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Effect of Incubator System and Strain on Productive Performance of Broilers

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ABSTRACT

This experiment was conducted to investigate the effect of the incubator system and broiler strain on broiler performance, carcass traits and economic evaluation. Total number of 900 hatchable eggs were distributed in a factorial arrangement 2×3 with 2 incubator system [multi stage (MS) and single stage (SS)] and three broiler strains [Cobb (CB), Avian (AV) and Indian River (IR)] totaling six groups with three replicates (50 eggs of each). After complete hatching, 180 unsexed broiler chicks one day-old were wing-banded, weighed individually and divided into at the same design into 18 floor pens according to their incubator system and strain. Live body weight, weight gain, feed consumption and feed conversion ratio were measured at 7, 14, 21, 28 and 35 days of age. Carcass traits, blood plasma constituents and economic efficiency were recorded at the end of trial (day 35). The broiler chicks produced from (SS) had significantly differences in live body weight, weight gain, feed consumption and feed conversion ratio than those produced from (MS). The same trend was observed in (AV) strain for these traits than the other strains (CB) and (IR).Carcass traits and blood plasma constituents showed insignificant figures in most parameters. Blood parameters showed insignificant figures in most parameters. However AST activity and A/G ratio have significant difference (P≤0.05) for (AV) strain and their interaction with incubator system (SS) than the other groups. The incubator system (MS) had highest net return and economic efficiency compared with the incubator system (SS). While, Avian broilers strain had the highest net return, economic efficiency and performance indexes compared to Cobb and Indian River broiler chick strains. These results conclude that the incubator system (single stage) realize the best values of most productive performance traits, also Avian strain was recorded higher productive performance compared with as compared with Cobb and Indian River strains. The best economic efficiency and performance index were recorded for Avian broiler chicks strain which produced from incubator system (multi stage).

Keywords: Incubator system, strain, broiler, performance, economic.

INTRODUCTION

Several factors have been shown to affect broiler performance, carcass traits and economic efficiency. These factors include incubator system and strain. Nowadays, the egg incubation time is an essential stage in broiler production which represented about 32–35 % of the total broiler lifespan. Thus, the impact of the incubation conditions on embryonic growth is more critical for the success of broilers and health in their subsequent performance.

At the present, there are two types of incubator system (multi stage and single stage) used in the commercial hatcheries. Multi-stage incubator system (MS) set one or more loads of eggs per week. Therefore, lots of embryos at different stages of development are incubated in a single setter and is operated with average parameters of temperature, humidity, and ventilation, which partially satisfy the embryonic requirements (Pacheco Villanueva *et al;* 2016). In (MS) incubators, older embryos transfer heat to younger embryos, they may also cause the increased growth rate of embryos leads to an increase in the metabolic heat production of the eggs, and it accumulates inside the setter (Barri *et al.,* 2011). On the other hand, single-stage incubators (SS) are fully loaded with a single egg lot. Therefore, all embryos have the same developmental stage, allowing temperature, suitable ventilation and relative humidity to be set according to the embryos' needs (Molenaar *et al.,* 2010). Araújo *et al.,* (2016) concluded that both single stage and multi stage incubators provided adequate conditions for embryonic development. Pacheco Villanueva *et al;* (2016) found that during the growth period from 1-40 days, the broiler chicks hatched in (SS) setter were heavier, higher body weight gain and better adjusted feed conversion ratio, without differences in feed consumption compared with those hatched in (MS) machine. Also they noticed that the incubation conditions employed in the incubation system (SS) resulting in an improvement in broiler performance by about (2.98%). Similarly, Silva et al; (2011) reported that the broiler chicks hatched in (SS) setters showed higher daily weight gain and better feed conversion ratio compared with those hatched in (MS) machines.

The success of broiler production has been strongly related to the improvements in growth performance and carcass yield of broiler strain. El Faham *et al;* (2015) indicate that neither live body weight nor body weight gain were insignificantly affected by strain at the overall experimental period (0-5 weeks). They added that Cobb chicks strain had superior performance (live body weight by1.8% , body weight gain by1.9% and feed consumption by3.0%) compared to the Avian strain whereas, Avian broiler had significant in carcass traits (carcass by about 3.2% and total edible parts by about (2.5%). Alsobayel *et al;* (2016) reported that the strain of hatching eggs had a pronounced effect upon live body weight, carcass percentage, liver percentage, heart percentage and gizzard percentage. Also they showed that broilers of Arbor Acres had in general the best carcass traits than Ross or Isa broiler strains.

Very few studies have specifically examined the effects of incubator system on growth performance, carcass yield and economic return.

The aim of this study was to compare growth performance, carcass yield and economic returnee of three commercial broiler strains of (Cobb, Avian and Indian River) produced from two incubator systems (multi stage or single stage).

