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Effect of supplementation multi-enzyme on productive performance of two strains of Japanese quail

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Abstract
Five levels of multi-enzyme (Roxazyme) 0, 0.010, 0.020, 0.030 and 0.040% from total ration, and two strains of grower Japanese quail (*Coturnix coturnix japonica*), desert and white color strain, and the interaction, use in this study. 640 birds of quail of two strains distributed to 5 experimental treatments, in each one 64 birds, and then divided to 4 replicates, with 16 birds in it. The results assert significant differences ($p \leq 0.05$) for strain, multi-enzyme addition and the interaction between them on body weight, weight gain, feed conversion coefficient, water conversion coefficient, carcass weight, dressing percentage, edible giblets percentage, breast percentage, Globulin on blood serum. The results of interaction between strain and multi-enzyme addition also show significant events ($p \leq 0.05$) on feed intake and water intake. Finally, Desert quail strain recorded the best net revenue (Iraqi Dinar/Kg live weight) (Iraqi Dinar/Kg carcass), the treatment of multi-enzyme addition 0.030% (T4) as well as registered heist net revenue (Iraqi Dinar/Kg live weight) (Iraqi Dinar/Kg carcass) and interaction between these treatments also show up best net revenue (Iraqi Dinar/Kg live weight) (Iraqi Dinar/Kg carcass). No significant effect in all other traits in this paper.

Keywords: Multi-enzyme, productive performance, strains, Japanese quail

1. Introduction

Poultry diets generally contain protein sources which are meals and protein concentrates, energy sources which are grains, oils and fats, as well as sources of minerals and vitamins which are lime stone, common salt and premix (Al-Dalawi and Al-Hadeedy, 2019) [3]. Soybean meal is the main component of plant proteins in poultry diets in general. As it constitutes approximately 28-33% in the diets of growing quail (AL-Fleeh, 2018 and Kesab, 2018) [5, 35], and the proportion of 20-25% in the diets of laying quail (Kesab and Al-Kado, 2014) [36]. As for yellow corn grains, they are the main and first source of energy represented by the carbohydrate source in poultry diets, they constitute 30-55% of the diets of growing Japanese quail (Kesab *et al*., 2020) [39], and also constitute 40-55% of the diets of laying Japanese quail (Kesab *et al*., 2019) [38].This means that soybean meal and corn make up about 88% of the components of the rations of growing Japanese quail and 80% of the diets of laying Japanese quail, and it may be higher than these percentages.

Although these feed materials are used in high rates in diets of growing and laying Japanese quail, they are contain many anti-nutritional factors. For example, soybean meal contains trypsin inhibitors (Bedford *et al*., 2016) [13], phytic acid (Shewita and Ahmed, 2015) [65], lectins (Pan *et al*., 2021) [55], and Non-Starch Polysaccharides (Khattab and AL-Baddy, 2016) [40]. While yellow corn contains phytic acid, which binds with two-thirds of the organic phosphorous in the plant (Metwally *et al*., 2020a and Metwally *et al*., 2020b) [48,49], it also contains Non-starchy polysaccharides dissolved in water (Khattab and AL-Baddy, 2016 and Shim *et al*. 2017) [40, 66]. Because the digestive system of monogastric animals such as poultry has a weak ability to produce enzymes that digest Non-starchy polysaccharides, so the use of exogenous enzymes in the diet of these animals is very important in the digestive process (Tusun *et al*., 2020) [68]. Therefore, a multi-enzymes and not a single enzyme should be added to poultry diets to achieve the best productive performance of these birds. Some researchers studied the addition of the multi-enzyme in diets of growing Japanese quail and broiler. Ali *et al*. (2019) [6] found not significant differences ($p \leq 0.05$) in body weight, weight gain, feed consumption, and feed conversion coefficient for growing Japanese quail when using

The multi-enzyme of 0 and 50 g/100 kg of diet. As for the researcher Metwally *et al*., (2020a) [48] and Metwally *et al*., (2020b) [49], they confirmed significant results ($p\leq 0.05$) in body weight and weight gain when the broiler was fed with three diets, which are 0, 250 and 500 µg / kg feed from multi-enzymes. But Tuzun *et al*. (2020) [68] did not find significant differences ($p\leq 0.05$) in body weight, weight gain, feed consumption and feed conversion ratio when fed developing Japanese quail 0 and 1 g / kg diet. The growing Japanese quail strain plays an important role in displaying production and carcass characteristics, Kesab *et al*. (2019) [38] did not find a significant difference ($p\leq 0.05$) in body weight, weight gain, feed consumption, feed conversion coefficient, carcass weight and dressing percentage between two strains of growing Japanese quail, desert and white. Researcher Waleed (2020) [70] found a significant result ($p\leq 0.05$) in body weight, weight gain, feed conversion coefficient and carcass weight for three strains of growing Japanese quail, desert, black and white.

