Egypt. Poult. Sci. Vol. (41) (II): (369-392)(2021) (2105-1161)

Egyptian Poultry Science Journal

http://www.epsj.journals.ekb.eg/

ISSN: 1110-5623 (Print) – 2090-0570 (Online)

EFFECT OF ADDING CITRIC ACID (CA) TO CORN DISTILLERS DRIED GRAINS WITH SOLUBLES (DDGS) DIETS ON REPRODUCTIVE AND PRODUCTIVE PERFORMANCE OF RABBITS

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Received: 08/05/2021 Accepted: 06/06/2021

ABSTRACT: This study aimed to investigate and evaluate the effect of feeding two DDGs levels with or without citric acid on reproductive and productive performance of Black Baladi rabbits. The experiment used Fifteen mature female and fifteen males at seven and eight months' age with average live body weights (LBW) of 2900 ±100 g and 3300 ±100 g, respectively. Following, Forty-five produced growing bunnies with average LBW of 511±13 g at five weeks age lasted for six weeks growing period (5-11 weeks). All experimental rabbits were fed *ad libitum* on T1: Basal diet without DDGs and citric acid; CA (Control), T2: diet contained 40% DDGs, T3: diet contained 50% DDGs, T4: 40% DDGs and T5: 50% DDGs plus 1% CA each. Feeding DDGs diets with or without CA did not affect some reproductive traits of does and litter size at birth and weaning. While, litter weight significantly and live weight gain (non-significantly) improved with 40% DDGs plus CA at birth and weaning. Mortality rate significantly increased in DDGs groups during suckling period, but decreased with CA. Semen quality traits were improved with 40% DDGs plus CA. The LBW and daily weight gain (DWG) of growing rabbits improved with CA. Average daily feed intake/rabbit non-significantly increased and feed conversion ratio significantly improved with 40% DDGs with and without CA. The DDGs diets were of positive impact on rabbits blood parameters and slaughtering weights as well.

It conclusion, the use of DDGs in the diets of mature and growing rabbits up to 40% with adding CA is fruitful in reproductive and productive traits of rabbits.

Keywords: DDGs, reproductive traits, semen, growing, carcass, blood, rabbits.

INTRODUCTION

Rabbit production plays a major role in covering the protein gap in the developed countries where average daily consumption fall-down the recommended daily allowance of humans (Onyimonyi and Onu, 2009). Scientists in the developed countries always looking forward finding resources have no competition with human food to be used in animal feed industry in order to reduce the production costs. Within this frame, animal nutrition specialists used corn dried distillers' grains with soluble (DDGs) as feed ingredients (co-product) resulted from corn starch fermentation for ethanol extraction in animal feed ration formulation. The DDGs characterized by its contents of all the corn kernel non-starch nutrients, remaining after starch fermentation, which estimated three times more nutritional value than that found original in corn (Davis, 2001). Corn DDGs considered a good source of energy, protein, fat and available phosphorus, so with the new processing technologies advancement it becomes available for feeding different livestock (Noll *et al.*, 2007). Although, DDGs' nutrient composition (Swiatkiewicz and Koreleski, 2008) is of great variability due to grain composition, efficiency of fermentation for ethanol production and fermentation period, amount of soluble added back and drying procedures. Kim *et al.* (2008) found that corn DDGs contains considerable amount of arabinoxylan (anti-nutritional factor). Since the feeding process is the most expensive tool in animal production in such countries, scientists went to replace the expensive feed ingredients with low price good by-products, e.g. DDGs which proved to provide formulated diets with non-starch polysaccharides (NSP) than the parent materials and accordingly sufficient metabolizable energy (ME) for rabbit industry. The corn DDGs used generally as a partial replacement for yellow corn and soybean meal in the diets of different farm animals, since it can lower the production costs compared with conventional ingredients (Schauer *et al.*, 2005). Kleinschmit *et al.* (2007) studied the effect of DDGs from different sources with lactating dairy cow, up to 20% of the diet ingredients on dry matter basis, safely. Moreover, Koger *et al.* (2010) added DDGs at the rate of 20 and 40% in the finishing steer diet without adverse effects on carcass quality considering the oxidative rancidity exposure which may result from its high proportion of polyunsaturated fatty acids (PUSFAs). Although, Gaines *et al.* (2006) and Spencer *et al.* (2007) addressed that there were no negative effects of corn and sorghum DDGS inclusion up to 30% on growing performance . Other studies observed a reduction in the weanling pigs performance before day 21 post-weaning with DDGs inclusion in the diets (Burkey *et al.*, 2008 and Feoli *et al.*, 2008).

Moreover, DDGs have high potential to be included in formulating rabbits' diets because of its rich contents of digestible energy, protein, fat and soluble fiber (De Blas *et al.*, 2010) that give convenient growth performance when it used up to 20% in the diet (Youssef *et al.*, 2012; Alagón *et al.*, 2014 and Ysnagmy *et al.*, 2013). Gilbert (2013) concluded that DDGS may be of special interest raw material, that enrich the feed with energy and protein, for use in feeding rabbits whose high fiber content may be better received in rabbits than other mono-gastric animals due to the digestive particulars of rabbits. The DDGs can also be included in the fattening diets of rabbits up to 30% without adverse effect on performance indicators (Bernal-Barragn *et al.*, 2010; Liu, 2011 and Alagón *et al.,* 2014) and improved the economic efficiency (EE) of growing fattening rabbits (Youssef *et al.,* 2012). Thus, in Egypt, DDGS imports have grown in last decade from 81000 MT in 2010 to 158000 MT in 2019 (USDA, 2020). Several attempts have been made, recently, in Egypt to determine the optimal DDGs inclusion levels in the diets of rabbits Hussein and EL Desoky, (2011) and broilers (Dorra *et al.*, 2013) with or without enzymatic and/or organic acids addition to avoid the adverse effects which based mainly on the evaluation of production and economic efficiency of such feed ingredients.

Rostamzad *et al.* (2011) considered CA as a growth promoter, acidifier, bacterial inhibitor, antioxidant and antitoxin. Moreover, Chowdhury *et al.* (2009) reported that CA lowers the pH in the gut, thus reducing harmful microbiota and modifying the distribution of bacterial species. Also, Romero *et al.* (2011) reported that including formic and citric acids in growing rabbit diets improved weight gain in the period of 56-77 days, which had a trophic effect on the jejunal mucosa at 56 days and controlled the hypertrophy of gut-associated lymphoid tissues. Uddin *et al.* (2014) added CA at the rates of 0, 0.5, 1.0 and 1.5% to the concentrate feed mixture for rabbits and assumed that the CA up to 1.5% in the diet may have positive effect on growth performance of growing rabbits.

The objective of the present work was to test the inclusion levels of 40 and 50% DDGs with and without 1% CA effect on reproductive and productive performances, growth performance of bunnies, hematological and serum parameters as well as carcass characteristics and economic efficiency of mature female and male Black Baladi rabbits.

MATERIAL AND METHODS

This study was conducted at El-Serw Research Station, Animal and Poultry Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt. The present study included two experiments. In the first one; Fifteen mature female Black Baladi rabbits at seven months' age with average LBW of 2900 ±100 g and fifteen males Black Baladi rabbits at eight months' age with average live body weight of 3300 ±100 g were randomly assigned into five dietary experimental groups (each treatment used six rabbits; three females and three males). Mature doe rabbits were kept separately in well ventilated individual wired-cages (50 x 50 x 35 cm). Each cage has a stainless-steel nipple for water supply which offered with pelleted diets *ad libitum* according to the NRC (1977) requirements. Cages and nest boxes were cleaned and disinfected regularly before each kindling. Light in their houses was allowed for 12-14 hours/day. Every day morning urine and faces dropped on the floor from the cages were cleaned. The tested levels of DDGs inclusion in the diets build up on the previous work of Mohamed *et al.* (2013) and El-Abd (2017) who replaced, on the expense, yellow corn and/or soybean meal with DDG at the rate of 40, 50 and 100%, respectively.

Mature rabbits in the five experimental treatments were fed the following tested rations; T1: Basal diet without DDGs or CA; CA (Control), T2: diet contained 40% DDGs, T3: diet contained 50% DDGs, T4: diet contained 40% DDGs plus CA and T5: diet contained 50%

DDGs plus CA. Citric acid was added to the diets contained DDGs at the rate of 1%. The tested diets formulation and calculated chemical composition is presented in Table (1).

For mating purpose, each doe was transferred to the cage of assigned certain buck which receive the same treatment diet and returned back to her own cage after being mated. Does, generally, were palpated 10 days after mating to determine pregnancy. Litter were checked and date of birth, number of kits, stillbirth removed and weight of kits were recorded within the first 12 hours after kindling. Litter sizes (LS) were examined each morning during the suckling period for recording and removed the dead ones. Young rabbits were weaned at five weeks of age (35 day) and each 5 ones were transferred to the progeny wired-cage.

