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RESPONSES OF BROILER CHICKS TO STARVATION PERIOD LENGTHS AND EFFECTS ON GROWTH PERFORMANCE, DIGESTIBILITY, CARCASS YIELD, BLOOD INDICATIONS AND ECONOMICS

SHORT TITLE: FEED RESTRICTION AND ITS EFFECTS ON BROILER PERFORMANCE

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ABSTRACT: The study aimed to evaluation the effects of feed restriction with different levels on growth, carcass yield, digestibility of nutrients and some blood evidences in broilers .One hundred twenty Arbor Acres, unsexed-one-day chicks were used. It had divided into 4 experimental groups, each with 3 replicates (10 chicks/ replicate). The first treatment chicks were fed a commercial diet constantly during starting and growing periods, whereas feeds in the other treatments were restricted as follows: the second treatment starved for 3 hours \ day (from 4.00 to 7.00 pm), the third treatment starved 6 hours \ day (from 1.00 to 7.00 pm) and the last treatment starved 9 hours \ day (from 10.00 am to 7.00 pm). All chicks had full access to drinking water during the experimental period. The obtained results showed that broilers served *ad libitum* had significantly higher live body weight, and body weight gain compared with the treated broilers. Feed restriction significantly lowered blood LDL (in the last treatment), highest HDL (in the third), increased and improved insignificantly giblets weights or giblets percentage and FCR in the whole period respectively (in the last), improved carcass weight, dressing percentage (in the third) and enhanced significant digestion coefficient of CP for the third too. In conclusion, feed restriction had not negatively affected growth performance or metabolic responses, and it positively affected total feed costs, economic efficiency and relative economic efficiency for high level starved broilers. Therefore, the results support feed restriction by starvation methods for broiler chickens.

Keywords: restriction of feed, broiler performance, digestibility, carcass, blood measurements

INTRODUCTION

Broiler chicken growth characteristics have improved over the last 30 years, owing to genetic progress, improved feeding, and a more controlled environment, so that it now takes less time to reach a final body weight (Wilson, 2005). Unfortunately, this increased growth rate is associated with metabolic stress ,increased body fat deposition, a higher mortality rate, a higher frequency of metabolic illnesses and skeletal (Scott, 2002) which are most prevalent in *ad- libitum* broilers (Cuddington, 2004; Nielsen et al., 2003). The major cost of poultry production comes via feed, establishing up to 70 % of the total cost. The confront from various strategies is improve growth performance and reducing feed cost by using alternative feed ingredients, supplementation of exogenous enzymes, addition of natural feed additives as growth promoters, or restriction of feed intake by restricting the amount of daily feed offer for some time (Novele et al., 2009; Makinde, 2012). Feed restriction strategies are one of the most common growth curve manipulation and controlling feed consumption approaches for enhancing production efficiency and reducing the negative consequences of high growth rates in the broiler chicken industry, and they can be beneficial in terms of broiler chicken increased efficiency (Sahraei, 2014). It's done by giving each bird a calculated amount of food each day to prevent wastage of feed (Sahraei and Shariatmadari, 2007). To achieve a market body weight comparable to the control group, early feed restriction programmers rely on a process known as remedial growth or corrective growth. Compensatory growth is well-defined as fast growth after a period of dietary deprivation (Mahmood, 2012).

Recently, many studies on broiler chicks indicate that approach feed restriction programs at different ages causes depressing body weight and carcass fat and enhances feed efficiency (Al-Taleb, 2003), however, it's more severe in young birds (Mench ,2002). Hard feed restriction cause changes in gastrointestinal tract anatomy and physiology of broilers (Schwean-Lardner et al., 2013), increases the size and the storage capacity of the crop (Svihus et al., 2013) and modifies bird's behavior of the feeding, resulting in an increment of in feed intake directly before the start of the feed withdrawal phase (Shynkaruk et al., 2019). Furthermore, ascites, which is common in fast-growing broiler birds, might result in carcass condemnation or mortality (Julian, 2000) and humble reproductive results (Mench, 2002; Tolkamp et al., 2005). This is especially common in broilers that are fed *ad libitum* (Nielsen et al., 2003). One of the biggest issues faced by broiler producers is excessive fat deposition as a result of *ad libitum* feeding. This not just affects offering crop and feed efficacy, but likewise it increases consumer refusal of the carcass and complicates broiler manufacturing (Navidashad et al., 2006; Khajali et al., 2007). As a result, the major goals of this study were to investigate the broiler's growth performance, hematological parameters, carcass dressing percentage and relative economic efficiency with different levels of feed restriction (FR) via starvation with different levels under local conditions.

MATERIALS AND METHODS

1- Chicks management:

This study was carried out during the period from 28 March to 11 May (2019) to investigate the effect of feed restriction by starvation method with different levels on growth, feed efficiency, carcass yield , digestibility of nutrients and some blood parameters in broilers. The experimental procedures were carried out in accordance with the Institutional Committee of the Department of Animal and Poultry Production, Faculty of Agriculture, Minia University, Egypt. One hundred twenty (120), one day old, unsexed Arbor Acres chicks (47 ± 1.22g) were used . Chicks and basal diet were obtained from Cairo Company for poultry, Egypt. It was randomly allocated into four experimental groups each of (3 replicates× 10 chicks). Chicks were housed in an open house under similar managerial conditions. Every replicate (10 chicks) was located in floor pens of 100 x120 cm width x length.