Materials and Methods

This research was carried out during the period 2/11/2021 to 7/12/2021 in the poultry field of the Animal Production Department of the College of Agriculture and Forestry at the University of Mosul/Mosul/Iraq. The aim of the study was to find out the effect of adding 5 percentages of the multi-enzymes of the type (Roxazyme), which are 0, 0.010, 0.020, 0.030 and 0.040% of the total ration, and two strains of growing Japanese quail (*Coturnix coturnix japonica*), desert and white, as well as the interaction between them. 640 birds are distribute from the two previous breeds at random into 5 treatments, in each one 64 birds, divided into 4 replicates in each of 16 birds. They use multi-enzyme (Roxazyme) which contains a number of enzymes: (Amylase, Xylanase, Cellulase, Pectines, Glucanase 1, 4: 3 1 - beta - Endo) and produced by the Swiss company Roch, and it was used in the above mentioned proportions after mixing it With a small amount of feed, then mixing it with a larger quantity to ensure homogeneity of mixing the enzyme with the feed. The birds were provided with a standard diet with a crude protein content of 23.98% and metabolism energy with 2917 kcal/kg of feed. The requirements of birds for compounds and nutrients and the calculation of the calculated chemical analysis for the fodder materials were as stated in (NRC, 1994) [54], and as shown in Table (1). Feed and water were provided to the birds as free *ad-libitum* throughout the study period. The search lasted from 1-35 days.

The birds were raised in iron cages measuring 50 x 50 x 50 cm for length, width and height respectively. Each cage included a feeder and a water drinker. All the administrative and environmental conditions were provided for the care of developing Japanese quails and appropriate breeding, and the birds were placed under a veterinary and preventive program under the supervision of the veterinary unit in the Animal Production Department. The quail birds were weighed periodically for the purpose of following them, and then the weight gain was extracted by the difference method, and growth rate was calculated as mentioned (Brody, 1949) [14]. Whereas the mortality percentage were recorded on a daily basis and then their percentage was calculated at the end of the study, the feed intake was calculated by the weight of the additive and the remainder to extract the feed consumed, as well as the feed conversion coefficient (g feed: g weight gain). The water intake was calculated as follows: water intake (ml water/bird) = added water (ml/bird) - remaining water (ml/bird), as the drinkers were filled with water at the full capacity of 2 liters, then the remaining was recorded by means of a 10 ml graduated tube while according to the water conversion coefficient (ml: g weight gain), as well as calculating crude protein intake and Crude protein conversion coefficient (g protein: g weight gain) and representative energy intake and energy conversion coefficient represented (kcal.: g weight gain) as stated in (Kesab and AL-Shuraby, 2018) [37].

Before slaughtering, the birds fasted for 6 hours, at the end of the research period (35 days), after which they weighed and this weight was considered as pre-slaughter. 12 males and 12 females were slaughtered from each treatment, and then traits of carcasses were registered, Dressing percentage with edible giblets and edible giblets percentage relative to the weight of the live body before slaughter, while the proportion of breast percentage is calculated in relation to the weight of the carcass as stated in (Al-Fayyad *et al*., 2011) [4]. Kits were used, which were prepared by the French company Bio Labo Reagents, to measure the biochemical characteristics of blood serum by means of a spectrophotometer. The economic values for producing 1 kg of live weight and 1 kg of carcass weight at the age of 35 days. The statistical program SAS (SAS, 1996) [59] was used by using the computer to statistically analyze the data for a factorial experiment with two factors, the Strain and the Multi-enzyme addition (2 × 4), and it was applied by means of complete random design (CRD), and the significance of the differences between the averages was tested by using a multiple Duncan test Range, while the standard error value of these averages is found.

Table 1: Calculated chemical analysis of diet:

The components	(%)	Calculated chemical analysis	value
Soybean meal•	35	ME(kcal/kg diet)	35
Yellow corn	38.80	Crude protein%	38.80
Wheat grain	15	Ether extract%	15
Protein concentrate••	8	crude fiber%	8
Sun flower oil	2	Ash%	2
Limestone	0.50	NFE%	0.50
Di calcium Phosphate	0.20	Lysine%	0.20
Vit. Min. premix	0.25	Methionine%	0.25
Common salt	0.25	Calcium%	0.25
Total	100	Available phosphorus%	100

• Soybean meal is Brazilian origin: it contains 45% crude protein, and 2250 kcal./Kg metabolism energy.

••: Protein concentrate is French origin, Golden type, contains: .93.30% dry matter, 40% crude protein, 4.80% ether extract, 3.50% crude fiber, 14% ash, 31% soluble carbohydrates, 2270 kcal / kg metabolism energy, 3.80% lysine, 3% methionine, 1% cysteine, 2% linoleic acid, 8% calcium, 3.20% available phosphorous, 0.40% sodium, 0.35% chlorine.

