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EFFECTS OF OMEGA-3 AND PROBIOTIC-SUPPLEMENTED ON GROWTH PERFORMANCE AND CARCASS CHARACTERISTICS OF BROILER CHICKS

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ABSTRACT: This research was conducted out at Jerash University farm in Jordan, 2020. The aim was to evaluate the effect of some feed additives, two levels of Omega-3 (5 kg/ton) [T1], (10 kg/ton) [T2] and (Probiotics with exogenous enzymes mixture, 1 kg/ton) [T3], and commercial feed [T4] on growth performance and carcass parameters during 16-35 days of age. A hundred forty and four birds at sixteen days old Hubbard chicks were distributed randomly into four treatments. Each treatment included 3 replicates, each of 12 chicks. Live body weight (Wt) at 28-day-old, T1 had a higher than the T4. Weight gain (WG) was significantly differed among treatments, as it exceeded the T1 during the fourth week and the T4 during the fifth week. Feed consumption (FC) significantly differed among treatments; T4 had the least FC during the third and fourth weeks while T3 had the least FC values during the fourth and fifth weeks. The feed conversion ratio (FCR) was significant among treatments during the fifth week, with T2, T3, and T4 values being significantly lower. WG and FCR were non-significant, while FC and mortality were significant between treatments, with T3 being the lowest over the entire period (16-35 days). Carcass characteristics were not significant except for dressing ratio and spleen weight which was lower at T1 and T3, respectively. The research findings indicated that Probiotics with exogenous enzymes could decrease FC without affecting the final body weight of Hubbard broiler chickens under the conditions of production in Jordan.

Keywords: Broiler, Exogenous enzymes, Omega-3, Probiotic.

INTRODUCTION

The broiler industry is growing very quickly but has recently faced a shortage of fodder, which increases the cost of producing broilers, and to overcome the negative impact of feeding, it is combined with nutritional supplements (Mahfudz *et al.*, 2020). In addition, supplementing diets increased the quantity and quality of meat (Keegan *et al.*, 2019). Omega-3 fatty acids are unsaturated fatty acids that have a double bond that is three atoms away from the final methyl group in their chemical composition. Supplementing with Omega-3 fatty acids has been shown to have a beneficial effect in improving gut health and nutrient transport during the growth of broiler chickens (Wang *et al.*, 2020b). Besides, Wang *et al.* (2020a) showed that Omega-3 fatty acids have an anti-inflammatory effect, and it is acceptable without compromising the growth performance and quality of broiler poultry (Marco *et al.*, 2013).

Probiotics are microorganisms that provide health benefits when consumed, generally by improving or restoring gut flora, and they should be live when ingested, and safe for their intended use. It provided protective evidence of gut health (Rolfe, 2000), conferred health benefits on the host when consumed in adequate quantities (Sanders, 2008), and helped stimulate the innate immune system of the gastrointestinal mucosa (Norio & Shoji, 2001; Erika, 2001; Rajput *et al.*, 2013), and reduced diarrhea and gastroenteritis in developing organisms (Erika *et al.*, 2001; Collins and Gibson, 1999). Probiotics affect pathogens by activating immune cells and lowering the pH of the intestine (Collins & Gibson, 1999). Thus, Probiotics are an important vital nutritional supplement in broiler feed (Agboola *et al.*, 2015).

The effect of Omega-3 fatty acids and Probiotic-Supplemented on the broiler production system in Jordan has not yet been evaluated. Therefore, this experiment investigates the effects of supplementing with Omega-3 and Probiotics on the growth performance and carcass characteristics of Hubbard broiler chicks under condition rearing in Jordan.

