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Feed Restriction in Broiler Chickens Production: A Review

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Abstract: The feed restriction programs is on of the main techniques in growth curve manipulation for increasing production efficiency in broiler chicken. Quantities and qualitative feed restriction are procedures that can be used to manipulate the feeding strategies of poultry in order to decrease growth and metabolic rate to some extent and so alleviate the incidence of some metabolic diseases such as ascites, lameness, mortality and sudden death syndrome and so improving feed conversion and reducing feed cost. Also to produce a leaner bird and reduce the unfavorable effects of fat on human health and to reduce fat deposition in broiler carcasses using of feed restriction programs can be profitable in broiler chickens production. This article surveys new findings in feed restriction of broilers and evaluates the application of feed restriction methods to broiler chicken production.

Key words: Broiler Chicken · Feed Restriction · Compensatory Growth · Production Efficiency

INTRODUCTION

Growth performance of broiler chickens has been increased spectacularly over the last 30 years mainly due to the genetic progress, improvements of nutrition and controlled environment so that it takes only 33 days to reach finishing body weight of about 2 kg [1]. Unfortunately this growth rate is accompanied by increased body fat deposition, high mortality and high incidence of metabolic diseases and skeletal disorders [2]. These situations most commonly occur with broilers that consume feed *ad libitum* [3,4]. Thus feed restriction has been proposed to reduce these problems. Early feed restriction programs used to reduce abdominal and carcass fat in broiler chickens rely on the phenomenon called compensatory growth or catch up growth to produce market body weight similar to control groups, Compensatory growth or catch-up growth is defined as abnormally rapid growth relative to age. An enhanced rate of growth, exceeding the normal rate of gain, occurs when growth has been retarded by nutritional deprivation and followed by *ad libitum* feeding. This phenomenon has long been used as an effective methods to reduce growth rates and changing body composition of most animals [5], Also Wilson and Osbourn [6] said that compensatory growth as being the stage of rapid growth, rather than age, exhibited by mammals and birds after a period of nutritional deprivation. How over About 60-70 % of the expenditures involved in poultry production is feeding costs. As such ,the most reasonable phase in reducing the cost of broiler chicken production would be find possible methods, which are cheap, adequate and readily available for feeding livestock. One such method is restricting the amount of daily feed offer for sometime [7]. The main reason for controlling feed intake in broilers is to prevent wastage of feed. Furthermore, a competition between man and poultry for energy (cereal grains)has created a problem of shortage of these feed ingredients. The wastage of these feed sources through feeding the birds in *ad libitum* [8]. Also, high fat deposition in broiler chickens when feeding in extra of the broiler chickens requirements for maintenance and production is converted to the fat [9] does affect the carcass quality [2]. Excessive fat is one of the main problems faced by the broiler industry these days, since it not only reduces carcass yield and feed efficiency but also causes rejection of the meat by consumers [10] and causes difficulties in processing [5]. For overcome in these problems almost in many studies of feed restriction in broiler chickens have been impacted on feed efficiency and body fat deposition. Until very recently, feed restriction was thought to increase feed efficiency and reduce body fat deposition

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[11,12]. The use of this concept to address problems of high carcass fat requires more studies on the nutrition of the broiler chicken during the period of growth compensation.

Compensatory Growth: In general, compensatory growth is defined as the abnormally rapid growth relative to age within a breed of an animal after early growth retardation. The terms "catch-up growth" and "compensatory growth" are used in same concept. When is occurs catch up growth follows refeeding after a periods of under nutrition or recovery from illness. The mechanisms of this phenomena have been studied by a number of investigators [6]. Two hypotheses have been put forward to explain the mechanisms that govern compensatory growth, the central control hypothesis and the peripheral control hypothesis [2]. The central control hypothesis suggests that the body has a set point for body size appropriate for a particular age and that this control resides in the central nervous system [6]. Benschop [13] indicated that the key mechanisms in compensatory growth are decreased maintenance costs, increased feed intake, increased efficiency of growth and in some instances increased digesta load. The reduction in maintenance costs would then allow for comparatively more energy for growth upon realimentation, thus contributing to the compensatory growth responses [14]. Increased feed intake has been demonstrated by many researchers as the main mechanism that drives compensatory growth. Leeson and Zubair [15] reported that restricted-refed broiler chickens have shown higher feed intake relative to body weight when compared to the *ad libitum* control. Hence, higher feed intake as related to body weight and its associated digestive adaptations seem to be important contributing factors to any growth compensation. Birds with retarded growth due to undernutrition can achieve a growth rate higher than normal for chronological age after removal of the feed restriction [16]. Owing to the increased efficiency of protein deposition because of the concomitant water deposition that results in more gain per gram protein deposited than lipid deposited, higher rates of protein deposition during realimentation would have a significant impact on the overall growth rates [13]. Leeson and Zubair [15] showed that other adaptation observed by the restricted-refed broiler chickens is the relative enlargement of digestive organs, especially the gizzard, crop, pancreas and liver which enhance feed intake and help support compensatory growth. But , this finding is not supported by the findings of Susbilla *et al*. [17], who applied food restriction of 75% and 50% of *ad libitum* intake to broiler chickens from day 5 to 11 days of age and could not find any differences in proportional liver weight during the experiment.