MATERIALS AND METHODS

A total of 900 hatchable eggs laid by 3 commercial flocks of (Cobb, Avian and Indian River) broiler breeders were evaluated in the experiment. The eggs were weighted around 63.5 g ± 1.2 from three broiler breeder flocks at 42 weeks of age. Eggs were stored at 16o C and 75% relative humidity for three days, and warmed to room temperature

(22o C) before setting. Eggs were distributed according a randomized block experimental design in a (2 x 3) factorial arrangement, consisting of 2 incubator systems (MS or SS) and three breeder strains (CB, AV and IR) totaling 6 groups with three replicates of (50 eggs of each).

The hatchery was made in two incubators system multistage and the other singlestage in a commercial broiler hatchery Al-Kasabi, Jamassa Industrial city, Dakahlia Governorate, in summer 2015. Blocks corresponded to the position of the tray (upper, middle, or lower position) in the trolley. The multistage incubator (Petersime Vision) had a capacity of 115,200 eggs loaded on 24 trolleys of 32 trays each. Tray capacity was150 eggs. In (MS) incubator, initial temperature was set at (37.77oC) and relative humidity at 58%. The single stage incubator (Petersime Vision) had a capacity of 115,200 eggs, distributed in 24 trolleys with 32 trays each. Tray capacity was 150 eggs. While, initial temperature in (SS) incubator was set at (37.94oC) then gradually decreasing until to reach (36.77oC) at day18 in accordance with metabolism of development embryo and relative humidity were automatically set after the beginning of the incubation. On day 18 (432 h) of incubation eggs were then transferred to a hatcher (Petersime Vision), with a capacity of 19,200 eggs, set to maintain (36.78oC) temperature and 65% relative humidity. Hatchability of fertile eggs from (MS) and (SS) incubators were 94.3 and 92.1% respectively. While, the hatchability of fertile eggs for the three strains of broiler chicks Cobb, Avian and Indian River were 94.4, 93.8 and 93.4% respectively.

At (504 h) of incubation the hatched chicks were removed from the hatch baskets. A total number of one hundred and eighty unsexed broiler chicks one day-old produced from them were transferred to a private local broiler farm, located in Hajaja village Damietta Governorate Egypt. The chicks were wing-banded, weighed individually and randomly assigned into completely randomly (2 x 3) factorial with 3 replicates (10 chicks of each) according to their incubator system and strain into 18 floor pens covered wheat chaff litter. The starting brooder temperature was 33oC during the first week, then the brooder temperature decreased gradually from 2-3oC every week to reach 28 oC while light was 24 hours per day at the first three days of housing after that lighting was reduced to constant 23 hours daily throughout the remain period. All chicks were provided with feed in mash form and water ad libitum throughout the growing period. The chicks were fed on a starter broiler diet contained 23% crude protein and 2900 kcal ME/kg diet from 1-14 days of age, grower broiler diet contained 21% crude protein and 3000 kcal ME/kg diet from day 15 to 28 of age and finisher broiler diet contained 19% crude protein and 3100 kcal ME/kg diet from 29 to 35 days of age. The diets were corn-soybean meal-based and were formulated from plant origin to exceed the National Research Council recommendations (NRC,1994) as shown in Table 1. All chicks were reared under similar hygienic and managerial conditions.

The broiler chicks were individually weighed to the nearest 0.1g before offering rations at 7, 14, 21, 28 and 35 days of age. The body weight gain was calculated individually. Feed consumption and mortality were daily recorded. No mortality was recorded during the whole experimental period. The feed conversion ratio (g. feed/g. gain) were weekly calculated. At the end of the experiment (35 days of age), three birds from each treatment representing the average body weight of each treatment were deprived from feed for 16 h. After slaughtering and complete bleeding, the birds were scalded and feathers were removed. Carcass were eviscerated then feet, head and shanks were removed and the whole carcass weighed. Giblets including live, heart and gizzard (was cut, open and its contents cleaned) percentage were calculated in relation to respective live body weight. Weight of abdominal fat were recorded and expressed as relative weight (mg/100g of live body weight) according to Haddad (1989).

Table 1. Composition of the starter, grower and finisher diets.

Ingredients %	Starter (1-14day)	Grower (15- 28day)	Finisher (29-35day)
Yellow corn	58.34	62.38	67.60
Soybean meal (44%)	32.80	28.42	21.88
Corn gluten meal (60%)	5.64	4.91	5.52
Oil	0.00	1.00	1.50
Mono-calcium phosph.	1.00	0.90	0.90
Limestone	1.30	1.40	1.50
Vit.& Min. Premix[1]	0.30	0.30	0.30
Salt (NaCl)	0.30	0.30	0.30
Dl–methionine (97%)	0.12	0.09	0.10
L- lysine HCL(55%)	0.20	0.30	0.40
Total	100.00	100.00	100.00
Calculated values[2]			
Crude protein (%)	23	21	19
ME (kcal/ kg)	2900	3000	3100
Calcium (%)	0.86	0.86	0.89
Av. Phosphorus (%)	0.37	0.34	0.33
Methionine (%)	0.54	0.48	0.47
Lysine (%)	1.28	1.21	1.09
Price (LE /Kg diet)[3]	4.60	4.45	4.32

[1]-Each 3 kg of the Vit. and Min. premix contains: Vitamin A 10000000IU, Vit. D 2 000000 IU, Vit. E 10g, Vit. K2 g, Thiamin 1g, Riboflavin 5g, Pyridoxine 1.5g, Niacin 30g, Vit. BI2 10mg, Pantothenic acid 10g, Folic acid 1.5g, Biotin 50mg, Choline chloride 250g, Manganese 60g, Zinc 50g, Iron 30g, Copper 10g, Iodine 1g, Selenium 0.10g, Cobalt 0.10g. and carrier CaCO3 to 3000g.