Reproductive and productive parameters of does:

Reproductive performance of each doe rabbit including number of services per conception (NSC), parturition interval (PI, days), LS, LW (g) and litter weaning weight (g) were studied.

During gestation and suckling periods, LS and LW were recorded at birth till 35 days of age. Mean bunny weight (MBW) was measured at birth and 35 days of age and thereafter daily weight gain (DWG) calculated for the whole period from birth till weaning (at 35 days of age). Mortality rate (MR) as one of the sensitive economical return of production parameters was also recorded from birth till 35 days. Live body weight (LBW), daily feed intake (DFI) and number of dead rabbits were recorded. Daily weight gain every week and feed conversion ratio (FCR) were determined.

Reproductive parameters of bucks:

Semen quality parameters were also estimated in samples from the three bucks in each dietary treatment (Table 1) collected by artificial vagina twice a week at the beginning, middle and end of the experimental period. The studied characters included ejaculate volume (ml), motility (%), abnormal sperm (%), live sperm (%), dead sperm (%), total mass (5/5) and sperms' concentration (x 10^6/ml) according to **Smith and Mayer (1955)**.

Growing performance:

The second part of the experiment, Forty-five growing Black Baladi rabbits separated from their dams after weaning at five weeks age with average LBW of 511±13 g (each treatment used nine rabbits in three replicates of three rabbits/growing cage) which randomly assigned to the five dietary treatment groups and lasted from five till eleven weeks of age. Growing rabbits of this experiment were offered the tested diets (Table 2) and the remained amounts of feed were recorded for feed intake (FI) determination. Both, LBW as well as DWG was recorded at 5, 8 and 11 weeks of age. Average DFI and FCR was also calculated.

Carcass characteristics, serum biochemical and hematological parameters:

At the end of the growing period (marketing age), three male rabbits were taken randomly from each treatment, fasted for 12 hrs, weighed and slaughtered to estimate some of carcass traits. Carcass parts were presented as a percent of LBW which included carcass, heart, liver, giblets, kidney and head. Dressing percentage was calculated using the following equation (Lukefar *et al.*, 1982):

Dressing (%) = (Carcass weight + Giblets weight)/LBW x 100

Where, giblets weight = Head weight + kidney weight + liver weight + heart weight

Three blood samples (3 ml each) from each treatment, at the end of growing period, were collected without anticoagulant and kept at room temperature. Then, the tubes were centrifuged at 3500 rpm for 20 minutes to separate clear serum (1.5 ml). The blood serum was used to determine serum total protein (TP), albumin (Alb), triglycerides (TG), total cholesterol (TC) and liver enzymes (AST & ALT) activities by using commercial kits. Another blood samples were taken in vial tubes containing EDTA as anticoagulant to determine some hematological traits which included RBC ($x10^6$), HCT (%), hemoglobin (Hb, g/dl), WBC ($x10^3$), Lymphocytes (L, %), Neutrophils (N, %), Monocytes (M, %) and Eosinophils (E, %) according to Moore *et al.* (2015).

Economic Efficiency:

For economic efficiency (EE) evaluation of using the input–output analyses Kilmer and Armbruster (1984) for the tested feeds and additives in does' rabbit diets. The study used the records of total feed consumption/dam and feed consumption for does with their litter and total weight rabbits/dam up to the local market prices for both costs and return. The calculation of economic efficiency computed using to the following equations:

Total feed cost (L.E) = Total feed intake (Kg) x price/kg feed (L.E).

Total return (L.E) = Total weight rabbits (kg) x price/kg live body weight (L.E)

Net return (L.E) = Total return (L.E) - Total feed cost (L.E)

Economic Efficiency (E.E) = Net return (L.E) / Total feed cost (L.E)

Statistical analysis:

Data was statistically analyzed by using computer program of **SAS (2002)** using the general linear models (GLM). A simple one-way classification analysis of variance according to completely randomized design with five treatments and three replicates per treatment was conducted. All percentages values were transformed to arcsine before analyses. The statistical model used was:

$Y_{ij} = M + T_i + e_{ij}$.

Where, Y_{ij} = Any observation. M = Over all mean.

T_i = Treatments (i = 1, 2, 3, 4 and 3). e_{ij} = Experimental error.

Significance among treatment means were tested at (P<0.05) using Duncan's New Multiple Rang Test (Duncan, 1955).

RESULTS AND DISCUSSIONS

Reproductive and productive performance of does:

The results in Table (3) revealed that using DDGs either with or without CA did not affect significantly both of NSC and PI of Black Baladi rabbit does.

Average doe LS either at birth or at weaning did not showed significant differences among the five tested groups. While, LW showed a significant (P<0.01) effect of using DDGs in rabbit diets and adding CA with superiority of T4 group compared to the other four tested groups at both testing periods (at birth and at weaning). Average LWG followed the same trend of LW, but without significant differences among the five treatment groups. It is of interest to found that average MR (%) significantly (P<0.05) increased in groups of DDGs than the control. While, adding CA to T_4 and T_5 groups reduced significantly (P<0.01) this ratio by about 16.5 and 25.56%, respectively than T_2 and T_3 groups.

The results obtained in the present work in terms of reproductive performance of rabbit does clearly suggests that DDGs can be used up to 50% of their diets with adding 1% CA without adverse effects on dams or their bunnies from birth till weaning (35 day's age). Such positive effect confirmed by Hemke (2009) who stated that the presence of essential fatty acids from the maize DDGS' oil. Moreover, the improvement in average live weight gain (LWG) of does can be attributed to better utilization of both energy and protein of the DDGs diets. This result is in agreement with Villamide *et al.* (1989) who revealed that the digestibility of energy and protein were higher in rabbits fed DDGs compared to those fed wheat bran or corn gluten.

Reproductive performance of bucks:

Semen characteristics results are shown in Table (4), using DDGs either with or without CA significantly (P<0.01) improved ejaculate volume (ml), motility (%), live sperm (%), total mass (P<0.05) and sperms concentration of Black Baladi rabbit bucks. While, feeding the tested bucks DDGs with or without CA significantly (P<0.01) reduced abnormal sperm (%) and dead sperm (%).

This could be attributed to rich sulfur content of DDGs diets. Similar trend in sperm mass and progressive motility and sperm concentration was recorded by Domínguez-Muñoz *et al.* (2018) for using DDGs with rice polishings in rams' diets.

Attia *et al.* (2011) stated that rabbit bucks treated with 200 mg bee pollen/Kg body weight produced significantly better semen quality, less died spermatozoa and total died spermatozoa than the un-supplemented control. Also, Ahmed *et al.* (2020) reported that rabbit bucks treated with thyme essential oil (TEO) remarkably enhanced the semen characteristics compared to control group without additives and control group with antibiotic additive.

In this concern, Richter *et al.* (2012) stated that high dietary levels of sulfur in diets with DDGS can also alter the use of selenium and copper absorption. On the other hand, Van Emon *et al.* (2013) reported that sheep fed diets containing DDGs produced low sperm concentration and attributed this effect to high sulfur levels (0.44%) in DDGs that reduced copper absorption of lambs which could adversely influenced spermatogenesis.

Growing rabbits performance:

Data in Table (5) revealed that feeding growing rabbits on diets containing DDGs with or without CA improved generally its LBW at 8 and 11 weeks of age. As for DWG, the results showed the same trend of significant (P<0.01) improvement especially with using CA addition in the diets contained DDGs during the whole growing period (5-11 weeks of age) compared to the control group. In this respect, Dorra *et al.* (2013) obtained an increase in final LBW of broiler chicks when corn DDGS (CDDGS) partially replaced yellow corn and soybean meal. The highest values of final LBW and total BWG values were recorded when broilers fed 20% CDDGS level with 0.05% Galzym.

This is in agreement with El-Abd (2017) who showed that quail chicks fed DDGS had the highest (P≤0.05) body weight and body weight gain compared to the control group. Such increasing in body weight gain might be related to increasing quail feed intake. Also, Ghazalah *et al.* (2012) used DDGS in broiler diets and found significant effect (P≤0.05) on LBW and BWG although there was no significant effect on FI and FCR.

On the other hand, Gabr *et al.* (2008) recorded that feeding New Zealand White

(NZW) rabbits (8-14 weeks of age) 20% DDGS in their diets with or without enzyme addition did not significantly affect LBW and BWG. Moreover, Youssef *et al.* (2012) reported that weight gain did not differ among diets containing 0, 10, 20 or 30% DDGs with six- weeks -old fattening California x Newzeland rabbits. Ysnagmy *et al.* (2013) found also that the fattening rabbits fed diets with 0 and 10 % DDGS reached higher total and daily BWG without significant differences, while these differences in respect to the 30% DDGS diets which was not the best recommended level.

Feed utilization:

Data in Table (6) indicated that average BWG reached the highest values with inclusion of 40% DDGs either with or without CA compared to the control and the diets contained 50% DDGs with and without CA. The same level of DDGs (40%) with and without CA addition increased non-significantly average TFI/rabbit (total feed intake) over that of the control and 50% DDGs diets. Moreover, FCR (%) significantly (P<0.01) improved with 40% DDGs diets with and without CA addition compared to the control and diets contained 50% DDGs with and without 1% CA.