Feed Restriction Definition: Feed restriction is method of feeding that is time, duration and amount of feed were limited, have an impact on whether a bird is capable of achieving the same body weight as unrestricted birds [18,19]. In general, feed restriction included of quantitative and qualitative restriction that is in quantitative to limiting the amount of feed daily given to the animals whereas a qualitative restriction is related to nutrient dilution in the diet [15].

Feed Restriction Methods: Quantitative and qualitative feed restriction are procedures that can be applied to manipulate the feeding strategies of poultry in order to decrease growth and metabolic rate to some extent and so alleviate the incidence of some metabolic diseases as well as improving feed conversion in broiler chickens. These methods include: physical feed restriction, limiting the level of consumption of feed in time (skip-a-day feeding) or reducing the time of illumination of feeding [20], diet dilution, chemical methods of feed restriction and use of low protein or low energy diets [2].

Physical Feed Restriction: This method is one of the common procedure was used in controlling feed intake in poultry. Physical feed restriction supply a calculated amount of feed per bird, which is often just enough to meet maintenance requirements [21]. But practical application of physical feed restriction is not simple due to the problems of regularly weighing birds and calculating feed consumption on a daily basis. Moreover, it is necessary to provide sufficient feeder space in order to prevent competition among restricted birds and to prevent unequal growth of birds within a flock. Also in this method should be attention to educate consuming of micronutrient , coccideoastat and etc. Physical feed restriction programs for broilers have been extensively studied [22,23]. Severity of feed restriction, length of restriction and age at marketing are the main factors to take into account in a feed restriction program for broilers. Quantitative feed restriction has been observed to reduce mortality and culling [9,19], improve feed conversion ratio [24,11] and allow a complete recovery of body weight if the degree of restriction was not too severe and slaughter ages were extended beyond 6 weeks [24,25]. Dozier *et al.* [26], referred to feed restriction programs of yielding inconsistent results in the literature and that variation maybe partially attributed to differences in bird management, lighting, strain and ventilation. Plavnik and Hurwitz [27] showed that full compensatory gain with males but not females after early feed restriction. From their findings, it can be concluded that with females feed restriction should be started from 5 to 7 days of age and the duration should not exceed 5 days to achieve complete recovery of final body weight and optimum feed efficiency. Although the level of early feed restriction is an important factor influencing the broiler chicken response, early feed restriction at 30% of ad libitum intake was not able to influence broiler chicken performance at market age of 49 days[28].

Skip-a-day Feeding: Skip-a-day deprivation of feed is a technique for restricting early growth and has not been extensively studied in broiler chickens [26]. But this programs providing limited allotments are commonly used in broiler breeder's growth restriction. Removing feed for 8-24 hour periods during the starter period reduces early rapid growth and meat yield in broiler chickens. Skip-a-day feed removal has been reported in other studies to decrease early growth and reduce the incident of ascites without affecting final body weight [29,18].Oyedeji and Atteh [30] reported reduction in feed intake after exposing the birds to fasting on every other day. Oyedeji and Atteh [30] showed that skip-a day feeding for 3 weeks starting at day-old would improve carcass quality and reduce sudden death syndrome which is often associated with birds that are on *ad libitum* feed intake.