[2]- According to NRC (1994).

[3]-According to price of different ingredients available in Egypt at the experimental time.

Blood sample were collected at slaughtering in a heparinized test tubes then centrifuged at 3000 rpm for 15 minutes. The clear plasma were separated by automatic pipette and received in dry sterile sample tube, then kept frozen -20o C until used for biochemical analysis calorimetrically by using commercial diagnosing kits (produced by Bio-Diagnostics company, Egypt). Quantitative determination of blood was included the following: total protein (TP, g/dl), albumin (A g/dl), globulin (G) determined by subtraction the value of albumin for the sample from its corresponding value for total protein, A/G ratio also was calculated, total lipids, total cholesterol, triglycerides, high density lipoprotein (HDL),), Aspartate aminotransaminase (AST) and Alanine aminotransaminase (ALT).

Finally, the economic efficiency (E.E.) was calculated according to input-output analysis (Heady and Jensen,1954) in relation to prices of local market at the time of the study, also Performance Index (PI) was determined according to North (1984) as follows: PI=(live body weight (kg) /FCR)x100.

Data were analyzed using two-way analysis of using the General linear Model (GLM) procedure of SAS (2002) as following model: Yijk = M+Ii+Sj+ (IS)ij +eigk Where: Yijk=trait measured, M=Overall mean, Ii= Incubator system effect (i=1 and 2), Sj=Strain effect (j=1, 2 and 3), (IS) ij=Interaction between incubator system and strain, eijk=Experimental error. When significant differences among means were found, means were separated using Duncan's multiple range test (Duncan 1955).

RESULTS AND DISCUSSION

Body Weight:

The results of body weight of broiler chicks at 1, 7, 14, 21, 28 and 35 days of age were demonstrated in Table 2. It was clear that the body weight at one day were 42.7 and 43.7 g in (MS) and (SS), respectively. The differences in this respected were no significant. This result is in agreement with findings of (Pacheco Villanueva *et al;* 2016) who showed that no differences in chicks body weight at hatching refer to incubation system. The birds produced from (SS) had heaver body weight than (MS) at all ages studied. They were in (SS) and (MS) 214.0, 539.1, 1040.7, 1534.8 and 1824.7 vs. 162.6, 432.4, 875.4, 1377.6 and 1679.7 g at 7, 14, 21, 28 and 35 days of age, respectively. These differences were significant ($p \leq 0.01$). This results concluded that the incubator system (SS) was more effective than (MS)in body weight. The chick body weight of strain (AV) at hatch was 44.8 g comparatively heavier than that of strains (CB) and (IR) were 41.6 And 43.8 g, respectively. These results may be due to commercial aims of breeding strain (AV). Broiler strain differences in live body weight might be mainly attributed to the different genetic makeup of broiler breeder strains (Alsobayel et al; 2016).The (IR) strain had significantly ($P< 0.01$) heavier body weight at 7 and 14 days of age than the other strains. Rayan *et al;* (2015) indicated that live body weight at 3 weeks of age was significantly affected by strain, Cobb chicks were significantly heavier body weight compared to Avian chicks. There was no significant difference in body weight between broiler strains at marketing age (35 days).This result was in agreement with that obtained by Goliomytis *et al;* (2003), Korver et al; (2004), Mehaffey (2006), Deif (2008) and Kokoszyński *et al;*(2013). The interactions between incubator system and strain were highly significant ($P< 0.01$) at 7, 14, and 21 days of age.

Body Weight gain:

The incubator system(SS) was increasing the body weight gain significantly($P\leq0.01$) at the intervals 1-7,7-14,14-21and1-35 days of age than the incubator system (MS) by about 37. 9, 20.5, 13.2 and 7.1 %, respectively as shown in Table 3. The results are harmony with those obtained by Silva et al;(2011) and Pacheco Villanueva et al; (2016) indicated that chicks hatched in (SS) setters showed higher daily weight gain in relation to those hatched in (MS) machines. While, (MS) was increased significantly ($P< 0.05$) only at 29-35 days of age by about 11.2% than (SS). As present in Table 3 the broiler strains (IR) surpassed significantly ($P< 0.01$) than the (CB) and (AV) strains in body weight gain by about 11.0 and 6.4% respectively at the age of 7-14 days. While, the strain (AV) was gained significantly ($p< 0.05$) than the (CB) and (IR) at 29-35 days of age by about 5.5 and 7.6% , respectively. Korver et al; (2004) and El Faham et al; (2015) they showed that Cobb broiler chicks had higher weight gain Avian chicks strain during period (1-40 days) of age. However, results obtained herein disagree with those of Abdullah et al;(2010) and Rayan et al; (2015) they indicated that no significant difference ($P < 0.05$) between broilers strains for daily weight gain. The interaction between the incubator system and broiler strains in respect of body weight gain were significant ($P< 0.01$) at all ages. The best group of the broiler strain (CB) which produced from the incubator system (SS) at the most ages and 1-35 days of age.