Each pen had woods having's litter, one drinker and feeder. Chicks fed commercial basal diet which contained adequate levels of nutrients, 23% crude protein and 3050 k cal\kg diet for starting and 21% crude protein and 3150 k cal\kg diet for growing chicks with similar levels of calcium, phosphorus, and sulphoric amino acids as recommended by the National Research Council, **(NRC, 1994)** with no additions representing in the diet. Broilers were fed basal commercial starter and grower diets from 1 to 21 and from 22 to 42 days of age respectively. The laboratory proximate analysis of commercial starter and grower diets is present in Table 1. Broilers were provided with continuous light during first week of age after that it was (21 L + 3 D) until the end of experimental period.

The temperature in the first 3 day of brooding was about 34̊.5 C and it was reduced 2 ±0.5̊ C every week until the end of experiment. The interior ambient temperature and humidity percentage were measured in house and weekly recorded as averages. Then, temperature and humidity index (THI) was calculated as shown in Table 2. Chicks in the first treatment (1) fed *ad libitum* until the end of the experiment (42) days of age on the basal diet. while feeds in the other treatments were restricted as follow: the second treatment starved for 3 hours \ day (from 4.00 to 7.00 pm) , the third treatment starved 6 hours \ day (from 1.00 to 7.00 pm) and the last treatment starved 9 hours \ day (from 10.00 am to 7.00 pm). All chicks were full access to drinking water during the experimental period (from 1 to 42 days) of age.

2- Performance measurements:

The live body weight and feed consumption of each replicate recorded at 21 and 42 days of age. Feed conversion (g, feed/ g, gain) and body weight gain (g/ bird) were calculated during the periods 1 to 21, 22 to 42 and 1 to 42 days of age. Mortality rate throughout the experimental period was recorded for each replicate weekly up to the end of experiment period.

3- Digestibility trial:

At the beginning of the 7^{th} week of age, three birds from each treatment were individually detained in the same place for three days. Feed consumption was determined and feces output was collected daily, scattered feed and feather were separated and taken out of the feces. The collected excreta were sprayed with boric acid solution (2%) to prevent any loss of ammonia. Samples of the tested diets and collected feces for each treatment were pooled together, dried at 60º C till constant weight, ground in a mill and then kept in glass cans for chemical analysis according to the official methods of A.O.A.C (2010) and digestion coefficient of nutrients was calculated after fecal nitrogen was determined according to Jakobsen et al (1960) as follow:

Digestion coefficient = digested nutrient \ consumed nutrient ×100

4- Carcass traits:

At the end of the experiment (6 weeks of age), representative samples of birds (3 birds from each treatment) around average treatment body weight mean individually weighed. Birds were slaughtered and after complete bleeding, the birds were scalded and feathers were plucked. Dressing percentage was calculated (weight of carcass × 100 / per slaughter weight). Weights of liver, gizzard, heart abdominal and total giblets were recorded.

5- Blood parameters:

Blood samples were collected from three birds (3\group) during slaughtering (3 samples in un-heparinized tubes. Un-heparinized samples for each group were centerifugated at 3000 rpm\min. for 20 minute to obtain blood serum. The serum was stored at -20 ˚C until analysis. Blood measurements were determined using commercial assay kits (Diamond Diagnostics and Biomed companies, Egypt) as follow: Serum total protein, albumin, glucose, uric acid and total cholesterol values were determined according to Trinder (1976), serum Creatinine (Young, 1975), serum level of triglyceride (Fossati et al., 1982), serum high density lipoprotein (HDL) was determined (Castelli., 1977), low density lipoprotein (LDL) was calculated using the formula of Friedewald *et al.,* (1972). The activities of alanine aminotransferases (ALT), aspartate aminotransferases (AST) (Reitman and Frankle, 1957), gamma glutamyl transferase (GGT) and alkaline phosphatase (ALP) were assayed by (Tietz, 1994), lactate dehydrogenase (LDH) (Gordon *et al.,* 1977). Thyroid hormones, triiodothyronine (T3) and thyroxine (T4) concentration were determined by direct solid-phase I125 radio immunoassay techniques using RIA kits purchased from diagnostic products corporation at the laboratory of Atomic Energy Authority in Egypt. Corticosterone concentration (CORT) and adrenocorticotrophic hormones (ACTH) were determined by (Jezova *et al*., 1994) and (Rasmuson et al.,1996) respectively. Albumin\globulin, ALT\AST and T3\T4 ratios were estimated.

6- Liveability%, broiler farm economic index and economic efficiency:

Liveability percentage for each treatment was calculated as follow:

Number of survived chicks⁄ replicate⁄ treatment ×100

The initial number of chicks⁄ replicate⁄ treatment

Then, cumulative mortality percentage and broiler farm economic index (BFEI) were calculated using the formulas:

Mortality% = 100- liveability%

BFEI= average live weight (kg)× % livability\ FCR× growing period (days).

Economic efficiency (EE) and relative economic efficiency (REE) of different groups calculated according to Ragab, (2007) depending upon the local market prices during the experimental time.

7- Statistical Analysis:

Static analysis was performed using one-way ANOVA. The general liner model

(GLM) was applied to test the differences among the four experimental groups. P-values less than 0.05 were considered to be statistically significant SAS Institute (1998). The statistical analysis was calculated using the following equation:

$Yij= \mu + Ti + Eij$

Where:

Yij = Experiment observations.

μ = the overall mean.