MATERIALS AND METHODS

Experimental components: The experiment was conducted in a disinfected poultry farm affiliated with Jerash University. A total of one hundred and forty-four Hubbard chicks were randomly selected from a commercial flock after being reared for sixteen days under standard commercial conditions and allocated to twelve experimental pens (Twelve chicks/ replicate; dimensions: 1.2 square meters). Chicks were randomly assigned to one of the four treatments: T1, T2, T3, T4, three replicates per treatment. Sawdust was prepared and a robotic bell drinker, feeder, fodder, and clean water were provided for the duration of the experiment. The experiment was started at 16 days of age because feed intake during the last 3 weeks of chick life constitutes 80% of the total feed consumed during the entire experiment.

Omega-3 and probiotics with exogenous enzymes were purchased from the companies SALOMEGA and BACTIZAD, which recommended Omega-3 in proportions of 5 and 10 kg/ton, and probiotics with exogenous enzymes at the ratio of 1 kg/ton, respectively. As a result, test chicks were fed commercial broiler feeds in addition to feed additives. The added Omega-3 was a fish oil loaded with bran and probiotics with exogenous enzymes that were a powder. Half kg of Omega-3 was mixed with 5 kg of commercial feed, then this quantity was mixed well with 95 kg of commercial feed manually. Probiotics were mixed with commercial feed in the same way. Each 1 gram of probiotics contained microorganisms (Ruminococcus sp. 28×10^4) and exogenous enzymes (cellulase 7.1 IU, xylanase 2.3 IU, alpha-Amylase 61.5 IU, and protease 29.5 IU). The treatments were T1: Omega-3 (5 kg/ton), T2: Omega-3 (10 kg/ton), T3: a mixture of probiotics with exogenous enzymes (1 kg/ton), T4: commercial feed for 20 days. Chicks were kept under similar management conditions such as location, light, temperature, ventilation, and relative humidity up to 35 days of age. All chicks were vaccinated against Newcastle disease and infectious bronchitis by drinking water at 7 days of age. While chicks were vaccinated against Gumboro disease in the hatchery.

Performance Measurements: The amount of feed intake was recorded per week by finding the difference between the amount of feed provided and the refusals. Body weight was measured weekly on day 16, day 22, day 28, and day 35 individually and to determine growth performance and body weight gain (WG). The weekly feed conversion ratio (FCR) was calculated as the ratio of total forage consumption to total body weight gain.

Carcass traits: On the 35^{th} day, 36 birds (3 birds/ replicate) were randomly selected, fasted for four hours, and weighed. They were slaughtered through a single cut that severed the carotid artery and jugular vein, taking care to avoid pressure during the slaughter process. Slaughtered birds were weighed after being bled for 90 seconds. After bleeding, the feathers of birds were removed in a rotating drum picker and eviscerated manually. Then, the carcasses were weighed after cleaning to find the percentage of dressing (Smith *et al.*, 1998). The length of the small intestine was measured. Breast, legs, and visceral organs (spleen, liver, heart, giblets, kidneys, visceral fat, intestine, and glandular stomach) were obtained and weighed. The carcasses were cut into major parts of a breast and legs, in addition to the abdominal fat, and were calculated as a percentage of the carcass. The internal viscera were removed from each carcass in a precise manner according to the Fletcher (1999) method. The broiler production cost for each group was calculated based on body weight per kg to find out the economics of production of the birds for each treatment.

Statistical analysis: The collected data were statistically analyzed by ANOVA in a completely randomized design (SAS, 2012). The least significant difference was used to separate the means by Duncan (1955) test. A P value less than 0.05 was considered statistically significant.

