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Effect of Dietary Garlic Powder and Feeding Systems on Productive Performance of Broiler Chickens

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ABSTRACT

This study was conducted to investigate the effect of supplemented diets with garlic powder as a natural growth promoter and feeding systems on productive performance of broiler chicks. A total number of five hundred one day cobb broiler chicks of a nearly similar body weight were used in this study Chicks were randomly divided into equal ten experimental groups, each group of 50 chick. Birds of the 1st group were fed ad-libitum (ADL) on starter and grower basal diets and considered as a control group, chicks of the 2nd, 3 rd and 4 th group were fed basal diets supplemented with GP at a level of 0 mg/kg diet with feeding systems of provided chicks feed every day except for 24-hrs removal periods at 7 and 14 days of age (SKD2), at 7,14,21,and 28 days of age (SKD4) and at 7,14,21,28,35,and 42 days of age (SKD6) for the 2nd, 3 rd and 4 thgroup, respectively, chicks of the 5 th, 6 th and 7 th groups were fed basal diets supplemented with garlic powder at a level of 100 mg/kg diet with feeding systems of (SKD2) , (SKD4) and (SKD6), respectively. While, chicks of the 8 th, 9 th and 10 th groups were fed basal diets supplemented with garlic powder at a level of 200 mg/kg diet with feeding systems of (SKD2), (SKD4) and (SKD6), respectively. Results obtained showed that chicks of control group (ADL) showed the highest LBW, BWG, GR and FI followed by chicks exposed to SKD2, SKD4 and SKD6, respectively. Chicks exposed to SKD6 showed the best feed conversion, followed by chicks exposed to SKD4, SKD2 and control group (ADL), respectively during the period from 0-6 weeks of bird's age. The lowest averages of mortality rate were observed in control group (ADL), then by birds fed diet supplemented with garlic powder at a level of 200 and 100 mg/kg diet, respectively. Significant variations were found on absolute and relative weights of carcass, giblets and total edible meat due to treatments applied, except absolute weight of carcass and total edible parts due to GP levels only. Chicks fed diet supplemented with GP at levels of 200, 100and 0mg/kg diet, respectively significantly increased protein and ash percentage and significantly decreased moisture percentage of meat samples. Chicks exposed to SKD6 and SKD4 had significantly the highest averages of overall score of sensory characterizations, followed by chicks exposed to SKD2 and the control group, respectively. It could be recommended that SKD4, SKD2 and SKD6 and the interaction between G0 and each of SKD4 or SKD6, respectively seemed to be adequate to achive the favorable results and its being recommended from the economic point of view

Keywords: broilers- garlic - productive performance - feeding systems

INTRODUCTION

The poultry industry has become an important economic activity in many countries. Poultry meat and its products have a vast consumer market and are making a significant contribution to the supply of good quality animal protein, vitamins and minerals (Mothershaw *et al.*, 2009).

Garlic, a member of the Allium family (Liliaceae), has been used traditionally for ages to treat a wide array of diseases, namely, respiratory infections, ulcers, diarrhea and skin infections (Fenwick and Hanley, 1985). Reuter *et al.,* (1996) reported that garlic as a plant with antibiotic, anticancer, antioxidant, immunomodulatory, anti-inflammatory, hypoglycemic and cardiovascular-protecting effects. Moreover, garlic is very rich in aromatic oils, which enhance digestion and positively influenced respiratory system being inhaled into air sacs and lungs of birds. Also it was found that garlic has strong antioxidative effects (Gardzielewska *et al.,* 2003).

In pursuit of improved broilers health and in order to fulfill consumer expectation in relation to food quality, poultry producers commonly apply natural feeding supplements, mainly herbs (Gardzielewska *et al.,* 2003).

Feed restriction, whether qualitative or quantitative, is denying birds a full access to nutrients that are required for their normal growth and development (Khetani *et al.,* 2009). This will ultimately lead to reduction in feed and production costs, thereby, producing a lean quality meat at cheaper prices (Mahmud *et al.,* 2008).

Several quantitative and qualitative restricted-feeding programmers have therefore been employed in attempts to restrict feed intake of broilers in order to reduce feeding cost and fat deposition, improve feed efficiency, lessen the frequency of occurrence of metabolic diseases in the birds and reduce the unfavorable effects of fat on human health (Zhan *et al.,* 2007).

Feed restriction has been reported to reduce early growth, fat deposition and mortality rate and reduce the frequency of occurrence of these health problems (Mahmud *et al.,* 2008). Recent reports on feed restriction have been conflicting and have depended on factors such as the severity, timing and duration of restriction (Khajali *et al.,* 2007 and Hussein 2012).

Therefore, the current study aimed to investigate the effect of supplemented diets with garlic powder as a natural growth promoter and feeding systems on productive performance of broiler chickens.

MATERIALS AND METHODS

This study was carried out at private poultry farm at Moshtohor, El-Qalubyia Governorate, during the period from 13 October to 24 November, 2013. The chemical analysis was conducted at the laboratories of Animal Production Department, Faculty of Agriculture at Moshtohor, Benha University and Food Analysis Center, Faculty of Veterinary Medicine belonging to the same University.

Birds and their management:

A total number of five hundred one day old cobb broiler chicks of a nearly similar body weight were used in this study. Chicks were kept under similar, standard hygienic and environmental conditions in separate pens with 10 birds/m^2 stocking density until the end of the experiment. Wood shaving was used at 10 cm depth as a litter. Floor brooders with gas heaters were used for

brooding chicks. Brooding temperature was maintained at 33°C during for the first 5 days of chick's age then decreased by 0.4°C daily until the 28 days thereafter, normal temperature with natural ventilation through the windows was applied up to 43 days of age. Feed and water were offered ad-libitum. Chicks were fed a basal starter diet at the first of 4 week (28 days) then replaced with grower diet up to the end of experiment (43 days). The basal starter and grower diets were formulated according to the recommended requirements of NRC (1994) are shown in Table (1).