Table 2. Means and standard error of means of Live body weight (g) of broiler chicks at different ages as affected by incubator systems, strains of boiler and their interaction.

Factors		Age (days)					
		1	7	14	21	28	35
Effect of incubator systems							
MS		42.7	162.6^{b}	432.4^{b}	875.4^{b}	1377.6^{b}	1679.7^{b}
SS		43.7	214.0^{a}	539.1^{a}	1040.7^{a}	1534.8^{a}	1824.7^{a}
SEM		1.0	0.9	3.2	7.0	18.9	23.6
Sig.		NS	***	**	***	***	**
Effect of broiler strains							
CB		41.6	183.9^{b}	466.9^{c}	954.1	1438.9	1773.4
AV		44.7	192.0^{a}	487.3^{b}	949.5	1472.7	1775.5
IR		43.8	188.9^{a}	503.0^{a}	970.5	1457.0	1707.7
SEM		1.2	1.2	3.9	8.6	23.2	28.8
Sig.		NS	**	**	NS	NS	NS
Interaction effect							
MS	CB	38.7	156.3^{c}	404.4^{b}	846.9^{b}	1327.4	1673.0
	AV	43.1	170.0^{b}	446.9^{b}	884.0^{b}	1413.8	1742.0
	IR	41.2	161.40^{bc}	445.8^{b}	895.2^{b}	1391.5	1624.2
SS	CB	44.4	211.5^{a}	529.5^{a}	1061.3^{a}	1550.4	1873.8
	AV	44.3	216.5^{a}	527.6^{a}	1015.0^{a}	1531.6	1809.1
	IR	42.4	214.0^{a}	560.2^{a}	1045.8^{a}	1522.5	1791.2
SEM		1.7	1.6	5.5	12.2	32.8	40.8
Sig.		NS	**	**	**	NS	NS

$^{a,b\ and\ c}$ **means in the same column followed by different letters are significantly different ($p \leq 0.05$)**

NS not significant ** significant ($p\leq0.01$) * significant ($p \leq 0.001$)**

Table 3. Means and standard error of means of body weight gain (g) of broiler chicks at different ages as affected by incubator systems, strains of boiler and their interaction .

Factors		Age (Days)					
		1-7	8-14	15-21	22-28	29-35	1-35
Effect of incubator systems							
MS		119.9^{b}	269.8^{b}	443.0^{b}	498.6	331.7^{a}	1637.0^{b}
SS		170.3^{a}	325.1^{a}	501.6^{a}	489.7	298.2^{b}	1781.0^{a}
SEM		1.4	4.2	7.5	8.0	10.5	17.5
Sig.		***	***	***	NS	*	***
Effect of broiler strains							
CB		142.3	283.0^{b}	487.2	488.2^{ab}	335.4	1731.9
AV		147.3	295.3^{b}	462.2	515.3^{a}	310.8	1730.8
IR		145.2	314.1^{a}	467.5	479.0^{b}	298.8	1663.9
SEM		1.7	5.1	9.2	9.8	12.9	21.5
Sig.		NS	***	NS	*	NS	NS
Interaction effect							
MS	CB	117.6^{c}	248.0^{d}	442.5^{c}	476.2^{bc}	349.9^{a}	1634.3^{d}
	AV	126.9^{b}	276.9^{c}	437.1^{c}	523.1^{a}	334.9^{ab}	1698.9^{bcd}
	IR	120.2^{b}	284.4^{c}	449.3^{bc}	496.4^{abc}	310.5^{ab}	1583.0^{cd}
SS	CB	167.1^{a}	318.0^{b}	531.8^{a}	500.2^{abc}	320.9^{ab}	1829.4^{a}
	AV	172.2^{a}	313.6^{b}	487.4^{b}	507.4^{ab}	286.6^{b}	1755.8^{ab}
	IR	161.7^{a}	343.7^{a}	485.6^{b}	461.6^{c}	287.1^{b}	1748.8^{bc}
SEM		2.4	7.2	13.0	13.9	18.2	30.4
Sig.		*	*	*	*	*	*

$^{a,\ b,c\ and\ d}$ **means in the same column followed by different letters are significantly different ($p \leq 0.05$)**

NS not significant * significant ($p \leq 0.05$) * significant ($p \leq 0.001$)**

Feed consumption:

The present data in Table 4 showed that broiler chicks produced from the incubator system (SS) was significant increased feed intake ($p< 0.001$) throughout all experimental period compare to those produced from the incubator system (MS) by about 48.9, 58.1, 11.7, 9.5, 5.7 and 15.3% at 1-7, 8-14, 15-21, 29-35 and 1-35 days of age, respectively. This increasing of feed consumption was commuted by the increasing of live body weight as found in Table 2. The results were disagree with Pacheco Villanueva *et al;* (2016)) they not found any differences in feed consumption due to incubation system (1 to 40 day). Feed consumption was significantly ($p< 0.05$) increased by 17.9 and19.7% for strain (IR) as compared with (CB) and (AV) strains at 8-14 days of age, respectively. In contrast with intervals 15-21 and 22-28 days of age (IR) strain was significantly ($P< 0.01$) decreased feed consumption by about 6.4 to 8.4% as compared with those strains (CB) and (AV), respectively. Abdullah *et al;* (2010) reported that there was a significant difference in overall feed intake between strains. In contrast, Rayan *et al;* (2015) and Al-Rishan (2006) indicated that was insignificant difference among Hubbard, Ross and Arbor Acres strains for feed consumption. The interaction between Incubator System and strain on feed consumption was significant during all intervals studied except the interval 8-14 days of age. The group of chicks (CB) which produced from (SS) had more feed consumption than the other groups at most studied intervals.

Table 4. Means and standard error of means of feed consumption (g. feed / bird / week) of broiler chicks at different ages as affected by incubator systems, strains of boiler and their interaction.

Factors		Age (Days) 1-7	8-14	15-21	22-28	29-35	1-35
Effect of incubator systems							
MS		182.5^{b}	274.8^{b}	739.4^{b}	817.2^{b}	1101.1^{b}	3115.1^{b}
SS		271.7^{a}	434.5^{a}	825.6^{a}	894.5^{a}	1163.9^{a}	3590.2^{a}
SEM		11.6	13.7	9.8	7.9	9.85	25.6
Sig.		***	***	***	***	***	***
Effect of broiler strains							
CB		237.1	336.3^{b}	795.8^{a}	861.4^{a}	1150.0	3380.6
AV		200.8	331.3^{b}	803.3^{a}	887.5^{a}	1135.0	٩3357.
IR		243.3	396.4^{a}	748.3^{b}	818.6^{b}	1112.5	3319.3
SEM		14.3	16.7	12.01	9.67	12.1	31.4
Sig.		NS	*	**	**	NS	NS
Interaction effect							
	CB	224.2^{b}	269.0^{c}	730.0^{b}	801.7^{b}	1075.0^{b}	3099.8^{d}
MS	AV	136.7^{c}	269.0^{c}	756.5^{b}	812.5^{b}	1078.3^{b}	3053.0^{d}
	IR	186.7^{bc}	286.5^{c}	731.7^{b}	837.50^{b}	1150.0^{a}	3192.3^{c}
	CB	250.0^{a}	403.7^{b}	861. 7^{a}	921.1^{a}	1225.0^{a}	3661.4^{a}
SS	AV	265.0^{a}	393.6^{b}	850.0^{a}	962.5^{a}	1191.7^{a}	3661.4^{a}
	IR	300.0^{a}	506.3^{a}	765.0^{b}	800.0^{b}	1075.0^{b}	3446.3^{b}
SEM		20.2	23.6	17.0	13.7	17.1	44.4
Sig.		*	***	*	**	***	***

a, b, c and d means in the same column followed by different letters are significantly different ($p \leq 0.05$)

NS not significant * significant ($p \leq 0.05$)

** significant ($p \leq 0.01$) *** significant ($p \leq 0.001$)

Feed conversion ratio:

In Table 5, the broiler chicks produced from (MS) had the best feed conversion ratio than (SS) at 8-14, 22-28, 29-35 and 1-35 days of age by about 23.3, 9.8, 15.4 and 7.4% , respectively, and difference between the incubator systems were significant. Invers with Silva *et al.* (2011) they indicated that birds hatched in (SS) setters showed better feed conversion ratio in relation to those hatched in (MS) setters. The differences in feed conversion ratio at 1-7 and 15-21days of age due to strains differences were significant ($P< 0.05$). It was observed that the strain (AV) was the better significant ($P< 0.05$) feed conversion ratio at the first week of age than the other strains. However, the opposite situation was found at 15-21days of age, where it had the poorest value at the same period. Korver et al. (2004) reported that the overall feed conversion ratio of different strains of broiler were significantly different. While, Al-Rishan (2006), Abdullah *et al.* (2010) and Rayan *et al;* (2015) they reported that there was no significant difference in feed conversion ratio among broiler strains. The interaction between the incubator system and the strains on feed conversion ratio at all ages studied were significant ($P< 0.05$). The best group in feed conversion ratio at most ages was the (AV) broiler strain which produced from the incubator system (MS) than the other groups.

Table 5. Means and standard error of means of feed conversion ratio (g. feed/ g. body gain) of broiler chicks at different ages as affected by incubator systems, strains of boiler and their interaction .