RESULTS AND DISCUSSION

Averages and standard errors of body weights, weight gain, and mortality are shown in Table 1. The live weights of chicks at 16, 22, and 35 days of age were similar among the four experimental groups. Whereas the T1 (Omega-3 fatty acids, 5 kg/ton) group at 28 days of age had the highest weight gain ($P<0.05$) compared to other experimental groups. Alagawany *et al.* (2019) show that Omega-3 fatty acids play a role in the metabolism and production performance of poultry while Bharath *et al.* (2017) that it does not affect the performance of broiler chickens. The increase in the weekly live weight of the chicks was significant ($P<0.05$) during the fourth week, with the T1 group (Omega-3; 5 kg/ton) being superior to the T3 group (Probiotic with exogenous enzymes) and T4 (commercial feed). This result showed that Omega-3 fatty acids in poultry diets have an essential role in growth (Alagawany *et al.*, 2019) and improving weight gain in chickens (Bharath *et al.*, 2017). However, during the fifth week, the T4 group (commercial feed) significantly outperformed the T1 (Omega-3; 5 kg/ton) group ($P<0.05$); this result confirmed that the addition of Omega-3 fatty acids to broiler diets did not lead to an increase in overall growth performance (Wang *et al.*, 2020c) compared to commercial feed.

Probiotics with Exogenous enzymes (its components have been previously explained in materials and methods) are beneficial in terms of increasing growth (Ana *et al.,* 2015, Seenivasan *et al.,* 2016, Sankar *et al.,* 2016; Roque Breanna *et al.,* 2017). For mortality, there were statistically significant differences ($P<0.05$) between the four experimental groups, with the T3 group (Probiotic-Supplemented) reporting the lowest mortality; This result confirmed that Probiotics are beneficial in terms of survival in poultry (Seenivasan *et al.*, 2016); while Alagawany *et al.* (2019) reported that [Omega-3, 10 kg/ton fatty acid] increased immune response in poultry.

The mean values and standard errors of the feed consumption and the feed conversion ratio are shown in Table 2. The mean feed consumption among the experimental groups during the third, fourth, and fifth weeks and the total trial period were significant ($P<0.05$). The T4 group (commercial feed) was the lowest during the third and fourth weeks, while the T3 group (Probiotics with exogenous enzymes) was the lowest during the fourth and fifth weeks and the total trial period. Probiotics improve food consumption efficiency, eliminate irritating factors such as harmful microorganisms (Jabbari *et al.*, 2016), improve feed utilization (Safalaoh, 2006), and use nutritional supplements to form exogenous enzymes (Zheng *et al.,* 2018) to improve digestibility and utilization of nutrients (Salem *et al.,* 2015).

The mean feed conversion ratio among the experimental groups was not significant ($P>0.05$) for the third and fourth weeks and the entire trial period. While the differences between the averages were significant ($P<0.05$) during the fifth week, where the T1 group (Omega-3, 10 kg/ton) was the highest compared to the averages of the other experimental groups. The addition of Omega-3 fatty acids improved the nutritional conversion rate of chickens (Bharath *et al.,* 2017). Whereas, exogenous enzymes are effective in poultry foods because they improve the feed conversion rate (Roque Breanna *et al.,* 2017).

The mean values and standard errors of carcass weight characteristics and weight ratios are shown in Table 3. The averages and carcass fractions were not significant among the studied groups, except for the dressing and spleen percentages. The average T4 group had the highest weight compared to the rest of the groups. Group T1 had the lowest dressing rate while group T3 had the lowest spleen weight.

Omega-3 fatty acids improved the quality of carcass in chickens (Alagawany *et al.,* 2019) and had no negative effect on carcass characteristics such as dressing percentage, chest weight, liver ratio, and gizzard ratio, as well as reduce belly fat in poultry (Bharath *et al.,* 2017). Effective microorganisms improved the dressing percentage and reduced the fat belly of broiler chickens (Safalaoh, 2006). Table 3 showed that T1 (Omega-3 fatty acids, 5 kg/ton) reduced dressing percentage and T3 (Probiotics with exogenous enzymes) decreased spleen weight in chicks. On the other hand, Roque Breanna *et al.,* (2017) reported that exogenous enzymes improved carcass weight.

Table 4. Shows the total feed costs for T1, T2, T3, and T4 broiler production. Broiler production cost was calculated per kg of live weight excluding labor costs. The miscellaneous costs included the cost of electricity, gas, garbage, sterilization, vaccination, and medicine. The results of the study showed that the cost/kg of live weight was lower at T3, which achieved economic efficiency compared to commercial feeds, which led to the highest profitability compared to other treatments.

