±0.55
Thrice	55.54 ^{A} ±1.66	21.09 ^{A} ±1.64	12.14±0.58	3.80 ^{A} ±0.20	12.00 ^{A} ±0.31	11.60 ±0.92
Interaction effect						
Significant	P = 0.0091	P <0.0001	P = 0.0027	P = 0.0007	P = 0.2187	P = 0.0022
Females × once	40.26 ^{B} ±1.07	12.42 ^{D} ±0.46	11.15 ^{B} ±0.42	2.07 ^{C} ±0.21	8.93±1.76	10.70 $^{B\,C}$ ±0.26
Females × Twice	37.86 ^{B} ±2.20	20.59 ^{B} ±0.96	9.47 ^{C} ±0.52	2.71 ^{C} ±0.10	9.43±0.46	9.23 ^{C} ±0.50
Females × Thrice	53.02 ^{A} ±1.52	25.52 ^{A} ±1.42	11.97 ^{B} ±0.50	3.23 ^{B} ±0.09	12.58±0.43	12.77 $^{A\,B}$ ±1.09
Males × once	41.60 ^{B} ±1.34	17.43 ^{C} ±0.75	11.45 ^{B} ±0.45	2.43 ^{C} ±0.14	6.54±0.49	9.88 ^{C} ±1.33
Males × Twice	52.16 ^{A} ±2.50	16.57 ^{C} ±0.20	13.99 ^{A} ±0.37	2.72 ^{BC} ±0.09	9.95±0.34	11.70 ^{B} ±0.09
Males × Thrice	58.07 ^{A} ±2.62	16.65 ^{C} ±0.47	12.32 ^{AB} ±1.12	4.37 ^{A} ±0.10	11.41±0.27	13.97 ^{A} ±0.88

Means within the sex, feed frequency treatments or sex × feed frequency column with different letters are significantly different.

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الملخص العربي

تأثير الجنس وعدد مرات التغذية على أداء وخصائص ذبيحة وجودة لحوم ارانب سلالة كاليفورنيا النامية.

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هدفت الدراسة الحالية الي معرفة مدي تأثير زيادة عدد مرات التغذية على أداء ذكور وإناث ارنب سلالة كاليفورنيا وكذلك دراسة تأثيرها على خصائص الذبيحة وجودة اللحوم. تم استخدام 72 ارنب 36 ذكور و36 اناث في الأسبوع السادس من العمر وتم تقسيم الذكور والاناث الى ثلاث مجاميع متساوية في العدد والوزن. المجموعة الأولى تم تغذيتها مره واحده صباحا الساعة الثامنة وظل الغذاء امامها لفترة 24 ساعة، في حين تم تغذية المجموعة الثانية مرتين يوميا الساعة الثامنة صباحا والساعة الرابعة عصرا وتم تقديم الغذاء للمجموعة الثالثة ثلاث مرات يوميا الساعة السادسة صباحاً والثانية عشر ظهراً والسادسة مساءاً في كلا الجنسين الذكور والاناث وامتدت فترة التجربة لمدة ثمانية أسابيع تم خلالها تقدير كمية الغذاء يوميا وتسجيل اوزان الحيوانات أسبوعيا كما تم حساب معدل الزيادة اليومية وكفاءة التحويل الغذائي. في نهاية التجربة تم ذبح جميع الذكور والاناث لقياس اوزان الذبائح ونسبة التصافي وأجزاء الذبيحة وكمية الدهن ومواصفات الذبيحة ومدي تأثرها بزيادة عدد مرات التغذية في كل من الذكور والاناث.
وأوضحت النتائج المتحصل عليها ما يلي: -

1. ان زيادة عدد مرات التغذية اليومية أدى الى زيادة معنوية ($P<0.01$) في كمية الغذاء المأكول في كل من الذكور والاناث في جين لم يؤثر جنس الارانب على كمية التغذية المأكولة اليومية.
2. أدت كل من زيادة عدد مرات التغذية وجنس الحيوان الى زيادة معنويه ($P<0.01$) في وزن الحيوانات النهائي ومعدل الزيادة اليومية وكذلك الزيادة الكلية في وزن الحيوان خلال فترة التجربة.
3. لم تؤثر زيادة عدد مرات التغذية اليومية على كفاءة التحويل الغذائي في حين ان الذكور كانت أفضل معنويا ($P<0.01$) في كفاءة التحويل الغذائي مقارنة بالإناث.
4. رفعت زيادة عدد مرات التغذية وزن الذبيحة ونسبة التصافي بشكل معنوي ($P<0.01$)، في جين ان كانت وزن الذبيحة في الذكور أكبر معنوياً ($P<0.01$) ولم تتأثر نسبة التصافي بجنس الأرانب.
5. أدت زيادة عدد مرات التغذية اليومية الى تقليل كمية الدهن بالذبيحة بشكل معنوي ($P<0.01$) في حين لم يؤثر الجنس على محتوى الذبيحة من الدهن.
6. عمل كل من زيادة عدد مرات التغذية اليومية والجنس (الذكور) على زيادة كل من أجزاء الذبيحة واوزان العضلات المفردة معنوياً ($P<0.01$)، في حين لم يؤثر أياً منهما على نسب أجزاء الذبيحة.

التوصية: أدت زيادة عدد مرات التغذية على تحفيز كمية الغذاء ونمو كل من ذكور واناث أرانب سلالة كاليفورنيا النامية مما انعكس على اوزان الذكور والاناث النهائية وبدوره أنتج ذبيحه أكبر في جميع اجزائها منخفضة المحتوى من الدهن وعلية فان الدراسة الحالية توصي باستخدام عدد اكبر من مرات التغذية خلال فترة النمو لكل من الذكور والاناث. كما يوصى بأجراء مزيد من الدراسات حول زيادة عدد مرات التغذية في الارانب وعلاقتها بالهضم والامتصاص.