•••: According to the chemical analysis of diets as stated in NRC (1994) [54].

Results and discussion

In Table 2, the results of the statistical analysis confirm that the Japanese desert-colored quail breed is significantly (a ≤ 0.05) superior to the white-colored Japanese quail breed in terms of live body weight and weight gain at the age of 35 days, The reason for this excelled may be due to the fact that the local strains of Japanese quail carry impure genetic traits and a mixture that shows variable productivity traits from time to time (Kesab *et al*., 2019) [38], the result of live weight agreed with (Dzuriatmono *et al*., 2019, Mohammad *et al*., 2019, Penkov and Genchev 2019, Bai *et al*., 2020, Emam 2020 and Udoh *et al*., 2020) [20, 50, 56, 12, 21, 69] and differed with (Grzegrzolka and Gruszczynska 2019,Rabie 2019 and Abdulrazaq *et al*., 2020) [25, 57, 1],As for the weight gain, its results matched with (Dawood *et al*., 2021) [18] but did not match with (Hussen and Saleh 2019a and Hussen and Saleh 2019b) [29, 30]. While the rate of relative growth rate and total fatalities did not have a significant effect on the averages, the result of the rate of relative growth rate was similar with (Towfeq 2019) [67], While the result of the study on the percentage of fatalities agreed with (Monika *et al*., 2020) [51]. On the other hand, the results of this table show the effect of adding a mixture of enzymes, where the fourth treatment (adding a mixture of enzymes by 0.030%) outperformed the live body weight and weight gain. Perhaps the reason for this excel is that the addition of the enzyme mixture led to an improvement in the intestinal environment of beneficial microorganisms, increasing their number (Kim *et al*., 2021) [42] or increasing the length of the intestine (Attia *et al*., 2020b) [10], or increasing the length of the villi (Yaqoob *et al*., 2022) [71] and improved digestion of crude protein (Attia *et al*., 2020c) [11], which in turn leads to weight gain and weight gain. The result of live weight confirmed what came (Shehata *et al*., 2018, and Bromfield *et al*., 2021) [64, 15] at the same time, it did not confirm the results (Dafade *et al*., 2019, Hussein *et al*., 2019, Sadighi and Nobakht 2019 and Hussein *et al*., 2020) [17, 26, 61, 27]. As for the result of the increase The weight is similar to (Attia *et al*., 2020a) [9]. In the same table, we note that there is no significant excelled for any of the diets of adding the five enzyme mixture in the rate of relative growth rate and the percentage of deaths. The result of the first trait did not agree with (Shewita and Ahmed 2015) [65], but the results of the second trait agreed with (Rahbari and Taheri, 2019) [58]. Table 2 also displays the results of the interaction between the Japanese quail strain and the addition of the enzyme mixture, as the fourth interaction treatment (interaction of the desert quail strain and the addition of the enzyme mixture by 0.030%) achieved a significant (a ≤ 0.05) superiority in live body weight and weight gain, However, the interaction coefficients for the rate of relative growth rate and total losses were not significant. The reason for the significantly excelled of the previous treatment is due to the positive interaction of the effect of the desert quail strain and the effect of adding the enzyme mixture in the fourth treatment (0.030%), the desert quail strain and the fourth treatment had the highest significant difference between the treatments.

Table 2: Strain, multi-enzymes and interaction effect on body weight, weight gain, growth rate, and mortality percentage for quails the study:

Treatments		BW (g/bird)	WG (g/bird)	GR (%)	MP (%)
Strain					
Desert quail		193.74±2.98a	185.52±1.42a	183.72±0.52	0.31±0.31
White quail		183.45± 1.79b	175.33±1.25b	183.03±0.59	0.62±0.62
Multi-enzyme					
0% Multi-enzyme		186.70±3.17b	178.53±2.71**b**	183.21±0.80	0.00±0.00
0.010% Multi-enzyme		185.89±2.67b	177.73±2.86b	183.16±0.78	1.56±1.56
0.020% Multi-enzyme		187.65±5.59b	179.48±3.06b	183.29±0.73	0.78±0.78
0.030% Multi-enzyme		193.56±4.03a	185.40±2.77a	183.81±0.91	0.00±0.00
0.040% Multi-enzyme		189.18±3.56ab	180.99±2.60ab	183.41±0.90	0.00±0.00
Strain × Multi-enzyme					
Desert quail	0% Multi-enzyme	192.11±2.93ab	183.86±1.37ab	183.53±1.72	0.00±0.00
	0.010% Multi-enzyme	191.27±2.21ab	183.04±1.43ab	183.50±1.47	0.00±0.00
	0.020% Multi-enzyme	193.90±10.29ab	185.73±1.51ab	183.82±0.92	1.56±1.56
	0.030% Multi-enzyme	198.27±5.60a	190.07±3.98a	184.10±0.56	0.00±0.00
	0.040% Multi-enzyme	193.15±6.28ab	184.90±3.36ab	183.61±1.56	0.00±0.00
White quail	0% Multi-enzyme	181.29±1.87c	173.19±3.91c	182.88±0.87	0.00±0.00
	0.010% Multi-enzyme	180.51±1.32c	172.41±3.30c	182.81±0.87	3.12±3.12
	0.020% Multi-enzyme	181.40±3.35c	173.23±2.30c	182.75±1.23	0.00±0.00
	0.030% Multi-enzyme	188.84±5.27bc	180.72±0.84bc	183.51±1.98	0.00±0.00
	0.040% Multi-enzyme	185.20±2.82bc	177.08±2.70bc	183.20±1.24	0.00±0.00