Table 1. Composion and calculated analyses of basal diets:

Ingredients (%)	Starter (0 - 4) wks.	Grower (4 – 7) wks.
Yellow corn	30.00	40.00
Wheat	28.25	24.00
Soybean meal (48% protein)	31.75	24.80
Protein concentrate	5.00	5.00
Sunflower oil	2.90	4.40
Limestone	0.90	0.60
Di-calcium phosphate	0.70	0.90
Salt	0.30	0.10
Vitamins and minerals mixtures *	0.20	0.20
Total	100.00	100.00
Crude protein	23.00	20.00
ME, Kcal/Kg feed	3027.00	3195.3
Lysine	1.20	1.10
Methionine	0.49	0.46
Cysteine	0.36	0.32
Calcium	0.84	0.76
Available phosphorus	0.45	0.49

***: Vitamin and minerals mixture contains:**
Vit. A, 12000000 IU; Vit. D3, 2000000 IU; Vit. E, 10 g; Vit. K3, 2.0 g; Vit. B1; 1.0 g; Vit. B2, 5 g; Vit. B6;1.5 g; Vit. B12, 10 mg; choline choloride, 250 g; Biotn, 50 mg; folic acid,1 g; nicotinic acid, 30 g; Ca Pantothenate, 10 g; Zn, 50 g; Cu, 10 g; Fe, 30 g; Co,100 mg; Se, 100 mg; I, 1 g; Mn, 60 g and antioxidant, 10 g and complete to 3.0 kg by calcium carbonate.

Experimental design and grouping birds:

Chicks were randomly divided into equal ten experimental groups each of 50 chicks. Chicks of the 1st group were fed ad-libitum (ADL) on starter and grower basal diets and considered as the control group, chicks of the 2nd, 3rd and 4th group were fed basal diets supplemented with garlic powder (GP) at a level of 0 mg/kg diet with feeding systems of provided chicks feed every day except for 24-hrs removal periods at 7 and 14 days of age (SKD2), at 7,14,21,and 28 days of age (SKD4) and at 7,14,21,28,35,and 42 days of age (SKD6) for the 2nd, 3rd and 4thgroup, respectively, chicks of the 5th, 6th and 7th groups were fed basal diets supplemented with GP at a level of 100 mg/kg diet with feeding systems of (SKD2), (SKD4) and (SKD6), respectively. While, chicks of the 8th, 9th and 10th group were fed basal diets supplemented with GP at a level of 200 mg/kg diet with feeding systems of (SKD2) , (SKD4) and (SKD6), respectively .

Parameters estimation and data collection:

Birds were weighted individually at hatch, the 4th and at the 6th weeks of age. Weight gain and rate of growth were calculated. Feed intake was recorded weekly and feed conversation ratio was calculated during the studied period. Performance index was calculated according to North (1981), mortality and economical efficiency were also calculated.

Slaughtering and carcass characteristics:

At the end of the experiment (6 weeks), five birds from each experimental treatment were randomly taken. Birds were fasted for 16 hours prior to slaughter. Eviscerated weight, giblets (liver, gizzard and heart), total edible parts (carcass and giblets) were measured and proportional weights to live body weight were then calculated.

Carcass Meat Quality Traits:

Breast samples (without skin) from 3 broiler chicks from each treatment were taken to determine the chemical composition of meat, sensory evaluation and bacteriological examination**.**

Statistical analysis:

The obtained data were analyzed using SAS procedure guide (SAS, 2004). Significant differences among means were tested using Duncan multiple range test (Duncan, 1955). According to the following linear model:

$$X_{ijk} = \mu + T_i + F_j + TF_{ij} + e_{ijk}$$

Whereas:

X_{ij} = the observation of traits for ijkth birds.
μ = the overall mean.
T_i = the effect of the ith treatments.
F_j = the effect of the jth fasting periods.
$(TF)_{ij}$ = the fixed effect of the interaction between the ith treatments and the jth fasting periods.
e_{ij} = random error assumed to be independently and randomly distributed.

RESULTS AND DISCUSSION

Live body weight (LBW), body weight gain (BWG) and growth rate (GR):

Results obtained in table (2) revealed highly significant differences (P<0.01) on LBW due to garlic powder levels supplementation at the 6th week of chicks age. Control group (ADL) recorded the highest LBW, BWG and GR followed by chicks fed diet supplemented with GP at a level of 0, 100 and 200 mg/kg diet, respectively. The results obtained agree with those reported by Daneshmand *et al.,* (2012) who declared that the combination of the garlic (30 g/kg), oyster (2 g/kg) mushroom and propolis extract (0.2 g/kg) in amounts had significantly (P<0.05) decreased BW of male broiler chickens.

Fasting systems had highly significant effect (p<0.01) on LBW only. Chicks of control group (ADL) showed the highest average of LBW, BWG and GR followed by chicks exposed to SKD2, SKD4 and SKD6, respectively. The results obtained agree with those reported by Sarica et al., (2009) and Hussein (2012) who showed that chickens which subjected to 2 days of feed restriction showed insignificant differences for the LBW and chicks uniformity compared with birds fed ADL. Susbilla *et al.,* (2003) indicated that feeding program, including quantitative feed restriction, alter functional development of the enzymes of protein digestion and may therefore influence growth rate of broiler. Also, Nire *et al.,* (1996) showed that feed restriction can influence the development of the function of the gastrointestinal tract. Where, gastrointestinal function has been reported to influence the growth of broiler chickens (Nitsan *et al.,* 1991). Highly

significant differences (p<0.01) were found in average LBW, BWG and GR due to interactions applied.