Factors		Age (Days) 1-7	8-14	15-21	22-28	29-35	1-35
Effect of incubator systems							
MS		1.52	1.02^{b}	1.67	1.65^{b}	3.35^{b}	1.87^{b}
SS		1.62	1.33^{a}	1.65	1.83^{a}	3.96^{a}	2.02^{a}
SEM		0.08	0.05	0.03	0.05	0.14	0.03
Sig.		NS	***	NS	*	*	***
Effect of broiler strains							
CB		1.70^{a}	1.18	1.64^{ab}	1.77	3.50	1.95
AV		1.35^{b}	1.12	1.74^{a}	1.73	3.69	1.94
IR		1.66^{a}	1.24	1.60^{b}	1.72	3.76	1.95
SEM		0.10	0.06	0.03	0.06	0.17	0.04
Sig.		*	NS	*	NS	NS	NS
Interaction effect							
	CB	1.91^{a}	1.09^{bc}	1.65^{ab}	1.69^{ab}	3.10^{b}	1.90^{bc}
MS	AV	1.08^{b}	0.97^{c}	1.73^{a}	1.56^{b}	3.23^{b}	1.80^{c}
	IR	1.56^{a}	1.01^{bc}	1.63^{ab}	1.70^{ab}	3.73^{ab}	1.92^{abc}
	CB	1.50^{ab}	1.27^{ab}	1.63^{ab}	1.85^{a}	3.91^{ab}	2.00^{ab}
SS	AV	1.61^{a}	1.26^{ab}	1.74^{a}	1.90^{a}	4.16^{a}	2.08^{a}
	IR	1.76^{a}	1.47^{a}	1.58^{b}	1.74^{ab}	3.80^{ab}	1.97^{abc}
SEM		0.14	0.08	0.05	0.09	0.24	0.05
Sig.		*	*	*	*	*	*

a, b and c means in the same column followed by different letters are significantly different ($p \leq 0.05$)

NS not significant * significant ($p \leq 0.05$) *** significant ($p \leq 0.001$)

Carcass traits:

Data for the percentages of some carcass traits of broiler chicks are illustrated in Table 6. It observed that no significant differences in respect of total edible parts,

eviscerated carcass, total giblets, liver, gizzard, heart percentage and abdominal fat of broiler chicks due to the incubator system, broiler strains or their interaction. But the incubator system (SS) had the higher percentages of these carcass traits than incubator system (MS). Also, the three broiler stains were nearly the same proportion in the carcass traits. The best group in total edible parts, eviscerated carcass and total giblets was the (CB) broiler strain which produced from the incubator system (SS) than the other groups. Vieira and Moran (1998) and Kokoszyński *et al;(*2013) concluded that the commercial hybrids of broiler chickens under comparison did not differ significantly in the carcass traits. In contrast, Ojedapo *et al;* (2008) and Rayan et al; (2015) pointed that the strain had a significant effect on the carcass characteristics. Concerning abdominal fat, (AV) strain was higher relative abdominal fat compared to (CB) and (IR) strain. AL-Rishan (2006) found that the Arbor Acers and Hubbard broiler chicks were significantly higher abdominal fat percentage compared to Ross one. Also, Vieira and Moran (1998) evaluated the carcass yield of four different breeds at 49 day old chickens, they found differences of up to 20.0% in the amount of abdominal fat were verified between different commercial breeds.

Table 6. Means and standard error of means of carcass traits of broiler chicks as affected by incubator systems, strains of boiler and their interaction at 35 days of age.

Factors		LBW (g)	T.edible (%)	Evis. (%)	T.giblets (%)	Liver (%)	Gizzard (%)	Heart (%)	Abd. Fat (mg/100g)
Effect of incubator systems									
MS		1762.33	76.50	72.20	4.30	2.08	1.78	0.44	0.96
SS		1706.67	78.14	73.55	4.59	2.27	1.90	0.42	1.01
SEM		26.63	0.54	0.62	0.16	0.09	0.14	0.02	0.12
Sig.		NS	NS	NS	NS	NS	NS	NS	NS
Effect of broiler strains									
CB		1703.33	77.23	72.55	4.68	2.23	1.99	0.46	0.84
AV		1756.33	77.62	73.08	4.55	2.20	1.95	0.39	1.16
IR		1743.83	77.12	73.00	4.12	2.10	1.59	0.43	0.96
SEM		32.62	0.66	0.75	0.20	0.11	0.18	0.03	0.15
Sig.		NS	NS	NS	NS	NS	NS	NS	NS
Interaction effect									
	CB	1736.67	75.20	70.73	4.47	2.19	1.83	0.46	0.69
MS	AV	1806.00	77.44	72.88	4.56	2.05	2.10	0.41	1.08
	IR	1744.33	76.86	72.99	3.87	2.02	1.42	0.44	1.11
	CB	1670.00	79.26	74.37	4.89	2.27	2.16	0.46	1.00
SS	AV	1706.67	77.80	73.27	4.53	2.36	1.80	0.37	1.23
	IR	1743.33	77.38	73.02	4.36	2.18	1.76	0.42	0.80
SEM		46.13	0.93	1.07	0.28	0.16	0.25	0.04	0.21
Sig.		NS	NS	NS	NS	NS	NS	NS	NS