a-c that Mean differ significantly (p<0.05) in each column.
BW: Body Weight, WG: Weight Gain, GR: Growth Rate, MP: Mortality percentage.

The desert-colored Japanese quail strain recorded a significant decrease (p≤0.05) in the feed conversion factor and water conversion coefficient compared with the white quail strain. The reason for the significant decline in the fodder conversion coefficient of the desert strain may be due to this strain having a faster growth rate than the white strain on the one hand and a final live weight greater than the other strain on the other hand. It may be due to the correlation of the water conversion factor with the feed conversion ratio (Kesab *et al*., 2020) [39] on the one hand, and a final live weight greater than the other strain on the other hand. The result of the amount of feed intake was similar with (Kesab *et al*., 2019) [38] and different with (Kouatcho *et al*., 2022) [43], the result of the feed conversion ratio was similar with (Waleed, 2020) [70] and no similarity with (Kesab *et al*., 2020) [39], and the result of the amount of water intake was identical with (Kesab *et al*., 2019) [38], on the other hand, the result of the water conversion factor agreed with (Kesab *et al*., 2020) [39]. In this table there is also a reference to the effect of adding the enzyme mixture to quail diets. A significant decrease (a ≤ 0.05) was found in favor of the fourth treatment of this addition in the characteristics of the feed conversion factor and water conversion factor, while the parameters of the amount of feed intake and the amount of water intake did not refer to there are significant effects between its averages. The reason for the significant decrease in the feed conversion ratio is due to the fact that the birds of this treatment had the highest live weight, increased weight, and the lowest amount of feed intake, and the sum of these two figures produces the feed conversion coefficient. While the reason for the moral decline may be due to the water conversion factor because there is a direct correlation and relationship between the amount of feed consumed and the amount of water consumed. The result of the amount of feed intake confirmed what was stated by (Saki *et al*., 2017) [62] and did not confirm what was approved by (Javaid *et al*., 2022) [34], but the result of the feed conversion ratio matched with (Alqhtani *et al*., 2022) [7]. The results of Table 3 also showed that there were significant differences (A ≤ 0.05) for the effect of the interaction and for all the studied traits in this table. The fifth intervention treatment (desert quail breed and the addition of enzyme mixture by 0.040%) was excelled in the amount of feed intake and the amount of water intake, The reason for this is clear because this strain ate the largest amount of feed and water, in addition to the fact that the fifth addition treatment recorded the largest amount of feed and water intake. The fourth overlap coefficient recorded a significant decrease in the feed conversion ratio and the water conversion coefficient, and the reason for this is the cumulative effect coming from the desert quail strain and the addition of 0.030% of the enzyme mixture.

Table 3: Strain, multi-enzymes and interaction effect on feed intake and feed conversion coefficient, water intake and water conversion coefficient for quail the study:

Treatments		FI (g/bird)	FCC (g : g)	WI (ml/Bird)	WCC (ml : g)
Strain					
Desert quail		587.98±2.65	3.17±0.02b	1469.49±10.34	7.92±0.07b
White quail		583.96±1.75	3.33±0.02a	1448.42±8.49	8.26±0.05a
Multi-enzyme					
0% Multi-enzyme		585.34±3.11	3.28±0.04a	1462.88±9.65	8.20±0.04a
0.010% Multi-enzyme		587.19±2.15	3.30±0.04a	1459.80±8.44	8.21±0.07a
0.020% Multi-enzyme		583.88±4.92	3.25±0.04b	1457.93±13.86	8.12±0.08b
0.030% Multi-enzyme		583.04±2.85	3.14±0.04c	1439.71±18.21	7.77±0.11c
0.040% Multi-enzyme		590.42±1.88	3.26±0.03ab	1474.05±12.81	8.14±0.03b
Strain × Multi-enzyme					
Desert quail	0% Multi-enzyme	587.70±3.20ab	3.20±0.02c	1472.66±10.70ab	8.01±0.03de
	0.010% Multi-enzyme	589.36±3.36ab	3.22±0.01c	1469.34±10.70ab	8.03±0.03de
	0.020% Multi-enzyme	590.10±8.55ab	3.18±0.02c	1477.15±23.77ab	7.95±0.02e
	0.030% Multi-enzyme	579.85±3.56ab	3.05±0.01d	1431.62±23.42b	7.53±0.03f
	0.040% Multi-enzyme	592.89±3.12a	3.21±0.02c	1495.86±5.80a	8.09±0.02d
White quail	0% Multi-enzyme	582.98±2.67ab	3.37±0.03a	1453.10±12.27ab	8.39±0.02a
	0.010% Multi-enzyme	585.02±2.67ab	3.39±0.02a	1450.25±12.27ab	8.41±0.03a
	0.020% Multi-enzyme	577.65±3.07b	3.33±0.02ab	1438.71±5.16ab	8.31±0.02b
	0.030% Multi-enzyme	586.22±4.24ab	3.24±0.03c	1447.80±32.31ab	8.01±0.04de
	0.040% Multi-enzyme	587.94±1.36ab	3.32±0.01b	1452.23±17.63ab	8.20±0.03c