Interactions between each of G0 X SKD2, G0 X SKD4 and G100 X SKD2 had the highest averages of LBW, respectively. The highest averages of BWG and GR during the whole period (0-6 wks) were observed from the interactions between G200 X SKD6, G0 X SKD2 and G0 X SKD4, respectively compared with ADL group and other interactions applied.

Table 2. Least–square means and standard error (X±S.E) for LBW, BWG and GR for broilers of different experimental groups as affected by studied factors

Items	Treatments	Live body weight (g) at		Body weight gain (g) during 0-6 wks	Growth rate (%) during 0-6 wks
		Hatch	6WKs		
Garlic (mg / kg diet)	Control(ADL)	41.00± 0.73	1666.2± 28.8^{a}	38.67± 1.04^{a}	190.03± 1.22
	G 0	41.90± 0.42	1657.4± 17.2^{a}	38.46± 0.62^{a}	189.97± 0.73
	G100	41.50± 0.42	1592.0± 16.8^{b}	37.91± 0.60^{a}	189.70± 0.71
	G200	40.40± 0.42	1583.0± 16.8^{b}	37.84± 0.60^{a}	188.69± 0.71
Sig.	-	NS	**	NS	NS
Feeding systems	SKD2	41.51	1640.40^{a}	38.00	190.00
	SKD4	40.66	1605.20^{ab}	37.80	189.90
	SKD6	41.73	1583.30^{b}	37.20	188.30
	MSE	0.43	17.00	0.63	0.76
Sig.	-	NS	**	NS	NS
Treatments x Feeding systems:					
G0 x SKD 2		42.70	1726.7^{a}	40.09^{ab}	190.20^{ab}
G0 x SKD 4		40.10	1688.8^{a}	39.25^{abc}	190.60^{b}
G0 x SKD 6		42.00	1547.3^{b}	35.81^{c}	189.00^{ab}
G100 x SKD 2		41.90	1605.1^{a}	37.22^{bc}	189.70^{ab}
G100 x SKD 4		41.80	1571.9^{b}	36.43^{c}	189.40^{ab}
G100 x SKD 6		41.00	1599.4^{b}	37.11^{bc}	189.80^{ab}
G200 x SKD 2		40.00	1589.0^{b}	36.88^{bc}	190.00^{ab}
G200 x SKD 4		40.10	1561.5^{b}	36.22^{c}	189.90^{ab}
G200 x SKD6		41.20	1599.4^{b}	40.60^{a}	195.90^{a}
Sig.		NS	**	**	**
MSE		0.73	28.42	1.06	1.33

[a,b,c] Means with different superscript in the same column are significantly different at (P<0.05).* Significant (P<0.05 ** High significant (P<0.01) * Highly significant (P<0.001)**

Feed intake (FI) and conversion (FC)

Chicks fed diet supplemented with 200,100 and 0 mg GP/kg diet, respectively significantly (P<0.01) decreased averages of FI compared with ADL group. Also chicks fed diet supplemented with GP at a level of 200, 0 and 100 mg/kg diet, respectively improved feed conversion compared with ADL group (table, 3). The results obtained agree with those reported by Tollba and Hassan, (2003) they concluded that broiler fed on diet supplied with garlic, as a natural additive, improved FCR. Fadlalla *et al.,* (2010) found that broilers fed on diet supplemented with 0.3% garlic had significantly (P<0.05) better FCR compared to other dietary treatments (0.0, 0.15%, 0.45%, 0.6% garlic) and control.

Chicks of ADL group increased FI and decreased FC compared with different feeding systems. Chicks exposed to SKD4 and SKD6 decreased FI and significantly improved FC compared with ADL group. The results obtained agree with those reported by Shariatmadari and Moghadamian (2007) they indicated that FI of broiler chickens given 90 and 80 % of ADL was significantly low in comparison with birds fed ADL. Lien *et al.,* (2008) reported that FI reduced for broiler when, subjected to SKD removal period at 6,8,10 and 12 days of age, following the initiation of feed removal. FCR improved due to increased appetite, following refeeding which is largely responsible for improved FCR associated with compensatory growth and reduced overall maintenance requirements (Urdaneta Rincon and lesson, 2002).On the other hand, El-Faham et al., (2018) found that feed intake and feed conversion ratio were not affected by limited time feeding and there was any evidence of compensatory growth in the restricted birds.

The lowest significant averages of FI were observed from the interactions between G 200X SKD6, G100X SKD6 and G0 X SKD6, respectively. However, the best significant FC averages were observed from the interactions between G0 X SKD6,G200 X SKD6 and G100 X SKD6, respectively when compared with different interactions applied and ADL group.

Table 3. Least–square means and standard error (X±S.E) for feed intake and feed conversion values for broilers of different experimental groups as affected by studied factors

Items	Treatments	Feed intake (g/bird) during 0-6WKs	Feed conversion (g feed/g gain) during 0-6WKs
Garlic (mg / kg diet)	Control(ADL)	3512^{a}	2.16
	G 0	3296^{b}	2.05
	G100	3280^{b}	2.12
	G200	3224^{b}	2.08
	MSE	0.43	0.03
Sig.	-	**	NS
Feeding systems	SKD2	3301	2.12^{a}
	SKD4	3206	2.11^{ab}
	SKD6	3294	2.01^{b}
	MSE	43.3	0.03
Sig.	-	NS	**
Treatments x Feeding systems:			
G0 x SKD 2		3397^{ab}	2.14^{ab}
G0 x SKD 4		3271^{abc}	2.02^{ab}
G0 x SKD 6		3222^{cd}	1.98^{b}
G100 x SKD 2		3416^{a}	2.19^{a}
G100 x SKD 4		3287^{abc}	2.15^{ab}
G100 x SKD 6		3137^{cd}	2.01^{ab}
G200 x SKD 2		3345^{ab}	2.20^{a}
G200 x SKD 4		3244^{bcd}	2.04^{ab}
G200 x SKD6		3084^{d}	1.99^{b}
MSE		54.43	0.05
Sig.		***	**