Based on the results, this research concluded that adding Probiotics with exogenous enzymes (1 kg/ton) to commercial feed from 16 to 35 days old may help reduce feed intake without affecting the final body weight of broilers, and it reduces mortality. Thus, it reduces production cost without any negative effect on carcass properties at 35 days lifetime, which may improve profit.

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Table (1): Means and standard errors of live body weight (Wt), body weight gains (WG)/ grams and mortality (%) for broiler chicks.

Treatments / Traits	T1	T2	T3	T4	P value
Wt16	566.5±7.4	579.3±6.6	565.0±7.2	565.7±5.3	0.387
Wt22	1168.9±28.1	1143.9±15.1	1146.7±18.8	1131.9±17.7	0.640
Wt28	1846.7±30.8^{a}	1791.3±31.4^{ab}	1745.6±33.5^{ab}	1724.6±41.8^{b}	0.048
Wt35	2194.5±53.9	2202.7±52.4	2152.2±56.9	2202.4±47.6	0.894
WG3	558.8±12.0	532.8±9.1	551.4±11.0	542.9±9.8	0.343
WG4	677.8±20.1^{a}	647.4±21.7^{ab}	598.9±16.8^{b}	609.3±26.3^{b}	0.040
WG5	418.7±22.4^{b}	452.1±19.6^{ab}	479.8±24.1^{ab}	524.4±38.9^{a}	0.049
WG	2151.5±53.9	2159.7±52.4	2109.2±56.9	2159.4±47.6	0.894
Mortality%	0.1١±0.05^{ab}	0.13±0.03^{ab}	0.08±0.06^{b}	0.16±0.06^{a}	0.042

T1: Omega-3 fatty acids (5 kg/ton). T2: Omega-3 fatty acids (10 kg/ton). T3: Probiotic with Exogenous enzymes (1 kg/ton). T4: commercial feed. Wt16, Wt22, Wt28 and Wt35: live body weights at 16, 22, 28 and 35 days old/ grams, respectively. WG3, WG4, WG5 and WG: body weight gain (grams) during 3^{rd}, 4^{th}, 5^{th}/ weeks and full rearing period, respectively. $^{a,\ b}$: Similar letters within the same row denote no significant difference between means (p>0.05).

Wt at 1, and 7 days old were 43.0, and 171.0 grams, respectively. WG during 1^{st} and 2^{nd} weeks were 128.0 and 412.3 grams, respectively.

Table (2): Means and standard errors of feed consumption (grams/weeks) and feed conversion ratio (weeks) for broiler chicks.

Treatments / Traits	T1	T2	T3	T4	P value
FC3	845.7±6.5^{b}	858.3±4.5^{a}	851.7±1.3^{ab}	820.0±0.13^{c}	0.001
FC4	1364.3±18.3^{a}	1301.0±15.6^{b}	1263.7±8.4^{c}	1258.0±0.69^{c}	0.001
FC5	1564.1±27.5^{a}	1402.5±45.2^{b}	1244.6±3.6^{c}	1392.7±58.2^{b}	0.001
FC	4707.5±27.1^{a}	4494.2±44.3^{b}	4280.0±13.3^{c}	4403.1±57.5^{b}	0.001
FCR3	1.59±0.03	1.64±0.02	1.5٨±0.03	1.57±0.03	0.206
FCR4	2.١±0.05	2.١±0.08	2.٢±0.07	2.0±0.07	0.229
FCR5	3.7±0.17^{a}	3.2±0.15^{b}	2.8±0.21^{b}	2.9±0.14^{b}	0.001
FCR	2.2±0.07	2.1±0.06	2.10.08	2.1±0.04	0.254

T1: Omega-3 (5 kg/ton). T2: Omega-3 (10 kg/ton). T3: Probiotic with Exogenous enzymes (1 kg/ton). T4: commercial feed. FC3, FC4, FC5 and FC: feed consumption during 3^{rd}, 4^{th}, 5^{th} and full period (grams/weeks). FCR3, FCR4, FCR5 and FCR: feed conversion ratio during 3^{rd}, 4^{th}, 5^{th}, and full period (weeks), respectively. $^{a,\ b,\ c}$: Similar letters within the same row denote no significant difference between means (p>0.05).