Hussein and El Desoky (2011) found that FI of NZW growing rabbits was not significantly affected by DDGS levels as well as enzyme supplementation and their interaction during 9 weeks' experimental period. Although, they reported that the inclusion of 22 and 28% DDGS diets gave significant (P<0.05) improvement in FCR compared to the control group. They also recorded that all digestibility coefficients of nutrients and nutritive value were significantly improved (P<0.05) by DDGS, zylam 500 enzyme (zylanase) addition and their interaction.

Villamide *et al.* (2010) mentioned that it could be hypothesized that DDGS might be considered an interested raw material for growing rabbits due to their digestive potent, since their fiber requirements are much higher and the deficiencies in possible amino acids are associated with heat damage could be partially solved because of the caecotrophy contribution of recycled microbial protein.

On the other hand, Youssef *et al.* (2012) stated that inclusion of 10, 20 and 30% DDGs lowered FI by 6%, 6.6% and 7.2%, respectively, compared to rabbits fed no DDGs. But they noticed also that FCR was significantly (P<0.05) improved for rabbits fed 10% and 20% DDGs (1.97 and 1.94) comparing to control one (2.09). Moreover, with feeding 30% DDGs FCR showed positively (P<0.05) improvement (1.89) compared with those fed either 10% or 20% DDGs. Ysnagmy *et al.* (2013) recorded that the fattening rabbits consumed diet with 10% of DDGS consumed less feeds and determined better feeding conversion ratio.

The composition of diets including DDGS characterized with low starch and high EE values and fiber content affecting feed intake of growing rabbits (Belyea *et al.*, 2004 and Alagón, 2013). Although all the diets were within the range of digestible energy (DE; 2773.25 and 2785.25 Kcal / kg) which allow the regulation of energy intake (Gidenne and Lebas, 2005), other studies have not found any effect of starch level on consumption (Xiccato *et al.*, 2002, 2011). On the other hand, previous studies mentioned that low starch could lead to higher intake due to the regulation of voluntary consumption (Pérez *et al.*, 2000; Xiccato *et al.*, 2008; Pinheiro *et al.*, 2009). Moreover, Alagón *et al.* (2014)

denoted that diets with a higher fat content led growing rabbits to increase DE intake than that expected from the DE content and as a response of DDGS diets greater total fiber content it could promote the transit rate through the digestive tract that motivate greater consumption as reported by Pérez *et al.* (2000); Xiccato *et al.* (2008); Martínez-Vallespín *et al.* (2011) and Trocino *et al.* (2013). This means that the higher amount of insoluble and indigestible fiber in DDGS diets promotes lower mean retention time **(**García *et al.*, 2002) and accordingly higher feed consumption.

Hematological and serum biochemical parameters:

Data in Table (7) showed that, except the diet contained 50% DDGs without CA, the tested dietary treatments significantly (P<0.05) increased RBCs over the control ones. While all tested diets reduced non-significantly HCT (%) than the control group. In the same time, Hb improved non-significantly in all tested groups over that recorded for the control. Number of WBCs as well as TP of serum significantly (P<0.01) increased in rabbits received DDGs with and without CA. The rabbits fed 40% DDGs with and without CA recorded the highest values of both parameters compared to the control group and those fed 50% DDGs with and without CA.

Serum content of Alb slightly increased with dietary treatments without significant differences among the five tested groups. Meanwhile, except for M (%), all WBCs constituents showed no significant difference among the five tested groups. This could be indicator for the positive effect of using DDGs in rabbit diets on their health status and resistance. In this concern, Upendra and Yathiraj (2003); Miazzo *et al.* (2005) and Morales (2007) reported that the immunity of animals is expected to increase when DDGS used in their diets due to it contains manano-oligosaccharides in the yeasts wall, together with the contribution of nucleotides of the yeasts DDGS without mycotoxins.

Cholesterol content was significantly (P<0.01) decreased than the control, while triglycerides was reduced in the diets contained DDGs with and without CA, but without significant differences than the control. Liver enzymes (AST and ALT) significantly reduced in the four experimental groups fed DDGs with and without CA compared to the control group.

In this concern, Gabr *et al.* (2008) found that TP, TC, AST and ALT were not significantly affected by feeding diets contained 10, 15 and 20% DDGS. Moreover, Awad *et al.* (2011) reported that plasma parameters of Domyati Ducks were not afflicted by using of DDGS (0, 10, 20 and 30%) in their diets. They attributed this negative effect of DDGS on cholesterol to the low amount of soluble fiber present in the DDGS diets. Also, Gabr *et al.* (2008) found that cholesterol was not significantly affected by feeding diets contained 10, 15 and 20% DDGS in rabbit diets. Jia *et al.* (2009) found that addition of sorghum DDGS to the diets reduced plasma cholesterol in hamsters. Also, Awad *et al.* (2011) found that plasma total cholesterol was decreased by 9.19, 18.10 and 20.76 % for the groups fed diet contained 10, 20 and 30% DDGS as compared to control, respectively in Domyati laying ducks.

Kaya and Tarkan (2012) demonstrated that blood plasma total TG values were lower than control in broiler fed 5, 10 and 15 % DDGS. They also indicated that plasma total TG values were lower than the TG values found in the blood serum of ducks fed diets supplemented with 0, 6, 12 and 18% DDGS by Awad *et al.* (2011). However, Kimura (2005) found that the blood plasma TG concentration clearly decreased after feeding DDGS. On the contrary, Bor-Ling *et al.* (2011) found that plasma total TG was not impacted by the dietary treatments 0, 6, 12 and 18 % DDGS in laying hens.

Carcass characteristics:

Regarding the effect of using DDGs in the diets of the experimental rabbits on carcass characteristics and yield, data in Table (8) revealed generally that the inclusion of 40% DDGs with and without CA addition significantly (P<0.01) surpassed the control group and that received 50% DDGs with and without CA addition in LBW and slaughtering weight (g).

While, slaughtering yield (as % of LBW) was not significantly differed among the five tested groups. Feeding rabbits with 50% DDGs with and without CA produced significant (P<0.05) higher carcass weight (eviscerated weight, g) than that recorded with the control and 40% DDGs diets. Fore-, back-quarters and trunk increased in DDGs diet groups than the control and adding CA to those diets significantly the three component yield in general. Although giblets weight (g) significantly (P<0.01) increased in the DDGs diet groups than the control, the giblets (%) yield was significantly (P<0.01) reduced than the control ones. Moreover, dressing percentage significantly (P<0.01) decreased in the 40% DDGs group with and without adding CA. While it increased significantly (P<0.01) in the 50% DDGs groups with and without CA addition compared to the control group.

Similar trends were recorded by Hussein and EL Desoky (2011) who reported that eviscerated carcass, total edible parts as well as abdominal fat % insignificantly increased with increasing DDGs and zylam addition (0.5/Kg diet) than the control group of NZW growing period (14 weeks).

In this concern, Piles *et al.* (2000); Dalle (2002) and Gondret *et al.* (2002) hypothesized that the age of the rabbits at slaughtering is one of the factors that may influence on the carcass means. Similarly, Metzger *et al.* (2003) reflect that measuring carcass characteristics with its relevant body weight is more imperative, since it is a relevant influencing factor on the carcass parts' weight variation. In agreement with the results obtained in the present study Gabr *et al.* (2008); Gilbert (2013) and Ysnagmy *et al.* (2013) who found that the inclusion of DDGS in rabbits diets up to 20% is possible without altering the carcass yield.

Mader *et al.* (2009) stated that higher size of the vital organs could be an indicator of higher basal metabolism, with possible growth and feed use affection. This is clear in the present work especially with adding CA to the DDGs containing diets than the control. However, this can explain the reduction of the DWG (g) of rabbits fed 50% of DDGs with and without CA addition. Mohamed *et al.* (2013) concluded that, although carcass yield and dressing percentage tended to be lower than other treatments, the use of DDGS up to 40% in NZW rabbit diets had no declined effects on their growth performance and carcass traits.

Economic efficiency:

Table (9) indicated that FI of does significantly (P<0.05) TFI during its pregnancy and suckling periods which raised significantly (P<0.01) the total feed cost especially with adding CA.

This negatively affected (P<0.01) the net return of does and accordingly reduced the economic efficiency of using DDGs in their diets at both 40 and 50% either with or without CA addition. Regarding the use of 40% DDGs levels without CA addition in the diets of the growing rabbits, the results showed that although the net return significantly (P<0.01) improved over the control and 50% DDGs diets, the level of 50% DDGs and CA addition with both DDGs diets was not economically benefited.