[a,b, c] Means with different superscript in the same column are significantly different at (P<0.05). NS non-significant, *Significant (P<0.05),High significant (P<0.01)and*** Highly significant (P<0.001).**

Performance index (PI) and mortality rate (MR):

Chicks fed diet supplemented with GP at a level of 0, 200 and 100 mg/kg diet significantly improved PI compared with ADL group. While, chicks of control group and those fed diet supplemented with 200 mg GP/kg diet significantly decreased MR compared with different levels applied of GP (table, 4). These results agreed with those

reported by many investigators who stated that feeding on diets supplemented with different GP levels had significant increase in total white blood cell (TWBC) which reflected good immune response and decrease mortality rate of broiler chickens consequently as described by (Fadlalla *et al.,* 2010).

Table 4. Least–square means and standard error (X±S.E) for performance index and mortality rate for broilers of different experimental groups as affected by studied factors

Items	Treatments	Performance Index (%) during (0-6 wks)	Mortality (%) during 0-6 WKs
Garlic (mg/kg diet)	Control(ADL)	76.88 ±0.50^{b}	2.00±0.41^{c}
	G 0	80.49±0.50^{a}	6.60±0.41^{a}
	G100	75.00±0.50^{c}	4.00±0.00^{b}
	G200	75.98±0.50^{bc}	2.60±0.41^{c}
Sig.	-	***	***
Feeding systems	SKD2	77.35±1.46^{b}	2.00±0.33^{b}
	SKD4	75.81±1.46^{c}	2.60±0.33^{b}
	SKD6	78.60±1.46^{a}	6.60±0.33^{a}
Sig.	-	***	**
Treatments x Feeding systems:			
G0 x SKD 2		80.40±1.0^{ab}	2.00±0.33^{b}
G0 x SKD 4		83.20±1.0^{a}	2.60±0.33^{b}
G0 x SKD 6		77.80±1.0^{bc}	6.60±0.33^{a}
G100 x SKD 2		73.10±1.0^{d}	2.00±0.33^{b}
G100 x SKD 4		73.00±1.0^{d}	2.60±0.33^{b}
G100 x SKD 6		79.10±1.0^{bc}	6.60±0.33^{a}
G200 x SKD 2		71.80±1.0^{d}	2.00±0.33^{b}
G200 x SKD 4		76.46±1.0^{c}	2.60±0.33^{b}
G200 x SKD6		79.90±1.0^{b}	6.60±0.33^{a}
Sig.		***	**

$^{a,b,\ c}$ Means with different superscript in the same column are significantly different at (P<0.05). NS non-significant
*** Significant (P<0.05) ** High significant (P<0.01)**
*****Highly significant (P<0.001).**

Chicks exposed to SKD6 showed significantly (P<0.001) the higher average of PI. However chicks exposed to SKD2 had significantly (P<0.01) the lowest average of MR compared with different feeding systems and ADL group. The results obtained disagree with those reported by Osman *et al.,* 2010 who found that mortality rate were not significantly affected by limiting eating time.

Interactions between G0 X SKD4, G0 X SKD2 and G200X SKD6, respectively significantly increased PI. While, interactions between G0 X SKD2, G100 X SKD2 and G200X SKD2 significantly (P<0.01) decreased MR when compared with different interactions applied and ADL group.

Carcass characteristics

Significant variations (P<0.01) were found on absolute and relative weights of carcass, giblets and total edible meat due to treatments applied, except absolute weight of carcass and total edible parts due to GP levels and feeding systems.

The highest averages of LBW, absolute and relative weights of carcass and total edible meat were observed in the ADL group compared with different levels of GP supplementation. The results obtained disagree with those reported by Fadlalla *et al.,* (2010) who found that no changes were observed in hot and cold dressing percentages of broiler chickens fed on diet supplemented with garlic (0.3, 0.45 and 0.6%) compared to control group**.**

Chicks of control group (ADL) showed the highest absolute and relative weight of carcass and total edible meat, followed by birds exposed to SKD6 and SKD2, respectively. However, chicks exposed to SKD2, SKD4 and SKD6 had significantly the highest averages of absolute and relative weights of giblets when compared with control group. The results obtained disagree with those reported by Novel *et al.,* (2009) who stated that the level of feed restriction and sex of the chickens had no effect (P>0.05) on breast, thigh, drumstick, wing, gizzard and liver weights when expressed as percentage of carcass weight of the chickens at 42 days of age. Feed restriction did not significantly affected carcass traits during the whole periods (Hassanien *et al.,* 2011). Feed restriction of broiler chicks no significantly difference (P>0.05) in carcass weight, breast weight, thighs weight, heart weight, abdominal fat weight, liver weight and gizzard weight (Seyyed, 2016).

Interactions between treatments applied and feeding systems showed significant effects on all carcass traits except absolute weights of carcass and total edible meat.

Interactions between G 200 X SKD6, G 0 X SKD2 and G 200 X SKD4 significantly increased absolute and relative weights of carcass, giblets and total edible meat, respectively compared with different interactions applied (table,5).