a-c that Mean differ significantly ($p<0.05$) in each column.

FI: Feed Intake, FCC: Feed Conversion Coefficient, WI: Water Intake, WCC: Water Conversion Coefficient.

None of the Japanese quail strains showed significant differences in the amount of crude protein intake, crude protein conversion ratio, water intake and water conversion ratio, as shown by the data of Table 4. The result of the amount of crude protein intake and the crude protein conversion ratio confirmed the findings (Kesab *et al*., 2020) [39], while the result of the amount of water intake and the water conversion ratio differed with what was indicated (Kesab *et al*., 2020) [39]. Likewise with the treatments of adding the enzyme mixture, they did not show any significant differences between their averages for the previous four traits in Table 4. In the previous table, the results showed that there was no significant difference between the study interactions and all the studied traits in this table.

Table 4: Strain, multi-enzymes and interaction effect on protein intake, protein conversion coefficient, metabolism energy intake, and metabolism energy conversion coefficient for quails in the:

Treatments		PI (g/bird)	PCC (g : g)	MEI (Kcal./bird)	MECC (Kcal. : g)
Strain					
Desert quail		141±1.25	0.76±0.01	1715±9.36	9.25±0.06
White quail		140.04±1.29	0.80±0.02	1704±3.85	9.72±0.05
Multi-enzyme					
0% Multi-enzyme		140.37±1.33	0.79±0.02	1708±5.04	9.57±0.08
0.010% Multi-enzyme		140.81±2.71	0.79±0.02	1713±5.04	9.64±0.12
0.020% Multi-enzyme		140.02±1.65	0.78±0.01	1703±8.40	9.49±0.10
0.030% Multi-enzyme		139.82±1.00	0.75±0.02	1701±6.68	9.17±0.13
0.040% Multi-enzyme		141.59±1.72	0.78±0.01	1722±6.18	9.51±0.08
Strain × Multi-enzyme					
Desert quail	0% Multi-enzyme	140.93±2.21	0.77±0.03	1714±8.33	9.32±0.03
	0.010% Multi-enzyme	141.33±3.44	0.77±0.03	1719±8.33	9.39±0.02
	0.020% Multi-enzyme	141.51±3.05	0.76±0.02	1721±3.38	9.27±0.01
	0.030% Multi-enzyme	139.05±0.66	0.73±0.02	1691±6.47	8.90±0.03
	0.040% Multi-enzyme	142.18±3.21	0.77±0.03	1729±9.39	9.35±0.03

White quail	0% Multi-enzyme	139.80±2.17	0.81±0.04	1701±8.33	9.82±0.05
	0.010% Multi-enzyme	140.29±4.95	0.81±0.03	1707±4.41	9.90±0.03
	0.020% Multi-enzyme	138.52±1.43	0.80±0.01	1685±2.33	9.73±0.02
	0.030% Multi-enzyme	140.58±1.99	0.78±0.04	1710±2.33	9.46±0.04
	0.040% Multi-enzyme	140.99±2.05	0.80±0.01	1715±6.98	9.68±0.05

a-c that Mean differ significantly (p<0.05) in each column.
PI: Protein Intake, PCC: Protein Conversion Coefficient, MEI: Metabolism Energy Intake, MECC: Metabolism Energy Conversion Coefficient.