Ti= the effect of dietary treatment.

i= T1, ----- T4.

Eij = the experimental error

RESULTS AND DISCUSSION

1- **Growth Performance traits**:

The result showed significant ($P \leq 0.01$) effect of feed restriction on live body weight (Table 3) during starting and growing periods. At 21 and 42 day, birds on group 1 (*ad libitum*) showed superiority in terms of live weight while, feed restrictions recorded the lowest mean values of live weight. Also, the results showed significant ($P \leq 0.01$) differences of feed consumption (FC) at (1 – 21) days of age in response to feed restriction. Broiler chicks in the group 1 (ad libitum) had significantly the highest FC ($P \leq 0.05$) than all other groups. However, the Feed consumption during grower (from 22 to 42 D) and overall period (from 1 to 42 D) of age was affected insignificantly ($P \leq 0.01$) effect of feed restriction on FC. The effect of feed restriction on body weight gain (BWG) at (1 – 21), (22 – 42) and (1 – 42) days of age was significant ($p<0.01$). At periods (1 – 21) and (1 – 42) days of age, birds on group 1 (ad libitum) had significantly ($P<0.05$) the highest BWG than the others. While, birds on group 2 (starved for 3 hours\day) had significantly ($P<0.05$) the lowest WG than other groups at (22 – 42) days of age. Whereas, Feed consumption: body weight gain ratio (FCR) was not affected by feed restriction treatments during the periods (1 – 21) and (1– 42) of age, but significantly improved by compared with unrestricted feed group during the period of (22 – 42) period. FCR of feed restriction groups was significantly decreased ($P \leq 0.05$) during period (from 22 to 42) days of compared to the control group. The obtained results are conformity with the results of Jahanpour et al., (2014) conducted an experiment of feed restriction on productive growth performance of broiler chicks and found similar results. They detected that the growth rate of broilers was fewer in the restricted group than the control. Also, Njoku et al. (2012) and Sherif and Mansour (2019) found the same.

Chiemela Peter et al., (2015) indicated that broiler chicks with thirty percent withdrawal feed recorded significant decrease in weekly weight growth (WG) compared with broiler chicks fed full feed. Mahmood et al. (2007) illustrated that the broiler chickens reared under feed restriction for 3, 5 and 7 hours daily from the 8th to 28th day had lighter body weights than those reared under free feeding. Similar results were obtained by (Attia et al. 2017; Xu et al. 2017; Morais et al. 2017). Also, Cristiane Duarte et al. (2014) showed that the effect of feed restriction on performance of broilers, leading to a decline in body weight, weight gain and some carcass organs. However, Mohsen et al. (2016) who reported that feed-restricted chickens had ability to achieve normal market body weight at 42 day of age, the length and cruelty of the feed restriction used allowed broilers to reach market live weight for age, the same result was obtained by Azouz et al., (2019). In the same trend Esmail (2018) proposes that the deficiency of statistically significant variances in weight gain with feeding restriction methods may be due to the regular biological adaptation of chicks to the unlike diets, which probable improved the feed efficiency of the offered feed. The growth performance of broiler chickens may fall due to depreciation protein and energy values in quantities lower their daily needs (Abdel-Hafeez et al.,2016).

In agreement with the present results, Hassanien (2011) stated that chicks reserved under higher levels of feed restriction consumed a little feed. Onbasilar et al.(2009) observed that 4 h daily feed removal had no significant effects on feed intake of broiler chicks. Also, Omosebi et al. (2014) found that broiler reared under restriction (40 % for 6 weeks) had significantly reduced feed intake. Adeyemi et al. (2015) reported that broiler chicks kept under feed restricted (80-75%) decreased daily feed intake. Likewise, Novele et al. (2008) informed that feed intake was significantly decreased by feed restriction . Attia et al. (2017) found that feed restriction during the second week of age consumed feed without any major differences in feed intake. This agreed with work of Chiemela Peter et al., (2015) who reported similar findings on feed consumption by birds.

Rahimi et al., (2015) designed an experiment to evaluate the effect of feed restriction with different levels in broilers and they obtained that feed conversion ratios decreased as a result of increasing levels of feed restriction, as the same in the present study that feed restriction improved the feed conversion of chicks, perhaps due to the summary time existing for digestion. At the same time, broilers with feed restriction may have adequate time to use the nutrients in the feed more efficiently, leading to better feed efficacy than birds fed full diet (Abdel-Hafeez et al., 2016). Or this improvement owing to cheap global maintenance requirements because birds exposed to a period of feed restriction towards to have slighter body weights before they get market weight thus they require less for this purpose (Urdaneta-Rincon and Leeson, 2002), it endangered to feed restriction stress, have likely to use their feed more efficiently and stay longer near the feeder than those in an ad libitum feeding program (Adeyemi et al., 2015; Trocino et al., 2020). The findings results are contract with that reported by Zhong et al., (1995) who reported similar finding that feed conversion ratio was better ($P<0.05$) for restricted- feed broiler chickens than full fed birds. Similarly, Mehmood et al. (2013) found that feed restriction improved effectiveness of feed in broilers. In addition Adeyemi et al. (2015) found that feed restriction (30%) improved FCR of broiler chicks. Xu et al. (2017) and Kouki and Bergaoui (2016) reported that FC of the feed restricted group was significantly better than the control. Fanooci and Torki (2010) showed that no significant difference in the overall FCR (9-49 d) between chicks fed the restricted and non-restricted control diet, except for chicks fed on 20% restricted diet that had the highest FCR during the experiment

Bordin et al., (2021) demonstrated that feed restriction enhanced the feed efficient of birds, possibly due to the declining digestion time. On equal time, birds with feed restriction may have adequate time to use the nutrients more efficiently, leading to better FCR compared to control.