Table 5. Least–square means and standard error (X±S.E) of absolute and relative weight of carcass traits of broilers of different experimental groups as affected by studied factors

Items	Treatments	Live body weight (g)	Carcass weight		Giblets weight		Total edible meat	
			(g)	%	(g)	%	(g)	%
Garlic (mg / kg diet)	Control (ADL)	1698	1389	81.68^{a}	76.66^{a}	5.57^{b}	1465	86.23^{a}
	G 0	1572	1236	78.55^{b}	88.66^{a}	7.28^{a}	١٣٢٥	84.25^{ab}
	G100	1622	1273	78.34^{b}	84.00^{a}	6.71^{ab}	١٣٥٧	83.58^{b}
	G200	1577	1257	79.7^{ab}	81.33^{a}	6.54^{ab}	١٣٣٩	84.92^{ab}
	MSE	62.72	56.30	0.88	0.57	0.39	56.83	0.83
Sig.	-	NS	NS	**	NS	**	NS	**
Feeding systems	SKD2	1583	1252	79.04^{ab}	92.77^{a}	7.43^{a}	1345^{a}	84.91^{ab}
	SKD4	1616	1256	77.72^{b}	84.22^{ab}	6.77^{a}	1340^{a}	82.97^{b}
	SKD6	1572	1259	79.85^{ab}	77.00^{b}	6.33^{a}	1336^{a}	84.87^{ab}
	MSE	62.85	56.48	0.86	3.11	0.38	56.96	0.80
Sig.	-	NS	NS	**	**	*	NS	**
Treatments x Feeding systems:								
G0 x SKD 2		1590	1283	80.74^{a}	98.33^{a}	7.65	1381	86.91^{a}
G0 x SKD 4		1626	1235	75.84^{b}	88.33^{abc}	7.21	1323	81.30^{b}
G0 x SKD 6		1500	1192	79.08^{ab}	79.33^{bc}	6.97	1271	84.55^{ab}
G100 x SKD 2		1635	1276	77.85^{ab}	96.66^{ab}	7.64^{a}	1373	83.78^{ab}
G100 x SKD 4		1697	1323	77.93^{ab}	84.00^{abc}	6.41^{a}	1407	82.90^{ab}
G100 x SKD 6		1536	1221	79.26^{ab}	71.33^{c}	6.09^{a}	1293	84.06^{ab}
G200 x SKD 2		1525	1196	78.53^{ab}	83.33^{abc}	7.02^{a}	1280	84.05^{ab}
G200 x SKD 4		1525	1211	79.40^{ab}	80.33^{bc}	6.70^{a}	1292	84.71^{ab}
G200 x SKD6		1681	1365	81.20^{a}	80.33^{bc}	5.92	1445	86.02^{a}
MSE		114.2	103.3	1.48	5.16	0.72	103.8	1.36
Sig.		NS	NS	**	***	*	NS	**

$^{a,b,\ c}$ Means with different superscript in the same column are significantly different at (P<0.05). NS non-significant
*** Significant (P<0.05) ** High significant (P<0.01)**
*****Highly significant (P<0.001).**

Chemical examination of meat

Results tabulated in Table (6,7) show the effect of dietary GP supplementation and fasting systems on chemical examination of meat for chicks of different experimental groups.

Chicks fed diet supplemented with GP at a levels of 200, 100 and 0 mg/kg diet, respectively significantly (P<0.001) increased protein percentage and significantly (P<0.001) decreased moisture percentage of meat samples. However, birds fed diet with G100 and 200 significantly (P<0.01) decreased fat and crude fiber percentage, respectively compared with different treatments applied and ADL group (table,6).

Table 6. Least–square means and standard error (X±S.E) of chemical examination of meat of different experimental groups as affected by studied factors

Items	Treatments	Moisture %	Protein %	Fat %	C. fiber %
	Control (ADL)	74.90± 0.26^{a}	18.80± 0.37^{c}	3.30± 0.21^{a}	0.70± 0.10^{b}
Garlic (mg / kg diet)	G 0	73.73± 0.15^{b}	19.60± 0.21^{b}	3.16± 0.12^{a}	1.03± 0.06^{a}
	G100	72.80± 0.15^{c}	20.56± 0.21^{a}	2.66± 0.12^{b}	1.03± 0.06^{a}
	G200	72.23± 0.15^{d}	21.06± 0.21^{a}	2.96± 0.12^{ab}	0.96± 0.06^{a}
Sig.	-	***	***	**	**
Feeding systems	SKD2	73.43± 0.22^{a}	19.70± 0.22^{c}	3.30± 0.08^{a}	0.90± 0.04^{b}
	SKD4	72.90± 0.22^{ab}	20.36± 0.22^{b}	3.00± 0.08^{b}	1.13± 0.04^{a}
	SKD6	72.43± 0.22^{b}	21.16± 0.22^{a}	2.50± 0.08^{c}	1.00± 0.04^{b}
Sig.	-	**	***	***	**
Treatments x Feeding systems:					
G0 x SKD 2		74.30^{a}	19.10^{g}	3.60^{a}	0.90^{bc}
G0 x SKD 4		73.70^{b}	19.60^{f}	3.20^{bc}	1.10^{ab}
G0 x SKD 6		73.20^{c}	20.10^{e}	2.70^{ef}	1.10^{ab}
G100 x SKD 2		73.10^{cd}	19.70^{f}	2.90^{de}	1.00^{abc}
G100 x SKD 4		72.80^{e}	20.60^{d}	2.80^{de}	1.10^{ab}
G100 x SKD 6		72.50^{f}	21.40^{b}	2.30^{g}	1.00^{abc}
G200 x SKD 2		72.90^{de}	20.30^{e}	3.40^{ab}	0.80^{c}
G200 x SKD 4		72.20^{g}	20.90^{c}	3.00^{cd}	1.20^{a}
G200 x SKD6		71.60^{h}	22.00^{a}	2.50^{fg}	0.90^{bc}
MSE		0.07	0.07	0.7	0.07
Sig.		***	***	***	**

$^{a,b,\ c}$ Means with different superscript in the same column are significantly different at (P<0.05). NS non-significant
*** Significant (P<0.05) ** High significant (P<0.01)**
***** Highly significant (P<0.001).**

Chicks fed diet supplemented with GP at a levels of 200, 100 and 0 mg/kg diet, respectively significantly increased ash percentage. The highest averages of PH, total volatile nitrogen(TVN) mg% and thiobarbituric acid(TBA) mg/kg were found in the ADL group (table,7).The results obtained agree with those reported by Kim *et al.,* (2009) who found that dietary supplementation with (garlic bulb)GB and (garlic husk)GH resulted in significantly greater protein content and lower fat content in chicken thigh muscle compared with muscle from birds fed non supplemented diets (P<0.05). There was no difference between supplementation with GB compared with supplementation GH (P > 0.05). Sallam *et al.,* (2004) found that higher pH values in various types of garlic-treated chicken sausages compared with controls.