Feed consumption during 1^{st} and 2^{nd} were 190.0 and 742.0 (grams/weeks), respectively. Feed conversion during 1^{st} and 2^{nd} were 1.7 and 1.59, respectively.

Table (3): Means and standard errors of carcass characteristics/ grams and the relative weights of broiler chicks after finished full period/ 35-days.

Traits \ Treatments			T1	T2	T3	T4	P value
Weights of carcass and its parts	Body weight after slaughter		2090.0±43.0	2027.7±60.2	1960.5±50.2	1957.2±39.9	0.195
	Non eviscerated carcass		1777.8±39.2	1735.0±52.0	1688.3±46.3	1685.0±36.9	0.407
	Eviscerated carcass		1480.1±29.5	1445.6±55.4	1417.6±48.8	1446.8±36.0	0.778
	Dressing percentage		0.708±0.005[b]	0.717±0.007[ab]	0.719±0.005[ab]	0.731±0.006[a]	0.049
	Spleen		2.27±0.202[ab]	2.04±0.152[ab]	1.92±0.195[b]	2.57±0.162[a]	0.042
	Liver		56.7±3.12	46.2±3.44	50.9±5.24	49.0±2.12	0.231
	Heart		15.1±1.65	13.8±1.01	13.9±1.17	12.9±0.88	0.544
	Gizzard		29.3±1.02	28.5±1.53	28.6±1.87	26.6±1.21	0.602
	Giblets		103.1±4.28	90.3±4.82	95.4±6.14	91.1±2.58	0.204
	Breast		503.3±20.6	541.2±22.1	504.4±19.2	531.7±19.8	0.463
	Legs		398.8±21.0	367.7±16.6	374.4±11.6	381.1±11.2	0.541
	Visceral fat		10.6±1.87	12.0±1.78	10.2±1.29	9.4±1.82	0.714
	Intestine		153.3±8.89	142.7±6.35	148.8±3.88	136.1±6.38	0.298
	Glandular stomach		7.90±0.344	6.94±0.586	6.83±0.347	7.65±0.995	0.581
Intestine length			197.5±11.41	207.8±8.42	215.4±3.77	204.2±5.23	0.409
Weight ratios	to whole carcass	Giblets	0.057±0.002	0.051±0.002	0.056±0.003	0.054±0.001	0.199
		Intestine	0.085±0.004	0.084±0.005	0.087±0.003	0.082±0.004	0.637
	to carcass without viscera	Breast	0.340±0.013	0.369±0.007	0.358±0.007	0.368±0.008	0.137
		Legs	0.269±0.014	0.253±0.006	0.265±0.005	0.270±0.006	0.573
		Abdominal fat	0.007±0.001	0.008±0.001	0.006±0.001	0.007±0.001	0.942

T1: Omega-3 (5 kg/ton). T2: Omega-3 (10 kg/ton). T3: Probiotic with Exogenous enzymes (1 kg/ton). T4: commercial feed. [a, b]: Similar letters within the same row denote no significant difference between means ($p>0.05$).

Table (4): Average values of costs and profits for broiler chickens when fed with commercial feed with or without food additives (Omega-3 acids and Probiotic-Supplements) in Jordan.