2-Digestibility of nutrients

Effects of different levels of feed restriction of broiler chicks on digestibility of nutrients (dry matter (DM), organic matter (OM), crude protein (CP), crude fiber (CF), ether extract (EE) and nitrogen free extract (NEF)) for 3 days after ending experimental period (43 – 45) d of age are presented in Table 4.The results showed significant effect ($P<0.01$) of feed restriction on digestibility of nutrients (DM, OM, CP, CF, EE and NEF). Birds in the group 2 had recorded significantly ($P<0.05$) the highest values of DM, OM, EE and NFE than others groups. However, broiler chickens in the group 4 had significantly ($P\leq0.05$) the lowest CP and the highest CF coefficient digestion than others groups. The better utilization of feed intake detected in this study with broilers imperiled to feed restriction can be clarified by the increased absorption of available vital nutrients in the feed by the increased creation of digestive enzymes (especially trypsin activity) that cause the digestive system activity during the feed restriction period, and or less feed wastage because chicks fed not continuous diet spend less time and energy feeding, and by allowing the nutrients greater exposure to the absorptive cells via slowly passing of feed and consequently influences the efficiency of nutrient absorption and utilization. Therefore, improve ability of digestion (Mirghelenj and Golian, 2009). Also, Mohsen et al., (2016) that improve nutrient digestibility in broilers with feed regime because of reducing digesta viscosity viscosity and crypt cell proliferation and increased intestinal villus height. In this study, our savings of feed per chicken were 104 , 150 and 210 g in T2, T3 and T4 respectively. Dissanayake and David (2017), Saber et al., (2011) and Sahraei , (2012) revealed that reducing production cost, greater savings and profit and better digestibility coefficients with restricted feed broilers. Tallentire et al., (2016) demonstrated that the digestibility of chickens diet will contribute to the reduction of environmental impacts resulting from the contraction feeding system.

However, Malahubban et al., (2019) and Tesfaye et al. (2011) showed that no improvement observed for nutrient digestibility due to regime. Also, Bratte, (2011) concluded that no significant effect on dry matter and crude fiber digestibility during early feed restriction phase. Likewise, at the broilers finisher phase, extra activity and feed particles that may resulted in longer enzyme action can be responsible for the observed great apparent digestibility coefficients for nutrients of fed *ad libitum* mash diet group (Mingbin, et al., 2015, Amerah et al., 2007 and 2008).

3-Carcass characteristics

Data presented in **Table 5** showed that live body weight, carcass weight, dressing %, liver, gizzard, heart, giblets, abdominal fat weights, duodenum length, jejunum length, ceca length and large intestine length relative to LBW were not significantly affected by feed restriction, despite the little improvements of dressing%, liver, gizzard and giblets weights generally. Our results are similarly with Malahubban et al., (2019) who exhibited that the gizzard, liver, and intestine weights of early restricted-feed broilers were not significantly affected by with or without yeast addition. Unlike our results, as a result of increasing feed restriction durations, abdominal fat content of carcass was reduced due to fat mobilization for energy supply (Omosebi et al., 2014). The present data in Table 5 showed that slight increases for abdominal fat weight of restricted feed broilers in group 4 compared to other groups. Similarly the finding of Malahubban et al., (2019) who proved that significant increasing in abdominal fat values of restricted feed broiler chickens compared to fuul feed broilers chickens. In the same line with the present study, Tůmová et al., (2016) found that fat content and liver weight may play an chief role in fat metabolism, due to the liver is an vital organ that matures early. Thus, liver weight was numerically higher in restricted broiler chickens (Tůmová et al., 2019).Also, Saleh et al., (2005) observed that carcass weight of broilers with feed restriction significantly decreased. Moreover, Onbaşılar et al., (2009) discovered that feed-restricted broilers had much lower heart weight than the others in control diet. Mohsen et al. (2016) reported that the relative gizzard and liver weights were not significantly affected.

Cristiane Duarte et al. (2014) showed that the gizzard weight was slightly affected organ of feed-restricted birds in the finisher period, while the small intestine was the most part affected. According to Lazaro et al., (2004) and Govaerts et al. (2000), had observed that enlargement of gizzard and proventriculus weights connected to feed-restricted broilers. Unlike, Summers et al., (1990) and Jones and Farrell (1992) revealed that carcass yield or dressing percentage had not changed feed restriction. Also, the same were discovered by (Bortoluzzi et al., 2013 ; Chiemela Peter et al.,2015). The depression in carcass yield with limited feed intake due to limiting feed amount and usage the energy intake from feed for maintenance, with little energy left for growth (Massuquetto et al., 2019). Similar results of the present findings were obtained by (Younis et al., 2016; David and Subalini , 2015).

The effects of feed restrictions on the gastrointestinal tract characteristics of broiler chickens are reported by Davoodi-Omam et al., (2019) they found that restricted feed intake groups had significantly reduced relative weights duodenum, ileum ,colon and cecum lengths in comparison with the control feed intake. The reduction in gastrointestinal tract's lengths may be lead to the rapid growth in the starter period than the rest of the body and an alteration of gut development (Duarte et al. ,2014).