Table 7. Least–square means and standard error (X±S.E) for chemical examination for meat of different experimental groups as affected by studied factors

Items	Treatments	Ash %	PH	TVN (Mg %)	TBA (mg/kg)
	Control(ADL)	١.٤٠± 0.15^{b}	5.91± 0.08^{a}	13.57± 0.58^{a}	0.42± 0.08^{a}
Garlic (mg / kg diet)	G 0	1.66± 0.09^{ab}	5.85± 0.04^{ab}	10.16± 0.33^{b}	0.31± 0.04^{ab}
	G100	1.80± 0.09^{a}	5.75± 0.04^{ab}	8.01± 0.33^{c}	0.17± 0.04^{bc}
	G200	1.96± 0.09^{a}	5.71± 0.04^{b}	6.94± 0.33^{c}	0.17± 0.04^{bc}
Sig.	-	**	**	***	***
Feeding systems	SKD2	١.٥٣^{c}	5.80^{a}	9.63^{a}	0.24^{a}
	SKD4	1.83^{b}	5.77^{a}	8.18^{b}	0.20^{a}
	SKD6	2.06^{a}	5.74^{a}	7.31^{b}	0.17^{a}
	MSE	0.06	0.04	0.48	0.04
Sig.		***	NS	**	NS
Treatments x Feeding systems:					
G0 x SKD 2		1.50^{de}	5.88^{a}	11.75^{a}	0.37^{a}
G0 x SKD 4		1.60^{de}	5.85^{a}	9.97^{b}	0.31^{ab}
G0 x SKD 6		1.90^{bc}	5.83^{a}	8.78^{d}	0.26^{ab}
G100 x SKD 2		1.40^{a}	5.79^{a}	9.12^{c}	0.20^{ab}
G100 x SKD 4		1.90^{bc}	5.76^{a}	7.68^{f}	0.18^{ab}
G100 x SKD 6		2.10^{ab}	5.72^{a}	7.25^{g}	0.15^{ab}
G200 x SKD 2		1.70^{cd}	5.74^{a}	8.03^{e}	0.17^{ab}
G200 x SKD 4		2.00^{ab}	5.71^{a}	6.89^{h}	0.12^{b}
G200 x SKD6		2.20^{a}	5.68^{a}	5.92^{i}	0.10^{b}
MSE		0.07	0.07	0.07	0.07
Sig.		***	NS	***	**

$^{a,b,\ c}$ Means with different superscript in the same column are significantly different at (P<0.05). NS non significant
*** Significant (P<0.05) ** High significant (P<0.01)**
***** Highly significant (P<0.001).**

Chicks exposed to SKD6 and SKD4, respectively significantly increased protein percentage and significantly decreased moisture percentage of meat samples. However, chicks exposed to SKD6 and SKD2 significantly decreased fat and crude fiber percentage, respectively compared with different treatments applied and ADL group(table,6).

Chicks exposed to SKD6 and SKD4, respectively significantly increased ash, percentage. The highest averages of PH, TVN and TBA were found in the control group (table,7). The results obtained agree with those reported by Nielsen *et al.,* (2003) who stated that feed restriction could decrease fat content and increase protein deposition in carcasses, thus resulting in the improved carcass composition. Hassanabadi and Nassiri (2006) indicated that carcass fat content of restricted broiler chickens was significantly low compared with birds fed ADL. Zhan *et al.,* (2007) indicated that at 63 days of age, EE content of breast muscle was decreased, whereas CP content was increased in feed-restricted broilers. They added that early feed restriction severely affected the lipid metabolism. Also, Gajula *et al.,* (2008) showed that broiler breeder subjected to restriction programs has higher muscle protein and lower fat than birds fed ADL

Interaction effects between each two factors studied showed significantly increased protein and crude fiber percentage and significantly decreased moisture percentage compared with ADL group. However, significantly decreased in ph, TVN and TBA were found in all interactions studied compared with ADL group, which showed the lowest average of ash percentage.

Sensory of meat traits:

Significant variations (P<0.01), (P<0.05) and (P<0.001) were found on both external aspect, odor, color, muscle elasticity and the overall score of sensory evaluation of meat due to treatments applied(table,8)

Table 8. Least–square means and standard error (X±S.E) of sensory evaluation for different experimental groups as affected by studied factors