Parameters	Treatments			
	T1	**T2**	**T3**	**T4**
Cost of chicks (JD)	0.20	0.20	0.20	0.20
Feed consumed (Kg)	4.7075	4.4942	4.2800	4.4031
Feed price/Kg‡ (JD)	0.35+0.01	0.35+0.02	0.35+0.01	0.35
Total feed cost (JD)	1.648	1.573	1.498	1.541
Miscellaneous cost (JD)	0.10	0.10	0.10	0.10
Mean cost (JD)	1.95	1.87	1.79	1.84
Mean live weight† (Kg)	1.96	1.92	1.98	1.85
Sale price/Kg live weight (JD)	1.5	1.5	1.5	1.5
Cost/Kg live weight (JD)	0.99	0.97	0.90	0.99
Profit/Kg live weight (JD)	0.50	0.51	0.59	0.51
Economic efficiency compared to commercial feed (T4)	98.04	100	115.69	100

T1: Omega-3 (5 kg/ton). T2: Omega-3 (10 kg/ton). T3: Probiotic with Exogenous enzymes (1 kg/ton). T4: commercial feed. JD: Jordanian Dinar. †: Average marketed live weight was estimated taking into account mortality. ‡: The cost of Omega-3 and Probiotics was added to the commercial feed, noting that the price of one kilogram of them amounted to 2 dinars and 10 dinars, respectively.

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الملخص العربى

تأثير إضافة أوميغا-٣ ومكملات البروبيوتيك على أداء النمو وخصائص الذبيحة في دجاج اللحم

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تم إجراء هذا البحث في مزرعة كلية زراعة جامعة جرش عام ٢٠٢٠، الأردن. هدف البحث تقييم تأثير بعض الإضافات العلفية على أداء النمو وخصائص الذبيحة في دجاج اللحم. تم إضافة مستويين من أوميجا-٣ (٥ كجم/طن) [T1]، و(١٠ كجم/طن) [T2]، والبروبيوتيك مع خليط إنزيمات خارجية (١ كجم/طن) [T3]، والأعلاف التجارية [T4] خلال الفترة (١٦-٣٥) يوماً من عمر الصيصان. تم توزيع مائة وأربعة وأربعين طائراً عند عمر ستة عشر يوماً بشكل عشوائي على المعاملات، إذ تضمنت كل معاملة ٣ مكررات، يحتوي كل مكرر ١٢ صوص.
حققت صيصان المعاملة (T1) وزن جسم حي أعلى من المعاملة (T4) عند عمر ٢٨ يوماً. تباينت الزيادات الوزنية (WG) معنوياً بين المعاملات، حيث تفوقت المعاملة (T1) خلال الأسبوع الرابع بينما تفوقت المعاملة (T4) خلال الأسبوع الخامس. اختلفت كميات استهلاك العلف معنوياً بين المعاملات، حيث حققت المعاملة (T4) أقل استهلاكاً للعلف خلال الأسبوعين الثالث والرابع في حين حققت المعاملة (T3) أقل استهلاكا للعلف خلال الأسبوعين الرابع والخامس. حققت (T2) و(T3) و(T4) معنوياً أقل نسبة تحويل العلف الغذائي (FCR) بين المعاملات خلال الأسبوع الخامس. خلال كامل فترة التجربة وجد ان الفروق بين المعاملات غير معنوية لكل من (WG) و(FCR)، من ناحية أخرى وجد فروقات معنوية بين المعاملات لـ (FC) حيث حققت (T3) أقل استهلاكا للعلف وأيضاً أقل نسبة نفوق للصيصان خلال الفترة بأكملها (١٦-٣٥ يوماً). وجد فروق معنوي بين المعاملات لكل من وزن الطحال ونسبة التصافي حيث كانت الأقل في (T3) و(T1) على التوالي أما بقية الصفات كانت غير معنوية بين المعاملات.
أشارت نتائج البحث أن البروبيوتيك مع الإنزيمات الخارجية يمكن أن تقلل من استهلاك العلف دون التأثير على وزن جسم دجاج اللحم (Hubbard) عند التسويق تحت ظروف التربية في الأردن.

الكلمات المفتاحية: دجاج اللحم، إنزيمات خارجية، أوميغا ٣، بروبيوتيك.