The difference was significant (a ≤ 0.05) in favor of desert quail in carcass weight, dressing percentage, edible viscera and breast ratio, as shown by the results of Table 5. The reason for this significantly excelled in all these traits may be due to this strain obtaining the highest final live weight and a significant difference compared to the other strain, and this leads to obtaining greater rates in these four traits as stated in (Al-Fayyad *et al.*, 2011) [4]. The result of the carcass weight agreed with (Al-Tikriti and Al-Kaisi 2019, Glinkina *et al.*, 2020, Hussen *et al.*, 2020,Lukanov and Pavlova 2020 and Sabow *et al.*, 2020) [8, 24, 31, 47, 60], and the result of the dressing percentage was similar with each of (Ibrahim *et al.*, 2021 and Iqbal *et al.*, 2021) [32, 33] and was not similar with (Bughio *et al.*, 2020, Devi *et al.*, 2020, Hussen 2020 and Lajan and AL-Barzinji 2022) [16, 19, 28, 45], and also the result of the percentage of edible viscera was in line with (Semida *et al.*, 2020) [63], and with regard to the result of the percentage of the breast, it was identical with (Narinc and Genc 2021) [53]. The same results were repeated for the previous strain for the four traits in Table 5 with the treatment of adding the enzyme mixture. The fourth treatment confirmed its significantly excelled (A ≤ 0.05) for it. The reason for this significantly excelled for all of these traits may have come due to this treatment obtaining the highest live weight and with a significant difference, and this leads to obtaining large averages in these traits (Al-Fayyad *et al.*, 2011) [4]. The result of carcass weight was not similar with (Kutlu *et al.*, 2019) [44], while the result of the dressing percentage agreed with (Aghili *et al.*, 2019) [2], on the other hand, the result of the chest ratio did not match with the researcher (Tuzun *et al.*, 2020) [68]. Table 5 contains the results of the interaction of the two workers under study, It confirms the excelled of the fourth interaction treatment significantly (A ≤ 0.05) in all the studied traits. The reason for the excelled of this treatment is due to a cumulative effect by interaction with the desert quail strain and adding 0.030% of the enzyme mixture, As this strain and this addition obtained a significantly excelled in the weight of the carcass, the proportion of dressing, the proportion of edible viscera, and the proportion of the breast, which led to the emergence of this excelled in the interaction treatments**.**

Table 5: Strain, multi-enzymes and interaction effect on some carcass traits for quails at 35 days

Treatments		CW (g/bird)	DP (%)	EBP (%)	BP (%)
Strain					
Desert quail		138.88±1.75a	74.18±0.20a	4.76±0.06a	32.17±0.23a
White quail		127.82±1.77b	72.74±0.23b	4.40±0.04b	31.26±0.10b
Multi-enzyme					
0% Multi-enzyme		131.43±2.79b	73.17±0.35b	4.48±0.08c	31.35±0.19b
0.010% Multi-enzyme		131.04±3.08b	73.24±0.35b	4.46±0.08c	31.37±0.19b
0.020% Multi-enzyme		132.25±3.17b	73.31±0.51b	4.52±0.09bc	31.65±0.29b
0.030% Multi-enzyme		138.47±4.18a	74.19±0.59a	4.85±0.12a	32.52±0.43a
0.040% Multi-enzyme		133.59±3.31ab	73.54±0.31ab	4.62±0.07b	31.70±0.15b
Strain × Multi-enzyme					
Desert quail	0% Multi-enzyme	135.80±2.87abc	73.55±0.28abc	4.65±0.05bc	31.66±0.13bcd
	0.010% Multi-enzyme	135.94±4.49abc	73.89±0.31abc	4.62±0.10bc	31.72±0.22bcd
	0.020% Multi-enzyme	138.97±1.00ab	74.23±0.38ab	4.71±0.02b	32.10±0.46b
	0.030% Multi-enzyme	145.19±3.12a	75.13±0.41a	5.10±0.06a	33.43±0.20a
	0.040% Multi-enzyme	138.48±3.69ab	74.11±0.14ab	4.74±0.06b	31.95±0.12bc
White quail	0% Multi-enzyme	127.05±1.78c	72.78±0.41cd	4.30±0.05e	31.03±0.07d
	0.010% Multi-enzyme	126.13±1.78c	72.55±0.24cd	4.30±0.04e	31.01±0.10d
	0.020% Multi-enzyme	125.48±1.90c	72.28±0.45d	4.32±0.05de	31.20±0.13cd
	0.030% Multi-enzyme	131.74±5.71bc	73.17±0.78bcd	4.60±0.04bc	31.60±0.21bcd
	0.040% Multi-enzyme	128.70±4.17bc	72.93±0.31bcd	4.49±0.06cd	31.45±0.18bcd

a-c that Mean differ significantly (p<0.05) in each column.
CW: Carcass Weight, DP: Dressing Percentage, EB: Edible Bowels, BP: Breast Percentage.