Items	Treatments	Sensory evaluation					
		External aspect (3)	Oder (3)	Color (3)	Muscular elasticity (3)	Overall Score (12)	Sensorial Quality
Garlic (mg/kg diet)	Control (ADL)	2.0± 0.22^{b}	1.0± 0.15^{b}	2.0± 0.22^{b}	2.0± 0.22^{c}	7.0± 0.27^{d}	Acceptable
	G0	2.0± 0.13^{b}	2.0± 0.11^{a}	2.0± 0.13^{b}	2.6± 0.13^{ab}	8.6± 0.16^{c}	Acceptable
	G100	2.6± 0.13^{a}	2.0± 0.11^{a}	2.6± 0.13^{a}	2.3± 0.13^{bc}	9.6± 0.16^{b}	Excellent
	G200	2.6± 0.13^{a}	2.0± 0.11^{a}	2.6± 0.13^{a}	3.0± 0.13^{a}	10.3± 0.16^{a}	Excellent
Sig.	-	**	*	**	***	***	
Feeding systems	SKD2	2.00^{b}	2.00^{a}	2.66^{a}	2.33^{b}	9.00^{b}	Excellent
	SKD4	2.66^{a}	2.00^{a}	2.33^{a}	2.66^{ab}	9.66^{ab}	Excellent
	SKD6	2.66^{a}	2.00^{a}	2.33^{a}	3.00^{a}	10.0^{a}	Excellent
	MSE	0.13	0.11	0.16	0.13	0.25	
Sig.	-	**	*	*	**	**	
Treatments x Feeding systems:							
G0 x SKD2		2.0^{b}	2.0^{a}	2.0^{b}	2.0^{b}	8.0^{d}	Acceptable
G0 x SKD4		2.0^{a}	2.0^{a}	2.0^{b}	3.0^{a}	9.0^{c}	Excellent
G0 x SKD6		2.0^{b}	2.0^{a}	2.0^{b}	3.0^{a}	9.0^{c}	Excellent
G100 x SKD2		2.0^{b}	2.0^{a}	3.0^{a}	2.0^{b}	9.0^{c}	Excellent
G100 x SKD4		3.0^{a}	2.0^{a}	3.0^{a}	2.0^{b}	10.0^{b}	Excellent
G100 x SKD6		3.0^{a}	2.0^{a}	2.0^{a}	3.0^{a}	10.0^{b}	Excellent
G200 x SKD2		2.0^{a}	2.0^{a}	3.0^{a}	3.0^{a}	10.0^{b}	Excellent
G200 x SKD4		3.0^{a}	2.0^{a}	2.0^{b}	3.0^{a}	10.0^{b}	Excellent
G200 x SKD6		2.0^{b}	2.0^{a}	3.0^{a}	3.0^{a}	11.0^{a}	Excellent
MSE		0.14	0.12	0.18	0.14	0.95	
Sig.		**	*	**	**	***	

[a,b, c] Means with different superscript in the same column are significantly different at (P<0.05). NS non-significant * Significant (P<0.05) ** High significant (P<0.01) * Highly significant (P<0.001).**

Meat samples from birds fed diets supplemented with GP at a levels of 200 and 100 mg/kg diet recorded significantly the highest overall score of sensory characterizations, followed by those of birds fed diets supplemented with GP at level 0 mg / kg diet, then by those of the ADL group, respectively. It is clear from results obtained that meat samples of chicks fed diets supplemented with different levels of GP recorded better sensory characteristics than those recorded of birds fed the control diet.

The meat of birds fed GP has distinguish favorable odor, better accepted color, higher muscle elasticity , recorded higher overall score and excellent sensorial quality of sensory test. The results obtained agree with this reported by Kim *et al.* (2009) who stated that sensory panelists recorded greater hardness and flavor scores for the samples of garlic dietary supplementation (P<0.05), and disagree with those reported by Fadlalla *et al.,* (2010**)** found that there were no significant differences among dietary treatments in the tested characteristics (colour, flavor, tenderness and juiciness). Mehdi *et al.,* (2011) reported that sensory evaluation of thigh meat displayed no abnormal odor or flavour in meat induced by feed additives.

Chicks exposed to SKD6 and SKD4 had significantly the highest averages of the highest overall score of sensory characterizations (10.0 and 9.66, respectively, followed by chicks exposed to SKD2 and the control group, respectively (table,8)..

All interactions applied showed highly significant effects on sensory evaluations, interactions between G200 and each of SKD6, SKD4 and SKD2 and between G100 and each of SKD6, SKD4 and SKD2, respectively increased all sensorial quality compared with other interaction applied and ADL group.

Economical efficiency:

The results obtained (table,9) revealed that the highest economical efficiency (EE) and the relative economical efficiency (REE) values were recorded by chicks fed diet supplemented with GP at a level of 0, 100 and 200 mg/kg diet, respectively compared with control group.

Table 9. Least–square means and standard error (X±S.E) for economical efficiency of broilers of different experimental groups as affected by studied factors

items	Treatments	Average BWG (kg)	Total revenue/kg gain (L.E)	Total feed intake/ chick(kg)	Feed cost/ chick (L.E)	Costs of feed additives	Total cost	Other costs	Total cost	Net revenue / chick (L.E)	Economical efficiency (EE)	Relative economical efficiency (REE)
Garlic (mg / kg diet)	ADL	1624	21.11	3512	13.92	0	13.92	4.18	18.10	3.01	0.17	100.0
	G0	1615	20.99	3296	13.03	0	13.03	3.91	16.94	4.05	0.24	141.2
	G100	1592	20.69	3280	12.96	0.16	13.12	3.94	17.06	3.63	0.21	125.2
	G200	1589	20.65	3224	12.73	0.32	13.05	3.92	16.93	3.72	0.22	129.3
Feeding systems	SKD2	1596	20.74	3301	13.04	0	13.04	3.91	16.95	3.79	0.22	129.3
	SKD4	1588	20.64	3206	12.66	0	12.66	3.80	16.46	4.18	0.25	147.1
	SKD6	1562	20.30	3294	13.01	0	13.01	3.90	16.91	3.39	0.20	117.9
Treatments x Feeding systems:	G0 x SKD2	1684	21.89	3397	13.42	0	13.42	4.03	17.45	4.44	0.25	149.7
	G0 x SKD4	1648	21.42	3271	12.92	0	12.92	3.88	16.80	4.62	0.28	161.8
	G0 x SKD6	1504	19.55	3222	12.73	0	12.73	3.82	16.55	3.00	0.18	106.6
	G100xSKD2	1563	20.31	3416	13.50	0.17	13.67	4.10	17.77	2.54	0.14	82.4
	G100 xSKD4	1530	19.89	3287	13.00	0.16	13.16	3.95	17.11	2.78	0.13	74.9
	G100 x SKD6	1559	20.26	3137	12.40	0.15	12.55	3.77	16.32	3.94	0.24	141.2
	G200 x SKD2	1549	20.13	3345	13.21	0.34	13.55	4.06	17.61	2.52	0.14	82.4
	G200 x SKD4	1521	19.77	3244	12.81	0.32	13.13	3.94	17.07	2.70	0.16	94.1
	G200 X SKD6	1705	22.16	3084	12.18	0.31	12.49	3.75	16.24	5.92	0.37	217.6