In this regard, Youssef *et al.* (2012) concluded that the inclusion of DDGS up to 30% in the growing-fattening rabbit diets resulted in improved its performance and EE. Also, Mohamed *et al.* (2013) found that digestibility coefficients of nutrients and growth performance as well as economic efficiency were not significantly deteriorated by adding DDGS in NZW rabbit diets from 10 up to 40%. Moreover, Hussein and EL Desoky (2011) concluded that DDGS can be used in growing NZW rabbit diets economically up to 28% without negative effects on growth performance and animals' health.

On the other hand, Youssef *et al.* (2017) found that increasing inclusion levels of DDGS up to 20% in the diet of laying hens improves net return per hen and EE compared to the control and referred this effect back to the decreased feed consumption and feed cost. Moreover, El-Abd (2017) showed that the highest EE values were obtained with Japanese quail fed diets contained DDGS replaced 50 and 100% of yellow corn. Similarly, Choi *et al.* (2008) concluded that the cost of feed decreased as increasing DDGS levels in broiler diets without negative effects on their performance.

It could be concluded that DDGs can be used safely in the diets of mature rabbit does and bucks up to the level of 40% with adding CA. But, from economic point of view without adding CA, since its addition raise the feed cost and reduced the net return and accordingly gave lower economic efficiency than the control for both does and growing rabbits.

ACKNOWLEDGEMENT

The authors of this work feel hump full appreciation to Chief Researcher Dr. Adel El.M.I. El Desoky for his kind and valuable assistance during the implementation of this work.

Table (1): Composition and calculated analysis of the does tested diets.

Ingredients	T_1 (Control)	T_2 (40% DDGs)	T_3 (50% DDGs)	T_4 (40% DDGs plus CA)	T_5 (50% DDGs plus CA)
Yellow corn	6	0	0	0	0
Barley grain	23	26	25	26	25
Wheat bran	22.5	5	0	5	0
Soy bean meal (44 %)	17	4	0	4	0
Alfalfa hay	23	7.5	7.5	7.5	7.5
Mint straw	5	14	14	14	14
DDGs(1)	0	40	50	40	50
Citric acid (CA)	0	0	0	1.0	1.0
Di-calcium phosphate	1.3	1.3	1.3	1.3	1.3
Limestone	1.5	1.5	1.5	0.5	0.5
Sodium chloride	0.4	0.4	0.4	0.4	0.4
Mineral-vitamin premix(2)	0.3	0.3	0.3	0.3	0.3
Total	100	100	100	100	100
Calculated analysis(3):					
Crude protein %	18.30	18.32	18.32	18.32	18.32
DE (Kcal / kg)	2773.65	2773.25	2785.25	2773.25	2785.25
Crude fiber %	12.37	12.35	12.30	12.35	12.30
Calcium %	1.29	1.07	1.07	0.69	0.69
T. Phosphorus %	0.50	0.45	0.44	0.45	0.44

(1) DDGs: Corn distillers dried grains with solubles (3035 DE; 26.3% CP; 9% EE; 8.1% CF; 0.14% Ca; 0.73% T.P.; 0.3% A.P.; 0.66% Lysine; 0.51% Methionine and 0.89% Methionine plus Cystine.

(2) One kilogram of mineral–vitamin premix provided: Vitamin A, 150,000 UI; Vitamin E, 100 mg; Vitamin K3, 21mg; Vitamin B1, 10 mg; VitaminB2, 40mg; Vitamin B6, 15mg; Pantothenic acid, 100 mg; Vitamin B12, 0.1mg; Niacin, 200 mg; Folic acid, 10mg; Biotin, 0.5mg; Choline chloride, 5000 mg; Fe, 0.3mg; Mn, 600 mg; Cu, 50 mg; Co, 2 mg; Se, 1mg; and Zn, 450mg.

(3) Calculated analysis according to feed composition tables for rabbits' feedstuffs used by De Blas and Mateos (2010).

Table (2): Composition and calculated analysis of the growing rabbits tested diets.

Ingredients	T_1 (Control)	T_2 (40% DDGs)	T_3 (50% DDGs)	T_4 (40% DDGs plus CA)	T_5 (50% DDGs plus CA)
Yellow corn	6	0	0	0	0
Barley grain	23	26	25	26	25
Wheat bran	22.5	5	0	5	0
Soy bean meal (44 %)	17	4	0	4	0
Alfalfa hay	23	7.5	7.5	7.5	7.5
Mint straw	5	14	14	14	14
DDGs(1)	0	40	50	40	50
CA	0	0	0	1.0	1.0
Di-calcium phosphate	1.3	1.3	1.3	1.3	1.3
Limestone	1.5	1.5	1.5	0.5	0.5
Sodium chloride	0.4	0.4	0.4	0.4	0.4
Mineral-vitamin premix(2)	0.3	0.3	0.3	0.3	0.3
Total	100	100	100	100	100
Calculated analysis(3):					
Crude protein %	18.30	18.32	18.32	18.32	18.32
DE (Kcal / kg)	2773.65	2773.25	2785.25	2773.25	2785.25
Crude fiber %	12.37	12.35	12.30	12.35	12.30
Calcium %	1.29	1.07	1.07	0.69	0.69
T. Phosphorus %	0.50	0.45	0.44	0.45	0.44

(1) DDGs: Corn distillers dried grains with solubles (3035 DE; 26.3% CP; 9% EE; 8.1% CF; 0.14% Ca; 0.73% T.P.; 0.3% A.P.; 0.66% Lysine; 0.51% Methionine and 0.89% Methionine plus Cystine.

(2) One kilogram of mineral–vitamin premix provided: Vitamin A, 150,000 UI; Vitamin E, 100 mg; Vitamin K3, 21mg; Vitamin B1, 10 mg; VitaminB2, 40mg; Vitamin B6, 15mg; Pantothenic acid, 100 mg; Vitamin B12, 0.1mg; Niacin, 200 mg; Folic acid, 10mg; Biotin, 0.5mg; Choline chloride, 5000 mg; Fe, 0.3mg; Mn, 600 mg; Cu, 50 mg; Co, 2 mg; Se, 1mg; and Zn, 450mg.

(3) Calculated analysis according to feed composition tables for rabbits' feedstuffs used by De Blas and Mateos (2010).

Table (3): Effect of using different levels of DDGs with and without CA in the diets on some reproductive and productive traits of Black Baladi rabbit does.

Reproductive & Productive parameters		Experimental groups						
		T1	**T2**	**T3**	**T4**	**T5**	**SEM**	**Sig.**
NSC		2.3	2.0	2.3	1.3	2.0	0.24	0.1875
PI (days)		55	54	56	45	57	2.79	0.1519
LS	At birth	5.3	6.6	5.5	7.9	6.1	0.60	0.1159
	35 days	5.0	6.0	5.0	7.3	5.7	0.55	0.1168
LW (g)	At birth	247.0^{c}	255.0^{b}	259.0^{ab}	289.0^{a}	276.0^{b}	9.82	0.0052
	35 days	2650.00^{c}	3186.00^{b}	2693.75^{c}	4411.32^{a}	3138.19	411.2	0.0385
LWG (g)	0-35 days	2403.00^{c}	2931.00^{b}	2434.75^{c}	4122.32^{a}	2862.19^{ab}	402.8	0.0163
MR (%)	0-35 days	5.66^{c}	9.09^{a}	9.09^{a}	7.59^{ab}	6.56^{b}	0.88	0.0282

Means in the same raw with different superscripts are significantly different.
Sig. = Probability value SEM = Standard error of mean NSC = Number of services per conception
PI = Parturition interval LS = Litter size LW = Litter weight LWG=Litter weight gain
MR = Mortality ratio NS = Not significant

Table (4): Effect of using different levels of DDGs with and without CA in the diets on semen traits of Black Baladi rabbit bucks.

Parameters	Experimental groups						
	T1	**T2**	**T3**	**T4**	**T5**	**SEM**	**Sig.**
Ejaculate volume (ml)	0.75^{b}	0.86^{a}	0.77^{b}	0.89^{a}	0.79^{b}	0.03	0.0003
Motility (%)	65.53^{c}	71.83^{a}	68.60^{b}	75.33^{a}	70.50^{ab}	2.11	0.0069
Abnormal sperm (%)	13.91^{a}	11.00^{b}	13.80^{a}	9.82^{c}	13.20^{ab}	1.06	0.0000
Live sperm (%)	74.87^{c}	81.97^{b}	75.93^{bc}	85.67^{a}	78.10^{b}	2.58	0.0004
Dead sperm (%)	25.13^{a}	18.03^{b}	24.07^{b}	14.33^{c}	21.90^{ab}	2.58	0.0004
Total mass (5/5)	3.00^{c}	3.67^{b}	3.33^{b}	4.67^{a}	3.33^{bc}	0.37	0.0367
Sperms' concentration (x10^{6}/ml)	170.39^{d}	192.10^{b}	177.22^{cd}	198.15^{a}	181.61^{c}	6.47	0.0003

Means in the same raw with different superscripts are significantly different.
Sig. = Probability value SEM = Standard error of mean NS = Not significant

Table (5): Effect of dietary levels of DDGs with and without CA on live body weight (LBW) and daily weight gain (DWG) of Black Baladi growing rabbits.