The results of Table 6 showed that there were no significant differences (a ≤ 0.05) for all studied traits, except for the trait of serum globulin concentration, in which the desert quail was superior. The result of total protein concentration as well as albumin confirmed what was adopted (Fathi *et al.*, 2019) [23], to that the result of globulin concentration differed with (Fathi *et al.*, 2019) [23], while the result of cholesterol concentration was similar with (Semida *et al.*, 2020) [63]. The addition of different percentages of the enzyme mixture showed significant differences (A≤0.05) for the globulin concentration trait of the serum of quail birds only, while the remaining four trait in Table 6 did not show any significant differences. The result of the total protein concentration was in line with what was reached by the researcher (Attia *et al.*, 2020c) [11], and the result of the albumin concentration was also in line with the researcher (Alqhtani *et al.*, 2022) [7] but not in line with (Attia *et al.*, 2020b) [10], to that the result of globulin concentration confirmed the result of the researcher (Shewita and Ahmed 2015) [65], The result of the researcher (Mulaudzi *et al.*, 2022) [52] was not confirmed, and the result of total fat concentration differed with (Attia *et al.*, 2020b) [10], and finally, the result of cholesterol was similar to what was stated by (Javaid *et al*., 2022) [34], and the result of the researcher (Fanoodi *et al*., 2022) [22] was not similar. The effect of the interaction between the strain and the addition of the enzyme mixture did not have any significant differences in all the studied traits except for the concentration of serum globulin. This is shown in Table 6.

Table 6: Strain, multi-enzymes and interaction effect on some biochemical blood traits for quails at 35 days:

Treatments		TP (g/100ml)	ALB (g/100ml)	GLO (g/100ml)	TL (mg/100ml)	TC (mg/100ml)
Strain						
Desert quail		4.80±0.05	2.34±0.03	2.45±0.04a	707.86±5.35	169.25±1.27
White quail		4.71±0.04	2.34±0.02	2.38±0.04b	695.81±5.20	167.55±1.66
Multi-enzyme						
0% Multi-enzyme		4.70±0.04	2.32±0.02	2.38±0.01b	691.70±5.22	166.60±0.54
0.010% Multi-enzyme		4.64±0.03	2.32±0.02	2.32±0.03b	688.88±7.00	165.10±1.49
0.020% Multi-enzyme		4.64±0.04	2.30±0.01	2.34±0.01b	696.07±6.30	166.60±2.40
0.030% Multi-enzyme		4.81±0.05	2.33±0.04	2.48±0.04a	713.67±8.45	171.42±1.39
0.040% Multi-enzyme		4.99±0.03	2.44±0.06	2.55±0.06a	718.88±3.19	172.28±1.57
Strain × Multi-enzyme						
Desert quail	0% Multi-enzyme	4.75±0.05	2.34±0.01	2.41±0.04bcd	691.29±9.53	167.20±2.96
	0.010% Multi-enzyme	4.70±0.04	2.32±0.01	2.38±0.04bcd	695.40±12.53	166.33±1.87
	0.020% Multi-enzyme	4.62±0.07	2.29±0.02	2.33±0.02cd	704.87±8.28	167.90±2.26
	0.030% Multi-enzyme	4.88±0.07	2.34±0.08	2.54±0.05ab	725.61±8.35	172.36±1.61
	0.040% Multi-enzyme	5.03±0.04	2.43±0.05	2.60±0.05a	722.15±5.21	172.44±3.03
White quail	0% Multi-enzyme	4.64±0.02	2.29±0.04	2.35±0.04cd	692.11±6.98	165.99±3.18
	0.010% Multi-enzyme	4.58±0.02	2.31±0.04	2.27±0.03d	682.35±6.73	163.86±2.40
	0.020% Multi-enzyme	4.66±0.03	2.31±0.02	2.35±0.01cd	687.27±7.25	165.30±4.69
	0.030% Multi-enzyme	4.73±0.06	2.32±0.04	2.41±0.05bcd	701.72±12.03	170.47±2.49
	0.040% Multi-enzyme	4.95±0.05	2.45±0.03	2.50±0.10abc	715.60±3.59	172.11±1.76

a-c that Mean differ significantly (P<0.05) in each column.
TP: Total Protein, ALB: Albumin, GLO: Globulin, TL: Total Lipids, TC: Total Cholesterol.