4- Blood measurements:

4-1- Serum biochemistry and lipid profile

Data presented in Table 6 showed that total protein (TP), albumin (ALb), globulin (Glob), albumin/globulin (Alb/Glob), glucose, triglycerides(TG) and serum high density lipoprotein (HDL) serum low density lipoprotein (LDL) were significantly affected by feed restriction except of total cholesterol(TCho).

Broilers the group 3 had significant ($P \leq 0.05$) effect and the highest values of TP, Glob, and (HDL) than others groups. While, birds in the group 2 had significantly ($P \leq 0.05$) the lowest ALb, than others groups. Birds in the group 4 had significantly ($P \leq 0.05$) the highest ALb/Glob than others groups. However, Birds in the group 2 had significantly ($P \leq 0.05$) the highest Glucose than others groups. Birds in the groups 2 and 3 had significantly ($P \leq 0.05$) the highest (LDL) than others groups. However the lowest triglyceride value was recorded to birds in the group 3.The reduction in triglycerides value in group 3 may be attributed to that triglycerides concentrations in blood mediates with the reabsorption of lipids and cholesterol by absorbing bile acid and consequently bother lipid metabolism (Wang et al., 2017) or it might be due to the force use of substantial levels of triglycerides for energy response during feed restriction (Demir et al., 2004). The higher level of glucose in restricted-fed broiler serum (group 2) may be due to better feed conversion and nutrient digestion and absorption or may be due to low level of glucose value during fasting is prevented by glucose synthesis via gluconeogenesis (Boostani et al., ,2010). Also, Riesenfeld et al., (1982) proved that production of lactate occurs in intestine lumen from glucose before being transferred to the circulation.

Our results are agreement with Younis et al., (2016) and Boostani et al., (2010) as they decided that feeding restriction system modifies the biochemistry birds serum in trend of increased serum proteins, albumin and globulin . On the contrary, Xu et al., (2017) reported that feed restriction had no differences in plasma total protein, albumin or globulin of broilers. However, Afsharmanesh et al. (2016) found that blood levels of HDL, LDL and triglycerides of broilers were not influenced by feed restriction at a level of 50% from day 6 to day 12. Also, Zahir and Anwarul, (2019) showed that no significant difference was observed in serum cholesterol level between the feed restricted treatments and control group. Tůmová et al.,(2019), found that triglycerides and total cholesterol were numerically greater in chickens with limited feed , which led to a higher fat accumulation. Unlike wise, Zahir and Anwarul,(2019) found that the blood glucose level was found to be highest (207 mg/dl/bird) in control group and lowest (158 mg/dl/bird) in broilers with 13% FR.

4-2 liver enzymes and kidney functions

The activities of alanine aminotransferases (ALT), aspartate aminotransferases (AST), gamma glutamyl transferase (GGT), alkaline phosphatase (ALP), ALT\ AST ratio, lactate dehydrogenase (LDH) , creatinine and uric acid are presented in Table 7.

Data presented in Table 7 showed that ALT, LDH, GGT,ALP, Creatinine and uric acid were no significantly affected by feed restriction except of AST and ALT\AST ratio. Broilers in the group 4 had significantly ($P \leq 0.05$) the lowest AST than others groups. While, birds in the group 4 had significantly ($P \leq 0.05$) the highest ALT\AST ratio than others groups.

In agreement with our results, Kumar et al. (2015) and Sherif and Mansour (2019) reported that feed regimen had no negative effect on activity of liver enzymes (AST and ALT) of broiler chicks. Similar results were obtained by Rajman et al., (2006) as they determined that activities of Creatinine and AST values were higher in full fed chickens than restricted feed chickens. Also, Jahanpour et al., (2013) concluded that feeding restriction decreased the level of serum uric acid .Nassef et al., (2015) found that, broilers subjected to feed restriction by 20% from 7 to 21 days had insignificantly differences in ALT and AST. Davoodi-Oman et al., (2019) concluded that feed restrictions did not influence the blood uric acid of broiler chickens.

4-3 Thyroid and adrenal hormones

Data presented in Table 8 showed that T3, T4, T3/T4 , ACTH and CORT were no significantly affected by feed restriction . Birds in the group **1**(control) had the high values of T3,T4 and CORT than others groups.

Our findings are in agreement with Attia et al., (2017) who revealed that the effect of feed restriction on plasma T3, T4, T3/T4, and cortisone was not significant. Also, Lanhui et al., (2011) concluded that low concentration of T3 and high concentration of T4 had found in restricted-feed broilers. In addition, feed restriction decreased broiler plasma levels of both T3 and T4 at 35 day of age (Ghazanfari et al., 2010), but plasma T4 increased at 21 d of age (Rezaei and Hajati , 2010).On the contrary of our finding, Sherif and Mansour(2019) found that the high levels of corticosterone were recorded with the high levels of feed restriction percent (30, 35 and 40% from free feeding) comparing to their control. Differences in corticosterone concentration in broiler plasma may be depend on regulation of blood glucose levels (Hockhing et al., 1996; De Jong et al., 2002 ;Mench, 2002), or could be attributed to growth of chickens, duration and intensity of feed restriction (Attia et al.,2017).