Experimental groups	LBW (g)			DWG (g)		
	5	**8**	**11**	**5-8**	**8-11**	**5-11**
T1	530	1007.0	1140.0^{c}	22.71^{c}	20.61^{b}	21.66^{bc}
T2	470	1111.5	1578.0^{ab}	25.78^{ab}	22.21^{b}	23.99^{b}
T3	550	1034.0	1447.6^{ab}	23.04^{b}	19.69^{c}	21.36^{c}
T4	475	1127.0	1668.0^{a}	26.28^{a}	25.76^{a}	26.02^{a}
T5	530	1028.0	1470.0^{b}	23.71^{b}	21.04^{ab}	22.37^{bc}
SEM	12.04	17.98	66.63	0.54	0.79	0.64
Sig.	NS	0.1977	0.0046	0.0058	0.0000	0.0000

Means in the same column with different superscripts are significantly different.
Sig. = Probability value SEM = Standard error of mean NS = Not significant

Table (6): Effect of dietary levels of DDGs with and without CA in the diets on body weight gain (BWG, gm), daily feed intake (DFI, gm/day) and feed conversion ratio (FCR, %) during the experimental period of growing Black Baladi rabbits.

Parameters	Experimental groups						
	T1	T2	T3	T4	T5	SEM	Sig.
BWG At 11 weeks (gm)	910^{cd}	1008^{b}	897.6^{d}	1093^{a}	940^{c}	27.04	0.0046
Total FI (gm/rabbit)	3730	3750	3514	3970	3760	53.87	NS
FCR (%)	4.09^{a}	3.72^{c}	3.91^{ab}	3.63^{c}	4.00^{b}	0.08	0.0322

Means in the same raw with different superscripts are significantly different.
Sig. = Probability value SEM = Standard error of mean
NS = Not significant

Table (7): Effect of dietary levels of DDGs with and without CA in the diets on some blood parameters of growing Black Baladi rabbits.

Parameters	Experimental groups						
	T1	T2	T3	T4	T5	SEM	Sig.
RBCs (x10^{6}) µL	5.4^{c}	5.9^{b}	5.0^{d}	6.3^{a}	5.6^{bc}	0.28	0.0223
HCT (%)	34.6	34.3	29.03	33.5	30.5	1.43	0.1366
Hemoglobin (Hb, g/dl)	11.9	12.2	12.7	12.8	12.4	0.21	0.0707
WBCs (x10^{3}) µL	6.0^{d}	7.1^{b}	6.5^{c}	7.8^{a}	6.3^{c}	0.41	0.0067
Lymphocytes (L, %)	37.3	42.7	38.7	42.0	43.7	1.58	0.1060
Neutrophils (N, %)	55.7	53.7	56.7	54.7	54.3	0.69	NS
Monocytes (M, %)	6.7^{a}	2.0^{c}	3.3^{b}	2.3^{c}	1.7^{d}	1.18	0.0033
Eosinophils (E, %)	0.3	1.7	1.3	0.7	0.3	0.36	NS
Total protein (TP, g/dl)	5.1^{cd}	5.6^{b}	5.4^{bc}	6.4^{a}	5.3^{c}	0.29	0.0193
Albumin (Alb, g/dl)	3.2	3.5	3.0	3.7	3.3	0.16	0.1750
Total cholesterol(TC,mg/dl)	162.0^{a}	143.7^{d}	157.0^{b}	135.7^{e}	150.0^{c}	6.03	0.0003
Triglycerides (TG, mg/dl)	129.1	132.0	115.1	114.5	114.6	5.04	NS
AST (U/L)	9.0^{a}	4.7^{c}	6.7^{ab}	6.0^{b}	5.7^{b}	0.93	0.0288
ALT (U/L)	11.6^{a}	8.5^{b}	6.1^{c}	4.8^{d}	10.0^{a}	1.60	0.0018

Means in the same raw with different superscripts are significantly different.
Sig. = Probability value SEM = Standard error of mean NS = Not significant

Table (8): Carcass characteristics and carcass yield (% carcass weight) of Black Baladi rabbits fed different levels of DDGs with and without CA.

Parameters	Experimental groups						Sig.
	T1	T2	T3	T4	T5	SEM	
Live body weight (g)	1138.3[cd]	1448.3[b]	1128.3[d]	1581.7[a]	1200.0[c]	117.96	0.0182
Slaughtering weight (g)	898.3[c]	1178.3[b]	898.3[c]	1268.3[a]	966.7[c]	98.64	0.0162
%	78.92	81.36	79.62	80.19	80.56	0.53	NS
Eviscerated weight (g)	527.0[c]	666.7[b]	602.3[bc]	778.0[a]	796.8[a]	66.27	0.0262
Fore-quarters, g	176.7[e]	208.3[b]	195.0[c]	241.7[a]	188.3[d]	14.41	0.0234
%	26.68[a]	25.79[b]	25.92[b]	25.77[b]	19.75[c]	1.64	0.0243
Back quarters, g	153.3	198.3	183.3	213.3	185.0	12.82	0.1958
%	23.15[b]	24.55[a]	24.37[a]	22.74[c]	19.40[d]	1.20	0.0086
Trunk weight, g	83.3[d]	115.0[b]	111.7[b]	165.0[a]	96.7[c]	17.91	0.0086
%	12.58[c]	14.24[b]	14.85[b]	17.59[a]	10.14[d]	1.59	0.0238
Liver weight, g	50.0[c]	74.3[a]	50.0[c]	66.7[b]	55.0[c]	6.27	0.0236
%	7.55[c]	9.20[a]	6.65[d]	7.11[b]	5.77[e]	0.73	NS
Kidney weight, g	9.0	12.3	12.3	15.3	12.3	1.29	0.0674
%	1.36[c]	1.52[b]	1.63[a]	1.63[a]	1.29[c]	0.09	0.0142
Heart weight, g	6.3[c]	5.0[d]	10.3[a]	5.0[d]	7.3[b]	1.27	0.0033
%	0.95[b]	0.62[d]	1.37[a]	0.53[d]	0.77[c]	0.19	0.0102
Spleen weight, g	3.0	3.3	3.7	3.3	2.3	0.30	0.0952
%	0.45	0.41	0.49	0.35	0.24	0.06	NS
Head weight, g	70.0	68.3	73.3	81.7	75.0	3.01	0.0713
%	10.57[a]	8.46[cd]	9.74[b]	8.71[c]	7.87[d]	0.62	0.0142
Internal offal's weight, g	285.0[d]	461.7[a]	235.0[d]	416.7[b]	323.3[c]	53.95	0.0162
Giblets weight, g	135.3[a]	141.0[d]	150.0[c]	160.0[a]	156.7[b]	6.00	0.0188
%	20.43[a]	17.46[bc]	19.94[b]	17.06[c]	16.43[d]	1.04	0.0004
Dressing % [@]	58.18[cd]	55.77[d]	66.68[b]	59.30[c]	79.46[a]	5.55	0.0050

Means in the same raw with different superscripts are significantly different.

[@] Dressing percentage = 100 x (Carcass weight + Giblets weight) / Live body weight,

Where, Giblets weight = Liver weight + Heart weight + Kidneys weight) / Live body weight x 100.

Sig. = Probability value SEM = Standard error of mean NS = Not significant

Table (9): Economic efficiency of using different levels of DDGs with and without CA in Black Baladi rabbit diets.

Parameters	Treatments						
	T1	**T2**	**T3**	**T4**	**T5**	**SEM**	**Sig.**
Economic efficiency for does							
Total feed intake (Kg/doe)[1]	9.460[c]	10.570[b]	9.750[c]	12.750[a]	10.500[b]	0.74	0.0412
Total weight rabbits (Kg/doe)	2.650[e]	3.186[b]	2.694[d]	4.411[a]	3.138[c]	0.41	0.0136
Price/kg feed (L.E)	5.45[c]	5.82[b]	5.91[b]	7.21[a]	7.30[a]	0.49	0.0112
Total feed cost (L.E)[2]	51.56[d]	61.52[c]	57.62[dc]	91.92[a]	76.65[b]	9.43	0.0002
Price/kg live body weight (L.E)	35	35	35	35	35		
Total return (L.E)[3]	92.75[c]	111.51[b]	94.29[c]	154.38[a]	111.40[b]	14.37	0.0061
Net return (L.E)[4]	41.19[c]	49.99[b]	36.67[d]	62.46[a]	34.75[e]	6.57	0.0021
Economic efficiency (EE)[5]	0.80[a]	0.81[a]	0.64[b]	0.68[b]	0.45[c]	0.08	0.0082
Economic efficiency for growing rabbits							
Total feed intake (Kg/rabbit)[6]	3730	3750	3514	3970	3760	53.87	NS
Total weight gain (Kg/rabbit)	0.910	1.008	0.898	1.093	0.940	0.03	NS
Price/kg feed (L.E)	5.45[c]	5.82[b]	5.91[b]	7.21[a]	7.30[a]	0.29	0.0114
Total feed cost (L.E)[2]	20.32	21.82	20.76	28.62	27.44	1.31	NS
Price/kg live body weight (L.E)	35	35	35	35	35		
Total return (L.E)[7]	31.85[c]	35.28[b]	31.42[c]	38.25[a]	32.90[bc]	0.95	0.0345
Net return (L.E)[4]	11.53	13.46	10.66	9.63	5.46	0.99	
Economic efficiency (EE)[5]	0.57	0.62	0.51	0.34	0.20	0.06	