Lighting Programs: Birds are very sensitive to light. Light allows the birds to establish rhythmcity and synchronize many essential functions, including body temperature and various metabolic steps that facilitate feeding and digestion [31]. Light intensity, color and the photoperiodic regime can affect the physical activity of broiler chickens [32]. In the common production methods, broiler chickens are raising under 23 h Light per day, because it is thought that under this light regimen feed intake is greater and therefore growth rate is suitable. Although lighting programs are not categorized in the literature as a feed restriction method it has been applied. It is known that by changing Lighting periods by either reducing the hours of light or developing intermittent schedules feed utilization is improved [33,34] incidence of leg abnormalities is also lowered by reducing the hours of Light per day [35] as is mortality and specifically sudden death syndrome. The so called step-don and step-up lighting programs [35] have attained popularity because of reduced incidence of leg abnormalities, sudden death syndrome and mortality while maintaining the same market weight for age. Broilers under different reduced lighting programs therefore, will reduce their feed intake and so this program can be included within the definition of feed restriction. However, broilers do learn to eat during darkness when hours of lighting are low [36]. Buyse *et al*. [37] studied the effect of intermittent (step-up and step-down programs) and continuous lighting on the performance of female broilers. Lower cumulative feed intake and significantly improved feed conversion was observed in chickens under an intermittent program (1L:3D from 8 to 49 days) compared with those under a continuous lighting schedule (23 .SL:OSD or 23L: ID). These results are in agreement with Buyse *et al*. [38], who showed improved feed conversion and compensatory growth in male broiler chickens at 41 days with a light schedule from day 7 of 1L:3D repeated six times daily. The use of lighting programs has the advantage of reducing electricity costs, the incidence of leg abnormalities and sudden death syndrome and of improving feed efficiency with no reduction of weight at market age. Genotype, sex, feeder space, diet composition and stocking density are the main aspects that can interact with the lighting program [37] and affect the broiler's final performance.

Diet Dilution: The most problems form of physical feed restriction is usually considered to be maintenance allowance, described by Plavnik and Hurwitz [21] at 1.5 kcal ME/g$BW^{0.67}$/d. But for very young birds, this means a very small quantity of feed is distributed daily and so this leads to the alternate concept of diet dilution. Therefore many investigators have used diet dilution as an alternative method of nutrient restriction because of the advantage of attaining a more consistent growth pattern within a flock. In this method diets are mixed with non-digestible ingredients such as fiber and so are of reduce nutrient density. Jones and Farrell [12] used 50 to 65% diet dilution with rice hulls in order to retard early growth. This technique appeared to be successful and even though these birds ate more feed, adjustment was insufficient to normalize nutrient intake and so growth rate was reduced. In many of these physical feed restriction or diet dilution studies, there are reports of reduced body fat deposition, although this effect seems variable. The most consistent feature of all these studies, regardless of method of implementation, is improved feed efficiency.

Griffiths *et al*. [39] lowered the energy of a broiler chicken diet to 2233 kcal ME/kg DM from 3087 kcal ME/kg DM of feed by substituting ground yellow corn with oat meal as the main ingredient. Chickens fed the low energy diet consumed significantly more feed than those fed the high energy diet. When fed the low energy diet from 0 to 3 weeks of age, the chicks were not significantly different in body weight or in abdominal fat pad development from the *ad libitum* birds at 4 weeks of age. Sahraei and Shariatmadari [8] was used of different levels of finisher diet diluted with sand and wheat bran (wt:wt) (in levels 7, 14, 21 or 28%) of Arian strain. showed that feed intake in different levels was more than control birds. But live weight (at 45 ages), body weight gain only in 28% levels were less than control birds. Cabel and Waldroup [40] observed that diluting the starter diet with sand from 5 to 11 days of age moderately restricted growth, which was completely recovered by 49 days of age.