The results of Table 7 review the economic values of the cost of the available fodder, the other costs in the study, the total costs, the return and the profit when producing 1 kg live weight or carcass. kg live weight or carcass weight. As for the yield, it is the same in both strains, which is 9000 Iraqi dinars/kg live weight and 10,000 Iraqi dinars/kg slaughtered animal. As a result of the foregoing, the Sahrawi breed excelled in profit, as it was 4577 Iraqi dinars/kg live weight and 4320 Iraqi dinars/kg carcass, and the same previous breed outperformed in the percentage of profit: the total cost of producing 1 kg live weight or carcass. As for the effect of adding the enzyme mixture, the fourth treatment obtained the least accessible feed cost, the cost of other expenses and the total cost in the case of producing 1 kg of live weight or carcass weight. The result of the total cost agreed with the result of the researcher (Khatun *et al*., 2022) [41] that the treatment of adding the enzyme mixture had the lowest total cost compared to the control diet. The yield was equal for all additions of the enzyme mixture, which is 9000 Iraqi dinars/kg live weight and 10,000 Iraqi dinars/kg carcass. Therefore, the fourth treatment outperformed the profit, which was 4504 Iraqi dinars/kg live weight and 4330 Iraqi dinars/kg slaughtered animal. The result of the study was similar in terms of profit with the researcher's result (Khatun *et al*., 2022) [41] that adding the enzyme mixture achieved a greater profit than the control diet. This superiority led to the superiority of the same breed in the percentage of profit: the total cost of producing 1 kg of live weight or carcass. Finally, with regard to the interaction of the strain with the addition of the enzyme mixture, the results confirmed that the fourth interaction treatment had the lowest cost of accessible feed, the cost of other expenses and the total cost in the case of producing 1 kg live weight or carcass weight. As for the yield, it is equal for all overlap coefficients, as it was 9000 and 10000 Iraqi dinars in the case of producing 1 kg of live weight or a carcass, respectively. The same previous treatment showed excelled in the profit as well as in the profit: the total cost compared to the interaction of all the treatments in the case of producing 1 kg live weight or carcass.

Table 7: Strain, multi-enzymes and interaction effect on economic values for producing 1 kg of quail live weight and quail carcass weight at 35 days

Treatments		FIC (ID/Kg)	OC (ID/Kg)	TC (ID/Kg)	R (ID/Kg)	NR (ID/Kg)	%NR : TC
Producing 1 kg of live weight of quail							
Strain							
Desert quail		2526	1897	4423	9000	4577	103.48
White quail		2619	1964	4583	9000	4417	96.38
Multi-enzyme							
0% Multi-enzyme		2593	1949	4542	9000	4458	98.15
0.010% Multi-enzyme		2604	1955	4559	9000	4441	97.41
0.020% Multi-enzyme		2575	1934	4509	9000	4491	99.60
0.030% Multi-enzyme		2513	1893	4406	9000	4594	104.27
0.040% Multi-enzyme		2580	1923	4503	9000	4497	99.87
Strain × Multi-enzyme							
Desert	0% Multi-enzyme	2540	1917	4457	9000	4543	101.93
	0.010% Multi-enzyme	2554	1924	4478	9000	4522	100.98

quail	0.020% Multi-enzyme	2531	1890	4421	9000	4579	103.57
	0.030% Multi-enzyme	2457	1860	4317	9000	4683	108.48
	0.040% Multi-enzyme	2547	1895	4442	9000	4558	102.61
White quail	0% Multi-enzyme	2646	1980	4626	9000	4374	94.55
	0.010% Multi-enzyme	2653	1985	4638	9000	4362	94.05
	0.020% Multi-enzyme	2618	1978	4596	9000	4404	95.82
	0.030% Multi-enzyme	2568	1925	4493	9000	4507	100.31
	0.040% Multi-enzyme	2612	1950	4562	9000	4438	97.28
Producing 1 kg of carcass of quail							
Strain							
Desert quail		3273	2407	5680	10000	4320	76.06
White quail		3482	2562	6044	10000	3956	65.45
Multi-enzyme							
0% Multi-enzyme		3437	2529	5966	10000	4034	67.62
0.010% Multi-enzyme		3423	2512	5935	10000	4065	68.49
0.020% Multi-enzyme		3385	2497	5882	10000	4118	70.01
0.030% Multi-enzyme		3259	2411	5670	10000	4330	76.37
0.040% Multi-enzyme		3385	2474	5859	10000	4141	70.68
Strain × Multi-enzyme							
Desert quail	0% Multi-enzyme	3349	2467	5816	10000	4184	71.94
	0.010% Multi-enzyme	3329	2440	5769	10000	4231	73.34
	0.020% Multi-enzyme	3274	2400	5674	10000	4326	76.24
	0.030% Multi-enzyme	3118	2323	5441	10000	4559	83.79
	0.040% Multi-enzyme	3296	2405	5701	10000	4299	75.41
White quail	0% Multi-enzyme	3525	2591	6116	10000	3884	63.51
	0.010% Multi-enzyme	3516	2583	6099	10000	3901	63.96
	0.020% Multi-enzyme	3495	2593	6088	10000	3912	64.26
	0.030% Multi-enzyme	3400	2498	5898	10000	4102	69.55
	0.040% Multi-enzyme	3473	2543	6016	10000	3984	66.22

FIC: Feed Intake Cost, OC: Other Cost, TC: Total Cost, R: Revenue, NR: Net Revenue.
ID/Kg: Iraqi Dinar/Kg live weight or Iraqi Dinar/Kg carcass weight (1 USA Dollar = 1480 Iraqi Dinar).

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