Means in the same raw with different superscripts are significantly different.
Sig. = Probability value SEM = Standard error of mean NS = Not significant
1- Total feed intake (Kg/doe) = Pregnant doe daily feed intake x 30 days) + (Lactating doe daily feed intake x 35 days). 2- Total feed cost (LE) = Total feed intake (Kg) x price / Kg feed (LE). 3- Total return / doe (LE) = Total weight rabbits / doe (Kg) x price / Kg live body weight (LE). 4- Net return / doe or growing rabbit (LE) = Total return / doe or growing rabbit (LE) – Total feed cost /doe or growing rabbit (LE). 5- Economic Efficiency (E.E) = Net return per doe or growing rabbit (LE) / Total feed cost per doe or growing rabbit (LE). 6- Total feed intake (Kg/rabbits) = Daily feed intake x 63 days. 7- Total return/ rabbits (LE) = Total weight gain / rabbits (Kg) x price / Kg live body weight (LE).

REFERENCES

Alagón, G. 2013. Use of barley, wheat and corn distiller's dried grains with solubles in diets for growing rabbits: nutritive value, growth performance and meat quality. Ph.D. Thesis, Departamento de Ciencia Animal, Universidad Politécnica de Valencia, 128 pp. https://riunet.upv.es/bitstream/handle/10251/27648/Tesis_doctoral_Alagon%20V2a.pdf.PDF?sequence=1

Alagón, G.; Arce, O.N.; Martínez-Paredes, E.; Ródenas, L.; Cervera, C. and Pascual, J.J. 2014. Effect of inclusion of distillers dried grains and solubles from barley, wheat and corn in isonutritive diets on the performance and caecal environment of growing rabbits. World Rabbit Sci., 22: 195-205. doi: http://10.4995/wrs.2014.1458

Awad, A.L.; Hussein, M.A.A.; Ghonim, A.I.A. and Kasim, M.G. 2011. Effect of dietary inclusion level of distillers dried grains with solubles on growth performance of domyati ducklings. Egypt. Poult. Sci. J., 31(I): 65-75. http://nile.enal.sci.eg/cgi-bin/koha/opac-detail.pl?biblionumber=46941

Barrero, C.M.R., R. Gabalan, L. Alberto and E.E. Roa Guerrero 2018. A novel approach for objective assessment of white blood cells using computational vision algorithms. Advances in Hematology, Vol. 2018, Article ID 4716370, 9 pages. https://doi.org/10.1155/2018/4716370

Belyea, R.L.; Rausch, K.D. and Tumbleson, M.E. 2004. Composition of corn and distillers dried grains with solubles from dry grind ethanol processing. Bioresource Technol., 94: 293-298. doi: http://10.1016/j.biortech.2004.01.001

Bernal-Barragn, H.; Vazquez-Pedroso, Y.; Valerivi Nevaro, M.; Hermandez-Martinez, C.A.; Cerillo-Soto, M.A.; Juarez-Reyes, A.S. and Gutierrez-Orrielas, E. 2010. Substitution of sorghum and soy bean meal by distillers dried grains with solubles diets for fattening rabbits. J. Anim. Sci., 88: 368. https://www.jtmtg.org/JAM/2010/abstracts/0367.pdf

Bor-Ling, Shih; Li, A. Hsu and Chen, Y.K. 2011. Effects of corn distiller's dried grains with soluble on the productive performance and egg quality of laying hens. Division of Nutrition, Livestock Research Institute, Taiwan. Council of Agriculture. AGAPE Nutrition Consultant. http://www.ddgs.umn.edu/International/InternatlResrch/index.htm

Burkey, T.E.; Miller, P.S.; Moreno, R.; Shepherd, S.S. and Carney, E.E. 2008. Effects of increasing levels of distillers dried grains with solubles (DDGS) on growth performance of weanling pigs. J. Anim. Sci., 86(Suppl. 2): 50. https://www.thepigsite.com/articles/

Choi, H.S.; Lee, H.L.; Shin, M.H.; Cheorun, J.; Lee, S.K. and Lee, B.D. 2008. Nutritive and economic values of corn distillers dried grains with solubles in broilers diets. Asian-Aust. J. Anim. Sci., 21(3): 414-419. https://doi.org/10.5713/ajas.2008.70067

Chowdhury, R.; Islam, K.M.S.; Khan, M.J.; Karim, M.R.; Haque, M.N.; Khatun, M. and Pesti, G.M. 2009. Effect of citric acid, avilamycin and their combination on the performance, tibia ash and immune status of broiler chicks. Poultry Sci., 88: 1616-1622. https://doi.org/10.3382/ps.2009-00119

Dalle, Z.A. 2002. Review. Perception of rabbit meat quality and major factors influencing the rabbit carcass and meat quality. Livestock Prod. Sci., 75(1): 11-32. https://doi.org/10.1016/S0301-6226(01)00308-6

Davis, K. 2001. Corn milling and processing and generation of co-product. 62nd Minnesota Nutrition Conference and Minnesota Corn Grower Association Technical Symposium. September 11-12. Bloonington, MN. https://www.biofuelscoproducts.umn.edu/sites/biodieselfeeds.cfans.umn.edu/files/cfans_asset_14251.pdf

De Blas, C. and Mateos, G.G. 2010. Feed formulation. In: De Blas, C., Wiseman, J. (Eds), The Nutrition of the Rabbit.2nd ed. CAB International. Wallingford (UK), pp. 222-232. DOI: http://10.1079/9781845936693.0222

De Blas, C., G.G. Mateos and P. García-Rebollar 2010. Tablas FEDNA de la composición y valornutritivo de alimentos para la fabricación de piensos compuestos (3ª ediciion). Fundacion para el Desarrolo de la Nutricion Animal, Madrid, 502 p. https://www.feedipedia.org/node/22313

Domínguez-Muñoz; Miguel A.; Fernando Martínez-Cordero; Miguel Mellado; **Cecilia C. Zapata-Campos; Claudio Arzola-Alvarez and Jaime Salinas-Chavira 2018.** Effect of feeding with dried distillers grains with solubles and rice polishings on scrotal circumference and semen parameters of ram lambs. Tropical and Subtropical Agroecosystems, 21: 431–438. https://www.researchgate.net/publication/330480546_

Dorra, Tork, M.I.; Kalaba Z.M. and Younis, M.E.E. 2013. Effect of using corn distiller's dried grains with solubles in broiler diets without or with adding galzym on growth performance and some physiological parameters. J. Anim. and Poult. Prod., Mansoura Univ., 4(5): 263-283. https://jappmu.journals.ekb.eg/article_71334.html

Duncan, D.B. 1955. Multiple range and multiple F-tests. Biometrics. 11:1-42.

El-Abd, Niamat M. 2017. Yellow corn replaced by distillers dried grains with solubles (DDGS) of dietary japanese quail. Egypt. Poult. Sci. J., 37(II): 451-460. https://epsj.journals.ekb.eg/article_6798_f13f1f0fec7d7f58fcb99b2c547939b2.pdf

Feoli, C.; Hancock, J.D.; Gugle, T.L. and Carter, S.D. 2008. Effects of expander conditioning on the nutritional value of diets with corn-and sorghum-based distillers dried grains with solubles in nursery and finishing diets. J. Anim. Sci., 86(Suppl. 2): 50. http://DOI:10.4148/2378-5977.7023

Gabr, A.A., Sherif, Kh.El. and Naeem, A.F. 2008. Effect of inclusion dried distiller's grains with solubles with enzyme addition in rabbit diets on performance, digestibility, carcass traits and some blood constituents. J. Agric. Sci. Mansoura Univ., 33(2): 6335 - 6349. https://jappmu.journals.ekb.eg/article_86221_7914bfb7446d8c666de6beabc9a2391a.pdf

Gaines, A.; Ratliff, B.; Srichana, P. and Allee, G. 2006. Use of corn distiller's dried grains and solubles in late nursery pig diets. J. Anim. Sci., 84 (Suppl. 2): 120.