Use of Low Protein or Low Energy Diets: For retardations of growth rate in broiler chickens can be used of diets with low energy and protein concentrations. This method has an advantage in that it does not need any additional labor of weighing the feed and is accomplished by lowering the level of either protein or energy. In normal conditions broilers are given 22%, 20% and 18% of crude protein in the starter, grower and finisher periods respectively and 3200 kcal ME kg diet [41]. When broilers are fed with low nutrient dense diets they will increase their feed intake in an attempt to maintain nutrient intake [42]. The study of Plavnik and Hurwitz [43] showed that broilers fed *ad libitum* with a 9.4% crude protein diet from 8 to 14 days markedly reduced their feed intake and weight gain by about 57% and 41% respectively. This reduction in feed intake may have been due to of a protein and amino acid deficiency, since other nutrients were at normal levels. But Rosebrough and McMurtry [44] showed the effect of 6 days of d i e t energy restriction in broiler chickens, the restriction period was from 6 to 12 days and was designed to only support the maintenance requirements for body weight. Body weight at 54 days was achieved for birds given feed *ad libitum* from day 13 to 54 and for those fed *ad libitum* from 21 days onward. Feed efficiency was not significantly different between restricted and unrestricted birds. Leeson *et al*. [42] utilized finisher diets varying in energy level from 2700 to 3300 kcal ME kg and showed no significant difference in body weight at 49 days. There was increased feed intake by birds fed the lower energy level diets, Leeson *et al*. [42] reported that diluting commercial broiler chicken diets from 35 to 49 days of age with oat hulls and sand, which led to the diets deficient in energy content, caused a significant reduction in body weight at 42 days of age, although the growth was compensated thereafter. Birds seemed to maintain energy intake, therefore there was increased feed intake with energy deficient diet. Coon *et al*. [45] comparing the performance of male and female broiler chickens fed low or high energy rations for 56 days, found a significant improvement in the feed conversion ratio using a diet with high energy level.

Feed Textures: Feed forms such as pellet, crumble, mash and particle size also influences broiler growth and development [46,47]. Broilers fed crumble-pellet diets show improved weight gain, feed intake and feed conversion ratio compared to birds fed mash [48]. Also, the consume of mash feed at different phases of the broiler's growth may be employed as a method of limiting feed intake. Birds offered mash spend more time consuming their feed compare to birds fed pellets [49] and therefore, expend more energy in this process. Andrews [50] suggested that the improvement in growth rate due to eating pellets is related to some extent to the increase in bulk density of pullets which in some situations increases nutrient intake, which increases nutrient intake in some situations. Nir *et al.* [51] fed male and female broilers to 49 days with mash or crumble diets during the starter and grower periods and mash or pellets for the finisher period. Males showed a significant increase in body weight and improved feed conversion when fed pelleted compared to mash diets. On the other hand, the improvement in performance was not evident for females, which showed no significant difference either in body weight or feed conversion ratio at 49 days of age. Mortality was higher in birds fed pelleted diets. These results are in agreement with those of Jones *et al*. [47] and Hamilton and Proudfoot [52] where an improved weight gain and feed conversion at 6 weeks of age were obtained in birds fed pelleted compared to mash diets. The improvement in broiler performance with pelleted diets may be attributable to a greater digestibility of carbohydrates together with increased daily nutrient intake [52], better nutrient availability [51] and or less feed wastage [48,49]. Because chicks fed pelleted diets spend less time and energy feeding, they were less active than mash-fed birds [51] and so spend less energy for maintenance.

Chemical Methods: The other method that has been used to reduce feed intake in broilers is the use of chemicals or pharmacological agents. It has an advantage of equally distributing the feed among flock and so decreasing the variations in growth than can take place with physical feed restriction. Restriction of feed intake of broiler chickens by chemical methods was suggested by Fancher and Jensen [53]. Also Pînchasov and Jensen [54] used 1.5 or 3% glycolic acid as an anorectic agent fiom 7 to 14 days in order to suppress the feed intake of chicks. Feed intake was severely reduced, resulting in 22% and 50% weight reduction with 1.5% or 3.0% glycolic acid inclusion respectively. Oyawoye and Krueger[55] showed that 400 and 300 mg of phenylpropanolamine hydrochloride or monensin sodium per kg of diet, respectively, significantly decreased body weight of the broiler chickens at 4 weeks of age. Pinchasov and Elmaliah [56] used of 1 or 3% of acetic and propionic acids in the diet and found that weight gains of chemically restricted birds were close to those obtaining under a recommended program of quantitative feed restriction for female broiler breeders between 2 to 6 weeks of age. Savory *et al*. [57] used of 50g/kg of calcium propionate as an appetite suppressor and showed that weight gains of chemically restricted birds were close to those obtaining under a recommended program of quantitative feed restriction for female broiler breeders between 2 to 6 weeks of age.