Fuller, (1981) in review cleared that increased secretion of ACTH and corticosteroids as a result of using serotonin precursors, releasers, inhibitors, or receptor to acute stimulation of the serotonergic system. The decrease seen in CORT value in restricted feed broilers might be due to the activation effect that high corticosteroids causing metabolism in liver , thus decreasing brain serotonin (Green and Curzon, 1968; Curzon, 1971) and the resultant serotonin exhaustion could in turn result in a decrease in the corticosterone secretion induced by feed restriction (Mech, 1991).

5- Economic return:

The effect of different levels of feed restriction, liveability, mortality, feed costs, net revenue, broiler farm economic index, economic efficiency and relative economic efficiency of broiler chicks are presented in Table 9. The feed cost decreased as percent when FR was increased. When the feed restriction was occurred the amount of feed per bird was also reduced so the crucial feed cost was lower automatically, also higher value of FCR group is better for maximum profit in poultry production industry. These can be evaluated using the values of FCR and live weight gain by birds. Therefore, FR may be beneficial to farmers as they may get optimum profit from the reduction of FC through FR. Regarding mortality, the lowest mortality percentage was recorded to restricted feed broilers in group 2 (3.33%) compared with other broilers in different restricted or *ad libitum feed*. This finding is in agreement with Omosebi et al., (2014), Butzen (2012), Mohsen et al. (2016), Al-Aqil et al. (2009), and Wijtten et al., (2010) who reported a reduction in mortality rate following feed restriction. On the other hand, broiler in group 3 showed the highest mortality (10.00%) compared to other groups. However, mortality was the same (6.66%) in control group and 4 treatment.

Supporting the suggestion that limiting feed intake programs diminish metabolic and skeletal problems that can lead to the death of chicks (Rosa et al., 2000; Arce et al., 1992; Robinson et al., 1992) and that the measured feed supply evades overload of the gastrointestinal tract and this allows better utilization of nutrients and avoids mortality due to sudden death (Bhatt and Banday 2000).

Abdel-Hafeez et al. (2016) obtained a mortality rate was less in control chicks compared with restricted feeding chicks. In the present study, BFEI had the highest value for control group (3.66) followed by restricted broiler in group 4 (3.57) then equal for group 2 and 3 (3.41). Performance of broiler chicks in group 4 granted the greatest values of EE and REE compared to others groups via saving money and reducing feed waste and production costs.

Those results are disagreement with those reports by Makinde (2012) who reported that the highest revenue and the highest value of economic efficiency resultant from *ad-libitum* fed broilers because they had the highest final live body weights, followed by birds restricted for 7 days and then for 14 days. These results suggest that the lengths of starvation period of feed restriction can reduce production cost in broilers without extremely affecting growth performance parameters or economics of production depending on the restriction program practical like as Azouz et al., finding's in (2019).

CONCLUSION

We concluded that feed restriction by starvation for (9 Hrs\day) of broiler chicks could improve feed conversion ratio at whole experimental period, digestibility of crude fiber, economic efficiency and relative economic effeciency compared with full-feed broiler chicks. In generally, these results showed that the lengths period or timing of feed restriction via starvation method reduced production cost and improved economics of broilers chicks without extremely affecting negatively growth performance, digestibility, or blood biochemical parameters.

Table (1): The laboratory proximate analysis of the commercial basal diet:

Diet	Nutri-ents						
	CP%	**DM %**	**CF%**	**Ash%**	**OM %**	**EE %**	**NFE %**
Starter diet (1-21) days	22.89	89.05	3.48	5.63	83.42	4.72	63.28
Grower diet (22-42) days	20.75	92.64	4.17	7.02	84.82	7.09	60.97

Table (2): Averages of ambient temperature, relative humidity and THI during experimental periods:

Parameters	Periods (days)					
	1-7	**8-14**	**15-21**	**22-28**	**29- 35**	**36-42**
Ambient temperature, C°	35±0.5	32±0.5	30±0.5	28±1.0	27±0.5	25±0.5
Relative Humidity (RH), %	60±5.0	61±2.0	59±2.8	62±1.0	62±1.8	63±1.9
THI*	32.45	29.90	27.97	26.38	25.45	23.83

* $THI = T - (0.31 - 0.31\ RH)(T - 14.4)$ calculated according to Marai et al. (2001).

Table (3): Effect of different treatments on productive performance of broiler chicks:

	Treatments					
Items	**1**	**2**	**3**	**4**	**SE**	**P-value**
LW,g 1 day	46.43	48.11	47.17	46.28	0.99	0.572
21 days	854.02^{a}	814.58^{ab}	777.16^{b}	798.76^{ab}	16.87	0.062
42 days	2697.66^{a}	2528.42^{c}	2610.91^{b}	2608.52^{b}	21.78	0.004
FC,g(1-21) days	1282.43^{a}	1204.21^{b}	1217.54^{ab}	1217.08^{ab}	20.48	0.097
(22-42) days	3062.59	3040.22	2980.49	2921.44	61.37	0.414
(1-42) days	4348.02	4244.43	4198.03	4138.50	74.65	0.310
WG,g(1-21) days	807.59^{a}	767.00^{ab}	730.48^{b}	748.05^{b}	15.88	0.043
(22-42) days	1843.64^{a}	1713.84^{b}	1833.76^{a}	1808.09^{a}	27.70	0.038
(1-42) days	2651.23^{a}	2480.84^{c}	2564.24^{b}	2556.14^{b}	21.66	0.004
FCR (1-21)days	1.59	1.57	1.67	1.63	0.057	0.638
(22-42) days	1.66^{b}	1.78^{a}	1.62^{b}	1.62^{b}	0.035	0.045
(1-42) days	1.64	1.71	1.63	1.62	0.033	0.304