García, J.; Gidenne, T.; Falcão e Cunha, L. and de Blas, C. 2002. Identification of the main factors that influence caecal fermentation traits in growing rabbits. Anim. Res., 51: 165-173. doi: http://10.1051/animres:2002011

Ghazalah, A.A; Abd El-Samee M.O.; Abd El-Hakim and Ibrahim, M.M. 2012. Evaluation of using distillers dried grains with solubles (DDGS) in broiler diets. Egypt. Poult. Sci. J. 32(II): 381-397. https://www.cabdirect.org/cabdirect/abstract/20123229440

Gidenne, T. and Lebas, F. 2005. Le comportement alimentaire du lapin. In Proc.: 11èmes Journées de la Recherche Cunicole, 29-30 November. Paris, France, 183-195. https://www.researchgate.net/publication/253378677_

Gilbert, A.H. 2013. Use of barley, wheat and corn distiller's dried grains with solubles in diets for growing rabbits: nutritive value, growth performance and meat quality. Ph.D. Thesis, Department of Animal Science, Valencia University, Spain. https://m.riunet.upv.es/bitstream/handle/10251/27648/Tesis_doctoral_Alagon%20V2a.pdf.PDF?sequence=1&isAllowed=y

Gondret, F.; Combes, S.; Larzul, C. and de Rochambeau, H. 2002. Effect of divergent selection for body weight at a fixed age on histological, chemical and rheological characteristics of rabbit muscle. Livest. Prod. Sci., 76: 81. https://doi.org/10.1016/S0301-6226(02)00003-9

Hemke, I.G. 2009. Omega-3 for young broilers-improves health and performance. International Poult. Prod., 17: 23. http://www.positiveaction.info/pdfs/articles/pp17.4p23.pdf.

Hussein, M.A.A. and El Desoky, A.El.M.I. 2011. Effect of distillers dried grains with solubles (DDGS) supplemented with or without enzyme on the performance of growing rabbits. Egypt. J. of Rabbit Sci., 21(1): 83-100. http://DOI:10.21608/EJRS.2011.51620

Jia, Tse Hoi; Curtis, L.; Weller, Vicki Schlegel; Susan, L.; Cuppett, Ji-Young Lee and Timothy, P.C. 2009. Sorghum distillers dried grain lipid extract increases cholesterol excretion and decreases plasma and liver cholesterol concentration in hamsters. University of Nebraska–Lincoln, J. of Func. Foods;1(4):381-386. https://core.ac.uk/download/pdf/188122421.pdf

Kaya, Ö. and Tarkan, Ş. 2012. Effects of different levels of distillers dried grains with solubles on growth performance, carcass quality and some blood parameters in broilers. This study was produced of Özlem Kaya"s Ph.D. Thesis, Kafkas University. https://www.researchgate.net/publication/269813492_

Kilmer, R.L. and Armbruster, W.J. 1984. Methods for evaluating economic efficiency in agricultural marketing. Florida Agricultural Experiment Station Journal Series No. 5558, PP: 101-109. https://ageconsearch.umn.edu/record/29613/files/16010101.pdf.

Kim, Y.; Mosier, N.S.; Hendrickson, R.; Ezeji, T.; Blaschek, H.; Dien, B.; Cotta, M.; Dale, B. and Ladisch, M.R. 2008. Composition of corn dry-grind ethanol by-products: DDGS, wet cake, and thin stillage. Biores.

Technol., 99: 5165-5176. https://doi.org/10.1016/j.biortech.2007.09.028

Kimura, N.2005. Basic studies on the effect on layer hens of DDGS produced in USA. Chapter30. Summary of U.S. Grains Council Sponsored International Feeding Trials http://www.ddgs.umn.edu/articlespoultry/2005Kirmura%20Layer%20hens%20trial%20report%20summary.pdf

Kleinschmit, D.H.; Schingoethe, D.J.; Kalscheur, K.F. and Hippen, A.R. 2007. Evaluation of various sources of corn dried distillers grains plus soluble for lactating dairy cattle. J. Dairy Sci., 90(1): 522. https://doi.org/10.3168/jds.S0022-0302(06)72528-0

Koger, T.J.; Wulf, D.M.; Weaver, A.D.; Wright, C.L.; Tjardes, K.A.; Mateo, K.S.; Engle, T.E.; Maddocle, R.J. and Smart, A.J. 2010. Influence of feeding various quantities of wet and dry distillers grains to finishing steers on carcass characteristics, meat quality, retail-case life of ground beef and fatty acid profile of longissimus muscle. Anim. Sci., 88: 3399. http://doi:10.2527/jas.2009-2708. Epub 2010 Jun 18.

Liu, K.S. 2011. Chemical composition of distillers grains, a review. J. Agric. Food Chem., 59: 1508-1526. https://pubs.acs.org/doi/abs/10.1021/jf103512z#

Lukefar, S.; Hohenboken, W.D.; Cheeke, P.R.; Patton, N.M. and Kennick, **W.H. 1982.** Carcass and meat characteristics of Flemish Giant and New Zealand White pure-bred and terminal cross rabbits. J. Anim. Sci., 54: 1169-1174. https://doi.org/10.2527/jas1982.5461169x

Mader, C.J.; Montanholi, Y.R.; Wang, Y.J.; Miller, S.P.; Mandell, I.B.; McBride, B.W. and Swanson, K.C. 2009. Relationships among measures of growth performance and efficiency with carcass traits. visceral organ mass. and pancreatic digestive enzymes in feedlot cattle. J. Anim. Sci., 87: 1548. http://DOI:10.2527/jas.2008-0914

Martínez-Vallespín, B.; Martínez-Paredes. E.; Ródenas, L.; Cervera, C.; Pascual, J.J. and Blas, E. 2011. Combined feeding of rabbit female and young: Partial replacement of starch with acid detergent fibre or/and neutral detergent soluble fibre at two protein levels. Livest. Sci., 141: 155-165. doi: http://10.1016/j.livsci.2011.05.014

Metzger, Sz.; Kustos, K.; Szedró, Zs.; Szabo, A.; Eiben, C. and Nagy, I. 2003. The effect of housing system on carcass traits and meat quality of rabbit. World Rabbit Sci., 11: 1. https://doi.org/10.4995/wrs.2003.492

Miazzo, R.; Peralta, M.; Pico, M. and Nilson, A. 2005. Productive parameters and quality of broilers chickens feed yeast (*Saccharomyces cerevisiae*). Proc. XII European Symposium on the quality of poultry meat. Holand. World Poult. Sci. Assoc., 84: 330. https://www.cabi.org/Uploads/animal-science/worlds-poultry-science-association/WPSA-the-netherlands-2005/122.pdf

Mohamed, Kh. A.; A.M.A. Osman; M.A.H. Soliman and Enas M. A. Toson 2013. Using dried distillers grains with solubles (DDGS) by-product in fattening rabbit diets. Egypt. Poult. Sci. J., 33(IV): 695-702. https://www.cabdirect.org/cabdirect/ab stract/20143302021. URL : http://www.epsaegypt.com/wp-content/u...

Moore, D.M.; Zimmerman, K. and Smith, S.A.2015. Hematological assessment in pet rabbits: Blood sample collection and blood cell identification. Vet. Clin. North. Am. Exot. Anim. Pract., 18(1): 9-19. http://doi:10.1016/j.cvex.2014.09.003.

Morales, R. 2007. Las paredes celulares de levaduras *Saccharomyces cereviseae*: Un aditivo natural capaz de mejorar la productividad y salud del pollo de engorde. Ph.D. Thesis. Barcelona, España. https://www.tdx.cat/handle/10803/5689?show=full

Noll, S.E.; Parsons, C.M. and Dozier, W.A. 2007. Formulating poultry diets with DDGS- How far can we go. Proceedings 5th Med. Atl. Nutr. Conf., N.G. Zimmerman, ed., Univ. Maryland, College Park. https://www.semanticscholar.org/paper/Noll-Parsons/3982bae2bfb42e5e7abf45c050c30663ed7d3a03

NRC 1977. National Research Council, Nutrient Requirements of Rabbits. National Academy of Science. Washington, D.C.

Onyimonyi, A.E. and Onu, E. 2009. An Assessment of Pawpaw Leaf Meal as Protein Ingredient for Finishing Broiler. Int. J. Poult. Sci., 8: 995-998. http://DOI:10.3923/ijps.2009.995.998

Pérez, J.M.; Gidenne, T.; Bouvarel, I.; Arveaux, P.; Bourdillon, A.; Briens, C.; Le Naour, J.; Messager, B. and Mirabito, L. 2000. Replacement of digestible fibre by starch in the diet of growing rabbits. II. Effects on performances and mortality by diarrhoea. Ann. Zootech., 49: 369-377. doi: http://10.1051/animres:2000128

Piles, M.; Blasco, A. and Pla, M. 2000. The effect of selection for growth rate on carcass composition and meat characteristics of rabbits. Meat Sci., 54: 347. http://doi:10.1016/s0309-1740(99)00109-6.

Pinheiro V.; Guedes, C.M. and Outor-Monteiro D. Mourão 2009. Effects of fibre level and dietary mannanoligosaccharides on digestibility, caecal volatile fatty acids and performances of growing rabbits. Anim. Feed Sci. Technol., 148: 288-300. doi: http://10.1016/j.anifeedsci.2008.03.010

Richter, E.L.; Drewnoski, M.E. and Hansen, S.L. 2012. Effects of increased dietary sulfur on beef steer mineral status, performance, and meat fatty acid composition. J. Anim. Sci., 90: 3945-3953. http://doi:10.2527/jas.2011-4512.