Effect of Feed Restriction on Performance Parameters and Carcass Traits: The use of total feed restriction at an early age to elicit compensatory growth, improved feed efficiency and reduced abdominal fat pad has received considerable attention. Zubair and Leeson [58] suggested that physical feed restriction at early age of birds for a short period stimulated compensatory growth so that at the market age feed restricted birds performed similarly to those of the full fed groups. Novele *et al.* [7] also reported that early period 75% *ad libitum* restriction feeding gave an economic advantage over *ad libitum* feeding mainly by enhancing feed utilization and able to attain. But feed restriction can exert negative effects on the body weight at marketing age [54] and on the relative weight of breast muscle [46]. Plavnik and Hurwitz [21] used a severe feed restriction program at 6 to 7 days of age for a one-week period in birds and indicated the birds were much reduced in weight by two weeks of age, as compared to the control birds, but they body weights in market age were equal, feed efficiency was improved. Wilson and Osbourn [6] showed compensatory growth in poultry, following a period of growth retardation by early feed restriction. weight compensation by 42 days of age. Plavnik and Hurwitz [16,43], McMurtry *et al*. [5] and Pinchasov and Jensen [54] reported that birds subjected to feed restriction compensated for BW upon resumption of *ad libitum* feeding. On the other hand,Yu *et al.* [59] and Fattori *et al*. [60] indicated the ineffectiveness of feed restriction in chickens. Yu *et al.* [59], in an experiment conducted on chicks in which restriction started after 1wk of age and through d 14, reported that after refeeding *ad libitum*, no compensatory growth was observed. Other researchers [6,61] observed that even though feed-restricted birds had lower fat content in their carcass, they showed similar feed efficiency as those birds fed *ad libitum*. Many contradictory results concerning body fat deposition are also seen in the literature. Feed restricted birds have been shown to have lower carcass fat content at market age than birds fed *ad libitum* [62,63]. However, in recent reports Fontana *et al*. [9] and Scheideler and Baughman [23] observed no effect of feed restriction regimens on carcass fat content. Sizemore and Siegel [64] tested the effects of early energy restriction, while keeping protein and other nutrients constant, on different female broiler crosses. According to study of Zubair and Leeson [2], most weight loss during early feed restriction in birds can be normally compensated by 20 to 25 d of the refeeding period. Zorrila *et al.* [65], observed a linear increase in body weight gain when diet energy levels were increased. On the other hand, a linear decrease in carcass weight and breast meat yield was observed with birds fed both protein and energy deficient diets. These results suggested that birds can grow quite well on low energy diet but a period of 7 days is necessary to adjust their feed intake [42]. In contrast, Plavnick and Hurwitz [43] reported that broiler chickens fed low crude protein diets gained the least body weight and did not recover the body weight as measured at 56 days of age. Onbasilar *et al*. [66] observed that 4 h daily feed removal had no significant effects on body weight, feed intake, feed efficiency and carcass characteristics. The study of Fanooci and Torki [67] 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. It was concluded that dietary inclusion of wood caracole up to 10% to restrict broiler diets would not have deleterious effect on performance of broiler chicks with no adverse effect on abdominal fat and visceral and carcass measurements. Improved meat quality attracts more and more attention from consumers and excessive fat deposition is one of the important factors of poor meat quality of broilers. Some studies have shown that feed restriction could decrease fat content and increase protein deposition in carcasses, thus resulting in the improved carcass composition [12,68]. However, a lot of research has failed to reduce fat with feed restriction [2,69]. Variability in response to a period of undernutrition likely relates to the vast range of techniques used to impose growth regulation. Wilson and Osbourn [6] conclude that compensatory growth following undernutrition was influenced by duration, timing and severity of undernutrition, together with realimenation nutrition.

Effect of Feed Restriction on Metabolic Diseases: Early fast growth in modern broilers is associated with increased stress on the birds and can result in metabolic diseases and skeletal disorders that lead to economic losses due to reduced animal performance, high mortality rates and carcass condemnation at slaughter houses [70]. The benefits of early feed restriction are the monetary savings obtained by improved feed conversion, reduced sudden death syndrome [71], reduced death losses, ascites [29] and reduced skeletal disease [72].