NS not significant

Blood plasma constituents:

Blood plasma constituents (total protein, albumin, globulin, albumin/globulin ratio, total lipids, triglyceride, total cholesterol, high-density lipoprotein (HDL), liver enzymatic activity (AST and ALT) of broiler chicks as affected by incubator systems, broiler strains and their interaction are listed in Table 7. It is evidently show all studies plasma constituents were not significantly affected by incubator systems. Avian broilers strain had significantly (P< 0.05) higher concentration of plasma AST by 21.7 and 2.5%, respectively, as compared to Cobb and Indian River broiler chick strains at 35 days of age. Although most of blood parameters have not significant different affected by the interaction between the incubator systems or broiler strains. Regarding albumin/globulin ratio and AST, the results indicated that the group of (AV) broiler chicks strain which produced from the incubator system (MS) have significantly (P< 0.05) higher concentrations than those of the other groups.

Economic evaluation:

Data for economic evaluation are summarized in Table 8. Data indicated that the incubator system (MS) had highest net return (5.5 LE) and the highest economic efficiency (27.9%) compared with the incubator system (SS). The increasing of net return and economic efficiency may be due to with the least amount of diet consumed thus decreasing of total productive cost. The results indicate that Avian broilers strain had the best strain in respect of net return (5.4 LE), economic efficiency (35.3%) and Performance index(96.7%) as compared to Cobb and Indian River broiler chick strains at 35 days of age.These results showed that (AV) broiler chicks strain which produced from the incubator system (MS) have improved net return (6.80 LE), economic efficiency (25.6%) and Performance index(91.8%) more than the other experimental groups.

Table 7. Means and standard error of means of blood plasma constituents of broiler chicks as affected by incubator systems, strains of boiler and their interaction at 35 days of age.

Factors		Liver function						Lipid profile			
		T.prot (g/dl)	Album (g/dl)	Globun (g/dl)	A/G	ALT (u/l)	AST (u/l)	T.Lipid (mg/dl)	Triglyc (mg/dl)	T.chols (mg/dl)	HDL (mg/dl)
Effect of incubator systems											
MS		4.18	2.33	1.69	1.41	17.03	63.33	666.22	129.28	187.68	54.57
SS		4.07	2.38	1.85	1.27	15.63	57.46	683.28	137.69	205.13	55.14
SEM		0.09	0.06	0.06	0.05	1.14	2.51	11.11	3.80	5.91	1.93
Sig.		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Effect of broiler strains											
CB		4.13	2.37	1.75	1.37	13.60^{b}	53.22^{b}	687.88	132.65	201.78	53.24
AV		4.14	2.42	1.73	1.43	18.42^{a}	64.78^{a}	660.75	132.12	193.08	54.87
IR		4.11	2.27	1.84	1.24	16.98^{ab}	63.18^{a}	675.62	135.68	194.35	56.46
SEM		0.11	0.08	0.07	0.06	1.39	3.07	13.61	4.65	7.24	2.37
Sig.		NS	NS	NS	NS	NS	*	NS	NS	NS	NS
Interaction effect											
MS	CB	4.28	2.41	1.63	1.44^{ab}	13.87^{b}	56.83^{ab}	688.87	133.17	198.10	54.62
	AV	4.13	2.31	1.64	1.55^{a}	21.27^{a}	69.40^{a}	638.80	123.47	177.07	51.79
	IR	4.12	2.27	1.82	1.25^{ab}	15.97^{ab}	63.77^{a}	671.00	131.20	187.87	57.29
SS	CB	3.97	2.34	1.88	1.29^{ab}	13.33^{b}	49.60^{b}	686.90	132.13	205.47	51.86
	AV	4.16	2.52	1.81	1.30^{ab}	15.57^{ab}	60.17^{ab}	682.70	140.77	209.10	57.95
	IR	4.09	2.27	1.85	1.23^{b}	18.00^{a}	62.60^{a}	680.23	140.17	200.83	55.62
SEM		0.15	0.11	0.10	0.09	1.97	4.35	19.25	6.58	10.24	3.35
Sig.		NS	NS	NS	*	NS	*	NS	NS	NS	NS

[a, and b] means in the same column followed by different letters are significantly different (p ≤0.05)

NS not significant * significant (p ≤0.05)

Table 8. Economic traits of broiler chicks as affected by incubator systems, strains of boiler and their interaction.