^{a,b,c} – means with different letters in the same row are significantly different at (P<0.05).
SE, standard error of the mean. LW= live weight FC= feed consumption WG=weight gain FCR= feed conversion ratio

Table (4): Effect of different treatments on digestibility of nutrients:

	Treatments					
Items	**1**	**2**	**3**	**4**	**SE**	**P-value**
DM %	76.19^{ab}	77.35^{a}	74.65^{bc}	73.04^{c}	0.694	0.011
OM %	77.33^{ab}	78.13^{a}	75.70^{bc}	73.88^{c}	0.652	0.007
CP %	86.69^{a}	86.90^{a}	87.32^{a}	85.39^{b}	0.222	0.001
CF %	37.56^{ab}	34.08^{b}	37.01^{ab}	42.04^{a}	1.882	0.092
EE %	84.36^{c}	87.68^{a}	85.47^{b}	86.51^{b}	0.325	0.0005
NFE %	75.84^{b}	77.67^{a}	75.18^{b}	72.20^{c}	0.428	0.0001

^{a,b,c} – means with different letters in the same row are significantly different at (P<0.05). SE, standard error of the mean DM =dry matter OM =organic matter CP= crude protein CF = crude fiber EE = ether extract NFE= nitrogen free extract

Table (5): Effect of different treatments on carcass dressing and inner organs (weight\ gm) and digestive tract lengths (cm):

			Treatments			
Items	**1**	**2**	**3**	**4**	**SE**	**P-value**
LBW (gm)	2413.54	2270.37	2454.49	2289.46	165.33	0.833
CW (gm)	1929.62	1879.01	2036.54	1884.28	159.46	0.886
Dress. %	79.80	82.64	83.09	82.19	1.492	0.473
Liv. W (gm)	43.69	40.63	45.06	46.94	3.498	0.645
Gizz. W (gm)	32.69	37.34	31.02	34.13	3.177	0.571
Heart W (gm)	12.03	11.56	11.37	9.43	1.191	0.473
Ab. Fat W (gm)	19.06	17.70	21.90	22.10	3.942	0.823
Gib. W (gm)	107.47	107.03	109.35	112.61	7.786	0.954
Gib%	5.67	5.81	5.35	6.05	0.567	0.851
Duod. L.(cm)	34.67	34.67	30.70	31.66	1.394	0.167
Jej. + ile. L.(cm)	151.33	148.30	147.80	145.00	7.021	0.935
Ceca L. (cm)	18.00	18.33	17.10	17.67	0.942	0.780
Large intes. L.(cm)	8.00	7.00	7.33	6.70	0.849	0.725

^{a,b,c} – means with different letters in the same row are significantly different at (P<0.05). SE, standard error of the mean LBW=live body weight, CW= carcass weight, Dress.=dressing%, Liv. W= liver weight, Gizz. W=gizzard weight, Ab. Fat= abdominal fat, Gib.W= giblets weight, Duod. =duodenal, Jej.+Ile.=jejenum+ileum , Large intes= large intestine

Table (6): Effect of different treatments on serum biochemistry and lipid profile:

			Treatments			
Items	**1**	**2**	**3**	**4**	**SE**	**P-value**
TP mg\dl	5.27^{b}	5.57^{b}	7.17^{a}	5.73^{b}	0.303	0.009
Alb. mg\dl	1.72^{ab}	1.27^{b}	2.36^{a}	2.47^{a}	0.263	0.038
Glob. mg\dl	3.38^{b}	3.99^{ab}	4.81^{a}	3.27^{b}	0.388	0.077
Alb.\glob.	0.57^{ab}	0.33^{ab}	0.50^{b}	0.81^{a}	0.127	0.133
Glucose mg\dl	195.66^{ab}	245.67^{a}	186.00^{b}	209.70^{ab}	16.90	0.144
T. chol. mg\dl	221.66	256.70	277.67	220.00	17.28	0.121
TG mg\dl	93.67^{a}	94.00^{a}	71.33^{c}	84.00^{b}	2.40	0.0005
HDL mg\dl	158.33^{b}	133.00^{c}	197.00^{a}	178.78^{ab}	7.58	0.001
LDL mg\dl	74.60^{ab}	104.87^{a}	90.47^{a}	26.20^{b}	15.39	0.031

^{a,b,c} – means with different letters in the same row are significantly different at (P<0.05). SE, standard error of the mean. TP=total protein, Alb. =albumin, Glob. =globulin, Alb\Glob= albumin\gloulin ratio, T.chol=total cholesterol, TG= triglycerides, HDL= high density lipoprotein, LDL= low density lipoprotein

Table (7): Effect of different treatments on liver enzymes and kidney functions:

			Treatments			
Items	**1**	**2**	**3**	**4**	**SE**	**P-value**
ALT (U\L)	23.33	20.00	20.70	25.00	2.98	0.626
AST (U\L)	25.00[a]	23.00[ab]	23.10[ab]	19.67[b]	1.13	0.057
ALT\ AST	0.93[b]	0.87[b]	1.01[ab]	1.28[a]	0.087	0.041
LDH (U\L)	191.33	217.67	232.00	187.33	17.39	0.284
GGT (U\L)	37.00	35.00	41.00	50.00	9.03	0.660
ALP (U\L)	65.00	53.33	68.33	74.67	9.65	0.500
Creatinine (mg\dl)	0.64	0.45	0.53	0.49	0.084	0.457
Uric acid (mg\dl)	5.20	5.17	5.63	4.43	0.809	0.773