Ascites: The growth rate or body weight gain in broilers has been shown to positively correlate with incidence of ascites. Broilers genetically selected for fast muscle growth seem more susceptible to ascites compared with slow-growing strains. Manipulation of the early growth cycle of broilers, with a subsequent compensatory gain, seems a practical and viable method to minimize losses caused by ascites. In this context, various feed restriction programs have been tested. Acar *et al.* [73] studied the effect of early age feed restriction on the subsequent growth and the incidence of ascites in broilers. A feed restriction regimen was used from either 4-11 (feed restriction) or 7-14 (feed restriction) days of age, consisting of limiting daily intake of the birds to 75% of the ME required for normal growth. It was concluded that although ascites mortality could be significantly reduced in early feed-restricted birds, there was a decrease in body weight and breast meat yield in restricted vs. full-fed birds increases in the incidence of ascites in broiler chickens coincide with continuing genetic and nutritional improvements in enhanced feed efficiency and rate of growth. Ascites is a condition in which the body cavity accumulates serous fluid, leading to carcass condemnation or death. It is a consequence of cardiopulmonary insufficiency in rapidly growing broiler chickens [74]. Changes in feeding and lighting regimens can cause growth restriction [75,76]. The hypoxemia related to a high metabolic rate in broilers can be partially prevented by limiting the intake energy via feed restriction [77].

Sudden Death Syndrome (SDS): The important diseases that in feed restriction researches had been interested, is SDS, this problems is own of the costly factors in broiler chickens production industry. This syndrome mostly is take placed in heavier birds in the flock. Sudden death syndrome (SDS) has been recognized for over 30 years and is also referred to as acute death syndrome or "flip-overs". It is most common in males when their growth rate is maximized. Mortality may start as early as 3 to 4 days, but most often peaks at around 3 to 4 weeks of age, with affected birds being found dead on their back. Mortality may be found at 1.5 to 2.0% in mixed-sex flocks and as high as 4% in male flocks only [78]. Poultry nutritionist suggested that the high growth rate in modern broiler chicks is the main reason for this problems. In the experiments of Bowes *et al.* [79] by feed restriction about 25 % of *ad libitum* feed intake showed that SDS occurrence in feed restriction groups 0 % and in *ad libitum* feed intake groups 3.33 %. But in some experiments no significant difference were observed between control and feed restriction groups [24,23]. The reduction in BW for the high-density group was attributed to an increase in metabolic stress, because there was an increase in mortality (SDS and ascites) in broilers fed the high-density ration in contrast to those fed the low-density ration [80].

Leg Disorders: In growing birds of meat-type strains, which have been selected over the past 50 years for fast growth, the most common skeletal defects occur in leg bones and joints. It has been generally assumed that rapid weight gain has been a major cause of TD. Despite evidence that there is no genetic correlation between TD and body weight [81], nutritional evidence suggests that dietary regimens that depress growth rate decrease the incidence of TD [82]. The retardation in growth rate can be achieved by either qualitative or quantitative food restriction [83]. Robinson *et al*. [72] demonstrated that severe feed restriction in the second week of growth significantly reduced the incidence of skeletal disease in broiler chickens. These researchers reported that in three separate experiments, the incidence of skeletal disease was three-fold higher in full-fed birds compared to birds that were feed restricted. A reduction in the incidence of leg disorders and sudden death syndrome was also observed in broiler chickens exposed to intermittent light or a step-up lighting regimen [84,85]. One strategy to reduce leg weakness includes manipulating the rate of growth. Altering dietary energy and protein levels, implementing early feed restriction and offering various feed forms have all been strategies previously used to manipulate the growth rate in broilers. The use of low-density rations has been shown to significantly reduce the early growth rate of broiler chickens; however, Scott [80] found that broilers fed a low-density ration were heavier than those fed a high-density ration at 35 d of age. Regulating broiler lighting programs is also a management factor that can be manipulated to lessen the occurrence of skeletal abnormalities. By increasing exposure to darkness, the growth rate of broiler chickens can be reduced. In conjunction with this reduced rate of growth, a corresponding decrease in the incidence of leg abnormalities and metabolic disorders has been reported [84]. In addition, Classen *et al*. [86] suggested that metabolic changes associated with darkness may benefit broiler skeletal quality.

CONCLUSIONS

In general, the potential of feed restriction programs as a managements tool, related to decreasing the incidence of metabolic disease, carcass fat deposition, reduce maintenance requirements and improvement of feed efficiency in broiler chickens production. Also can be lead to economical saving in cost of feeding in broiler chicken production, thus may be usefulness for commercial broiler chicks production farms.

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