Romero, C.; Rebollar, P.G.; Dal Bosco, A.; Castellini, C. and Cardinali, R. 2011. Dietary effect of short-chain organic acids on growth performance and development of intestinal lymphoid tissues in fattening restricted rabbits. World Rabbit Sci., 19: 133-142. http://dx.doi.org/10.4995/wrs.2011.866

Rostamzad, H.; Shabanpour, B.; Kashaninejad, M. and Shabani, A. 2011. Antioxidative activity of citric and ascorbic acids and their preventive effect on lipid oxidation in frozen Persian sturgeon fillets. Lat. Am. Appl. Res., 41:135-140. https://www.researchgate.net/publication/232658612_

SAS Institute, 2002. SAS/DSTAT Users Guide, Institute Inc., Cary, NC.

Schauer, C.S.; Anderson, L.P.; Stecher, D.M.; Pearson, D. and Drolc, D. 2005. Influence of dried distillers grains on feedlot performance and carcass characteristics of finishing lambs. Western Dakota sheep and beef, 46: 31-33. https://www.researchgate.net/publication/237124471_

Smith, J.T. and Mayer, D.T. 1955. Evaluation of sperm concentration by the haemocytometer method. Fertil Steril, 6:271-275.

Spencer, J.D.; Petersen, G.I.; Gaines, A.M. and Augsburger, N.R. 2007. Evaluation of different strategies for supplementing distillers dried grains with solubles (DDGS) to nursery pig diets. J. Anim. Sci., 85(Suppl. 2): 96-97. https://www.researchgate.net/publication/291688626_

Swiatkiewicz, S. and Koreleski, J. 2008. The use of distiller's dried grains with solubles (DDGS) in poultry nutrition. World's Poult. Sci. J., 64:257-266. http://DOI:10.1017/S0043933908000044

Trocino, A.; García, J.; Carabaño, R. and Xiccato, G.2013. A metaanalysis on the role of soluble fibre in diets for growing rabbits. World Rabbit Sci., 21: 1-15. doi: http://10.4995/wrs.2013.1285

Uddin, M.J.; Islam, K.M.S.; Reza, A. and Chowdhury, R.2014. Citric acid as feed additive in diet of rabbit-effect on growth performance. J. Bangladesh Agric. Univ., 12(1): 87–90. https://ageconsearch.umn.edu/record/209901/?ln=en

Upendra, H. and Yathiraj, J. 2003. Effect of supplementing probiotics and mannan oligosaccharide on body weight. Feed conversion and viability in broiler chicks. Indian Vet. J., 80:1075. https://www.researchgate.net/publication/292638871_

USDA 2020. United States Department of Agriculture. Foreign Agricultural Service. Grain and Feed Annual Report. "Egyptian Wheat Imports Hold Steady Despite Increased Local Production". Report Number: EG2020-0005 In: GAIN "Global Agricultural Information Network". https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName

Van Emon, M.L.; Vonnahme, K.A.; Berg, P.T.; Redden, R.R.; Thompson, M.M.; Kirsch, J.D. and Schauer, C.S. 2013. Influence of level of dried distillers grains with solubles on feedlot performance, carcass characteristics, serum testosterone concentrations, and spermatozoa motility and concentration of growing rams. J. Anim. Sci., 91: 5821-5828. http://doi:10.2527/jas.2013-6369. Epub 2013 Oct 21.

Villamide, J.M., Nicodemus, N.; Fraga, M.J. and Carabaño, R. 2010. Protein digestion. In: The Nutrition of the Rabbit. 2nd ed., De Blas C., Wiseman J. (ed). CABI International. Wallingford, UK, 39-55. https://www.cabi.org/animalscience/ebook/20203122449

Villamide, M.J., de Blas, J.C. and Carabaño, R. 1989. Nutritive value of cereal by-products for rabbits. 2. Wheat bran, corn gluten feed and dried distillers grains and solubles. J. Appl.

Rabbit Res., 12: 152. https://www.feedipedia.org/node/7700

Xiccato, G.; Trocino, A.; Carraro, L.; Fragkiadakis, M. and Majolini, D. 2008. Digestible fibre to starch ratio and antibiotic treatment time in growing rabbits affected by epizootic rabbit enteropathy. In Proc.: 9th World Rabbit Congress, June 10-13, 2008. Verona, Italy, 847-851. https://www.researchgate.net/publication/285743957_

Xiccato, G.; Trocino, A.; Majolini, D.; Fragkiadakis, M. and Tazzoli, M. 2011. Effect of decreasing dietary protein level and replacing starch with soluble fibre on digestive physiology and performance of growing rabbits. Animal, 5: 1179-1187. doi: http://10.1017/S1751731111000243

Xiccato, G.; Trocino, A.; Sartori, A. and Queaque, P.I.2002. Effect of dietary starch level and source on performance, caecal fermentation and meat quality in growing rabbits. World Rabbit Sci., 10: 147-157. https://doi.org/10.4995/wrs.2002.487

Youssef, A.A.; Hassan, R.A.; Abd-El-Hamid, A.E. and Selim, W.S. 2017. Utilization of different levels of distillers dried grains with solubles (DDGS) in local laying hen diets. Egypt. Poult. Sci. J., (37)(II): 545-558. https://epsj.journals.ekb.eg/article_7000.html

Youssef, Amani W.; Soha, S. Abd El-Magid; Abd El-Gawad, A.H.; Eman, F. El-Daly and Ali, H.M. 2012. Effect of inclusion of distillers dried grains with solubles (DDGs) on the productive performamance of growing rabbits. American o-Eurosin J. Agric. A. Enviran. Sci., 12(3): 321-326. https://www.researchgate.net/publication/267408316_

Ysnagmy, V.; Bernal, H.; Valdivie, M.; Gutierrez, E.; Castellanos, I.M.; Hernandez, C.A.; Juarez, A. and Maria A. Cerrillo 2013. Use of dehydrated distillery grains with solubles in diets for fattening rabbits. Cubian J. Agric. Sci., 17(1): 2013. https://www.researchgate.net/publication/283090692_

الملخص العربى

تأثير إضافة حمض الستريك إلى علائق نواتج تقطير حبوب الأذرة بالسوائل على الأداء التناسلي والإنتاجي للأرانب

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استهدفت هذه الدراسة معرفة تأثير تغذية مستويين من DDGs مع أو بدون حامض الستريك على الأداء التناسلي والإنتاجي للأرانب البلدي الأسود. استخدم في الجزء الأول من التجربة خمسة عشر أنثى ناضجة و ١٥ ذكرًا في عمر ٧ و ٨ أشهر بمتوسط وزن الجسم الحي ٢٩٠٠ ± ١٠٠ جم و ٣٣٠٠ ± ١٠٠ جم على التوالي. بعد ذلك ، تم استخدام ٤٥ أرنبًا من النتاج بمتوسط وزن حي يبلغ ٥١١ ± ١٣ جم بعمر ٥ أسابيع واستمر لمدة ٦ أسابيع من النمو (٥-١١ أسبوعًا). تم تغذية المجموعات حتى الشبع على العلائق المختبرة T1: النظام الغذائي الأساسي بدون DDGs (المقارنة) ، T2: عليقة تحتوي على ٤٠٪ DDGs ، T3: عليقة تحتوي على ٥٠٪ DDGs ، T4 عليقة تحتوى على ٤٠٪ DDGs + ١% حامض ستريك و T5: عليقة تحتوي على ٥٠% DDGs + ١% حامض الستريك.

لقد اثرت تغذيه DDGs مع او بدون حمض الستريك على بعض الصفات التناسلية وحجم البطن عند الولادة والفطام. بينما تحسن وزن المواليد معنويا والزيادة الوزنية (بفروق غير معنوية) في مجموعة ٤٠٪ DDGs مع حامض الستريك عند الولادة والفطام. زاد معدل الوفيات بشكل معنوي في مجموعات DDGs ، لكنه انخفض مع إضافة حامض الستريك. تحسنت صفات جودة السائل المنوي .حدث تحسن مع ٤٠٪ DDGs + حامض الستريك في وزن الجسم الحي وزيادة الوزن اليومية للأرانب النامية باستخدام حامض الستريك. زاد معدل استهلاك العلف اليومي / الأرانب بشكل غير معنوي وتحسنت نسبة التحويل الغذائي معنويا ($P<0.01$) مع ٤٠٪ DDGs بدون ومع حامض الستريك. كان لعلائق DDGs تأثير إيجابي على مقاييس دم الأرانب وأوزان الذبح أيضًا.

نستنتج أن استخدام DDGs في النظام الغذائي للأرانب الناضجة والنامية حتى ٤٠٪ مع إضافة حامض الستريك مفيد في الصفات التناسلية والإنتاجية للأرانب.