Factors		Feed consump. (Kg)	Feed cost (LE)1	Total productive cost (LE)2	Live body weight (Kg)	Total return (L.E)3	Net return (L.E)	Econ. Effici. (%)4	Perform. Index (%)5
Effect of incubator systems									
M		3.12	13.79	19.70	1.68	25.2	5.50	27.94	89.84
S		3.59	15.93	22.75	1.83	27.45	4.70	20.65	90.59
Effect of broiler strains									
CB		3.38	15.44	22.06	1.77	26.55	4.49	20.37	90.77
AV		3.36	14.88	21.26	1.78	26.7	5.44	25.61	91.75
IR		3.32	14.72	21.03	1.71	25.65	4.62	21.96	87.69
Interaction effect									
M	CB	3.10	13.73	19.61	1.67	25.05	5.44	27.73	87.89
	AV	3.05	13.51	19.30	1.74	26.1	6.80	35.27	96.67
	IR	3.19	14.13	20.18	1.62	24.3	4.12	20.42	84.38
S	CB	3.66	16.23	23.19	1.87	28.05	4.86	20.96	93.50
	AV	3.66	16.24	23.20	1.81	27.15	3.95	17.00	87.02
	IR	3.45	15.32	21.88	1.79	26.85	4.97	22.70	90.86

[1-] L.E. = Egyptian pound.

[2-] Feed cost was calculated as 70 % of the total productive cost.

[3-] The local market price of 1 kg Live body weight = 15 L.E. at the experimental time.

[4-] Economic efficiency (%)= Net return (L.E) / Total productive cost(L.E)*100.

[5-] Performance index (%)=(live body weight (kg) /FCR)x100.

CONCLUSION

The incubator system (single stage) realize the best values of most productive performance traits, also Avian strain was recorded higher productive performance compared with as compared with Cobb and Indian River strains. The best economic efficiency and performance index were recorded for Avian broiler chicks strain which produced from incubator system (multi stage).

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تأثير نظام تحضين البيض و سلالة كتاكيت اللحم على الأداء الإنتاجي

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أجريت هذه الدراسة لبحث تأثير كلا من نظام محضن البيض و سلالة كتاكيت اللحم على أداء نمو الكتاكيت و صفات الذبيحة وبعض مكونات الدم والكفاءة الإقتصادية. أستخدم فى هذه الدراسة عدد ٩٠٠بيضة تفريخ متوسط وزنها ٦٣.٥ ±١.٢ جم مجمعة من أمهات كتاكيت اللحم عمرها ٤٢ أسبوع . قسمت عشوائيا إلى: ٦ مجموعات فى كل واحدة ١٥٠ بيضة لكل مجموعة , قسمت كل مجموعة الى ٣ مكررات (كل مكررة ٥٠ بها بيضة) . صممت تجربة عاملية (٣x٢), ٢نظام محضن البيض (متعدد الدفعات أو ذو الدفعة الواحدة) و ٣سلالات كتاكيت اللحم (كوب, أفيان و إنديان ريفر) تم تحضين البيض لمدة ١٨ يوم . وبعد الفقس تم تربية ٣٠ كتكوت لكل معاملة لمدة ٣٥ يوم على حدة بنفس التصميم والترتيب وكانت أهم النتائج المتحصل عليها ما يلى :سجلت الكتاكيت الناتجة من نظام المحضن ذو الدفعة الواحدة أعلى قيم معنوية لصفات وزن الجسم الحى ,وزن الجسم المكتسب , ومعدل إستهلاك العلف ومعدل تحويل العلف خلال فترة التجربة مقارنة بالكتاكيت الناتجة من نظام المحضن متعدد الدفعات. كذلك سجلت كتاكيت سلالة افيان أعلى قيم معنوية لصفات وزن الجسم الحى ,وزن الجسم المكتسب , ومعدل إستهلاك العلف ومعدل تحويل العلف خلال فترة التجربة مقارنة بباقى السلالات. بالنسبة لصفات الدم لا توجد أى فروق معنوية فى معظم المجموعات , إلا سلالة أفيان سواء كانت مستقلة أو متدخلة مع نظام التحضين ذو الدفعة الواحدة التى سجلت زيادة معنوية فى انزيم الكبد AST و كذلك النسبة بين الألبيومين الى الجلبيولين مقارنة بباقى المجموعات . أما بالنسبة للتقييم الإقتصادى فقد سجلت مجموعة الكتاكيت الناتجة من نظام المحضن متعدد الدفعات صافى ربح و كفاءة إقتصادية أعلى من نظام التحضين ذو الدفعة الواحدة إلا أن أفضل مجموعة على الإطلاق هى مجموعة كتاكيت سلالة أفيان الناتجة من نظام المحضن متعدد الدفعات. يمكن أن نخلص من هذه الدراسة : أن نظام المحضن ذو الدفعة الواحدة حقق أعلى قيم لمعظم صفات الأداء الإنتاجي ، كما سجلت سلالة الأفيان أداء إنتاجيا عاليا مقارنة بسلالتي الكب و الإنديان . أما من الناحية الإقتصادية فقد وجد أن الكتاكيت من سلالة الأفيان الناتجة من نظام المحضن متعدد الدفعات سجلت أفضل قيم للعائد الإقتصادي وللكفاءة الإقتصادية مقارنة بباقي المجموعات.