[a,b,c] – means with different letters in the same row are significantly different at (P<0.05). SE, standard error of the mean. ALT= alanine aminotransferases, AST= aspartate aminotransferases, LDH= lactate dehydrogenase (LDH), GGT= gamma glutamyl transferase , ALP= alkaline phosphatase

Table (8): Effect of different treatments on thyroid and adrenal hormones:

			Treatments			
Items	**1**	**2**	**3**	**4**	**SE**	**P-value**
T3 (ng\dl)	183.33	178.34	139.40	180.00	12.99	0.847
T4 (µg\dl)	3.00	2.91	2.95	2.91	0.337	0.996
T3\T4	61.90	64.47	47.96	66.05	13.12	0.758
ACTH (U\L)	29.00	30.67	29.70	28.33	4.04	0.979
CORT (µg\dl)	17.89	9.13	11.58	12.63	2.66	0.236

[a,b,c] – means with different letters in the same row are significantly different at (P<0.05). SE, standard error of the mean

Table (9): Effect of different treatments on mortality, broiler farm economic index, economic efficiency and relative EE of broiler chicks:

	Treatments			
Items	**1**	**2**	**3**	**4**
LW (kg)	2.70	2.53	2.61	2.61
FCR	1.64	1.71	1.64	1.62
F consumption (S)	1.282	1.204	1.217	1.217
F consumption (G)	3.062	3.040	2.980	2.921
TFC	32.04	31.28	30.95	30.52
TR(LW×price\kg)	81.00	75.90	78.30	78.30
NR(TR-TFC)	48.96	44.00	47.35	47.80
Number of dead chicks\group	2.00	1.00	3.00	2.00
Mortality %	6.66	3.33	10.00	6.66
Livability %	93.34	96.67	90.00	93.34
BFEI	3.66	3.41	3.41	3.57
EE(NR\TFC)	1.52	1.41	1.53	1.57
REE	100.00	92.76	100.66	103.28

LW= live weight (kg), FCR= feed conversion ratio, FC(S)= feed consumption during starting period, FC(G)= feed consumption during growing period, TFC=total feed cost, TR=total revenue, NR= net revenue, BFEI= broiler farm economic index , EE=economic efficiency, REE=relative economic efficiency. Price of (FI-S)=7.80LE\ kg, Price of (FI-G)=7.20LE\kg, price of LBW=30.00LE\kg.

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الملخص العربي

استجابة بدارى التسمين لطول فترات التجويع وتأثيره على الاداء الانتاجى، معاملات الهضم، محصول الذبيحة ، مكونات الدم والكفاءة الاقتصادية

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تهدف هذه التجربة لدراسة تأثير التحديد الغذائي عن طريق التصويم على كل من النمو، قياسات الذبيحة، معاملات هضم العناصر الغذائية، بعض قياسات الدم وكذلك حساب الكفاءة الاقتصلدية لدجاج التسمين. تم استخدام 120 كتكوت اربورايكرز غير مجنس عمر يوم ، وتم تقسيمهم الى اربعة مجموعات كل مجموعة تضم ثلاثة مكررات (كل مكررة 10 كتاكيت). المجموعة الاولى تم تغذيتها على عليقة تجارية لحد الشبع (مجموعة الكنترول) وتم تحديد الغذاء لكل من المجموعات الثلاثة الباقية كالتالى: المجموعة الثانية: تم تصويم الطيور لمدة 3 ساعات/اليوم، المجموعة الثالثة: تم تصويم الطيور لمدة 6 ساعات/اليوم ، المجموعة الرابعة: تم تصويم الطيور لمدة 9 ساعات/اليوم مع تقديم ماء الشرب باستمرار (حتى عمر 42 يوم). تم أخذ قياسات التجربة فى نهاية فترة البادئ ونهاية فترة النامى. اوضحت النتائج المتحصل عليها ان دجاج التسمين المغذى لحد الشبع (مجموعة الكنترول) اعطت اعلى وزن للجسم الحى، بينما المجموعة الثانية (تصويم لمدة 3 ساعات/اليوم) اعطت اعلى نسبة للحيوية واقل نسبة نفوق للطيور، بينما اوضحت المجموعة الثالثة (تصويم لمدة 6 ساعات/اليوم) ارتفاع بروتين الدم انخفاض الدهون الثلاثية ، وزيادة وزن الذبيحة، و نسبة التصافى،اما المجموعة الرابعة (تصويم لمدة 9 ساعات/ اليوم) اعطى افضل معامل تحويل غذائى واعلى كفاءة اقتصادية فى نهاية فترة التجربة (1-42 يوم). فى العموم: أوضحت هذه الدراسة عدم وجود اى تأثير سلبى للتحديد الغذائى بفتراته الثلاثة (3، 6 او 9 ساعات/اليوم) على قياسات النمو ، محصول الذبيحة ، قياسات الدم او معاملات الهضم لذلك أوصت الدراسة ان تطبيق برامج التحديد الغذائى (بفترة الصيام لمدة 9 ساعات/اليوم) لدجاج التسمين أدت الى تقليل تكاليف الغذاء وارتفاع نسبة العائد الاقتصادى للمربي.