The highest REE were found to be 147.1, 129.3 and 117.9 for SKD4, SKD2 and SKD6, respectively compared with ADL (100%). This may be attributed to the debasement in the total cost of feed, and also may be due to amelioration of FC and BWG. Hereupon, there are considerable costs evaluating with practica of SKD feeding systems, when compared with ADL group. It's well know that feeding cost accounts 70% of the broiler production (Smith 2001 and Hussein 2012).

Interactions between G200 X SKD6, G0 X SKD4, G0 X SKD2 and G100 X SKD6 showed the highest averages of REE, it mounted 217.6, 161.8, 149.7 and 141.2%, respectively compared with different interactions applied and ADL group.

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تأثير اضافة مسحوق الثوم للعليقة ونظم التغذية علي الأداء الإنتاجي لبدارى التسمين

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أجريت هذه الدراسة لبحث تأثير اضافة مسحوق الثوم كمنشط نمو طبيعي ونظم التغذية علي الأداء الإنتاجى لبداري التسمين. أستخدم فى هذه الدراسة عدد ٥٠٠ كتكوت تسمين (سلالة كب) عمر يوم متماثلة فى وزن الجسم الحى تقريبا , قسمت الكتاكيت عشوائيا الي ١٠ مجموعات متساوية , بكل مجموعة ٥٠ كتكوت. تم تغذية المجموعة الاولي علي العليقة الاساسية (حتي الشبع) بدون اضافات واعتبرت مجموعة الكنترول, تم تغذية كتاكيت المجموعة الثانية ,الثالثة والرابعة علي عليقة مضاف اليها صفر ملجم مسحوق الثوم/كجم عليقة مع نظام تغذية يوميا ما عدا اليوم ٧, ١٤ تم منع الغذاء لمدة ٢٤ ساعة (تصويم يومان), تغذية الكتاكيت يوميا ما عدا اليوم ٧, ١٤, ٢١, ٢٨ (تصويم اربعة ايام), تم تغذية الكتاكيت المجموعة يوميا ما عدا اليوم ٧, ١٤, ٢١, ٢٨, ٣٥, ٤٢ (تصويم ستة ايام) وذلك للمجموعة الثانية ,الثالثة والرابعة علي الترتيب, وتم تغذية كتاكيت المجموعة الخامسة والسادسة والسابعة علي العليقة الاساسية مضاف اليها مسحوق الثوم بمعدل ١٠٠ ملجم/كجم عليقة مع نظم التغذية تصويم يومان واربعة وستة ايام علي الترتيب , وتم تغذية المجموعة الثامنة والتاسعة والعاشرة علي العليقة الاساسية مضاف اليها مسحوق الثوم بمعدل ٢٠٠ ملجم/كجم عليقة مع نظم التغذية تصويم يومان واربعة وستة ايام علي الترتيب. أظهرت النتائج المتحصل عليها أن كتاكيت مجموعه الكنترول اعلي وزن جسم واعلي زياده مكتسبة في وزن الجسم ومعدل النمو ومعدل استهلاك الغذاء يليها تلك المعرضه لنظم تصويم لمده يومين و ٤ و٦ ايام علي الترتيب. أظهرت الكتاكيت المعرضه لنظام تصويم ٦ ايام افضل معدل لكفاءة تحويل الغذاء يليها الكتاكيت المعرضه ل ٤ ايام تصويم ويومين ومجموعه الكنترول علي الترتيب وذلك خلال الفترة من ٤ الي ٦ اسابيع من عمر الطيور. أظهرت طيور مجموعة المقارنة اقل معدل لنسبة النفوق يليها الطيور المغذاه علي عليقه مضاف اليها ٢٠٠ و ١٠٠ ملجم مسحوق ثوم / كجم عليقة علي الترتيب. أظهرت الطيور المغذاه علي عليقه مضاف لها مسحوق الثوم بمعدل ٢٠٠ ، ١٠٠ و صفر ملجم/كجم عليقة علي الترتيب زياده معنويه في نسبه البروتين والرماد وانخفاض معنوية في نسبة الرطوبه في عينات اللحم. أظهرت الطيور المعرضه لنظام تصويم قدره ٦ و٤ ايام معنويا أعلي متوسطات للمتوسط العام لاختبارات التذوق علي الترتيب يليها تلك المعرضه لنظام تصويم لمدة يومين ومجموعة المقارنة علي الترتيب. يمكن التوصيه باستخدام نظام تصويم اربعة ،اثنين و ستة أيام علي الترتيب وكذا التداخل بين مسحوق الثوم بمستوي صفر مع نظام تصويم قدره اربعة و ستة أيام علي الترتيب وذلك لتحقيق أفضل النتائج المرغوبة من وجهة النظر الإقتصاديه.

الكلمات الرئيسية: كتاكيت التسمين - الثوم - الأداء الإنتاجي – نظم التغذية