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EFFECT OF YUCCA (*YUCCA SHIDIGERA*) EXTRACT SUPPLEMENTATION ON EGG PRODUCTION, EGG QUALITY AND IMMUNE RESPONSE OF LAYING HENS

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ABSTRACT: Establishing stability between declining ecological influences and livestock growth is essential to confirming the sustainability of animal protein supply. In order to produce clean and healthy poultry products, it is necessary to add medicinal natural plant additives to the feed. *Yucca shidigera* found to do this mission in addition to it could be cultivated under tropical conditions of desert, which ensures its possibility for use as a tool for encountering the worldwide climate changes. Two Hundred and seventy (270) laying hens were used for studying the effect of two levels of yucca (0.25%, 250 g/ ton and 0.50%, 500 g/ ton) against control group. Egg production, quality, feed conversion ratio and cellular immune response were examined. Inclusion of *Yucca shidigera* in laying hens diet improved productive performance (egg number, mass and weight), Haugh unit, shell percentage, shell thickness, feed conversion ratio and partially cellular immune response. *Yucca shidigera* exhibited that it is capable of improving egg productive and quality criteria, feed efficiency and immune activity. So, Yucca may be incorporated in laying hens diet with a positive effect. However, the results of this study show the need for more research to study the economic cost of adding yucca to poultry diets and to confirm the recommendations of this study.

Key Words: *Yucca shidigera* extract, productive performance, immune response.

INTRODUCTION

The poultry production sector at Saudi Arabia has currently taken a great consideration. Poultry consumption in Saudi Arabia has been steadily growing at an average rate of 5% annually during the last two decades. Most producers add a lot of chemical compounds and antibiotics to fight bacterial diseases challenges, in addition of using vaccines to prevent viral diseases. Accordingly, the need arose to find safe and effective alternatives of these drugs and antibiotics that do not cause risks to human health. Here arises the need to use natural plant additives such as herbs or plant extracts, which have many benefits and lead to improve the productivity of birds, whether meat or egg production.

Scientists are looking for trustworthy alternative sources that could achieve the desired aims of feed additives in animal production since the use of antibiotics as growth promoters has already been banned due to concerns about resistance (Rehman *et al.,* 2011). Due to pathogenic bacterial resistance, the utilization of antibiotics in animal nutrition is being reconsidered on a massive level. Different feed supplements for poultry are therefore required. In order to improve poultry health and production, whether directly or indirectly, supplements are compounds that have been introduced to rations (Jun et al., 2002).

For poultry (Hossain et al., 2012), natural feed ingredients derived from various pharmaceutical herbs were proven to be beneficial. Some are incorporated in animals' ration to fulfill the requirements of necessary components and to enhance animal's health, feed consumption, growth efficiency and consequently improve feed competence (Shawle et al., 2016). Medicinal herbs may be related in various means for the healthy birds' production. They have antimicrobial and antioxidants Characteristics (Cross et al., 2007), assist in immune response system improvement and growing stimulate (Ko et al., 2008). Medicinal herbs hold numerous antioxidative ingredients with great protection ability against oxidation for nutrients in digestive system, in metabolism process and products (Wenk, 2003). They can control nutrients consumption and motivate gastric secretions, cause in enhanced ingestion capability and decrease hazard of gastric problems (Bunyapraphatsara, 2007).

Dietary supplementation with *Yucca shidigera* may possibly improve the performance of laying hens (Khaskheli et al., 2020). Substitute to antibiotics and anticoccidials include pharmaceutical herbs in the form of seeds, leaves, and extracts, however they have not yet been successfully utilized because there is a lack of enough researches (Kutlu, 2007; Tuncer, 2007). The utilization of natural dietary supplements has become more and more common globally. There are numerous feed supplements which can be added to the rations of livestock and poultry to enhance productivity. *Yucca shidigera*, commonly known as yucca, is a plant originate in the dry deserts of Mexico and Southwest America, is grown too as an ornamental plant in China's Zhejiang Province. It is recognized by indigenous Indians as a source of food and drugs due to its health-promoting effects (Patel, 2012). Their main application is in animal feed, particularly as a feed supplementation to lessen faecal odors and ammonia (Kelly and Kohler, 2003; El-Saidy and Gaber, 2004; Gaber, 2006).

Several studies have demonstrated the prospective use of yucca as an antioxidant source (Fidan and Dundar, 2008). Abaza and El-Said (2005) observed that dietary 100 ppm yucca powder improved body weight gain significantly ($P<0.01$). Also, dietary 120 mg/ kg yucca extracts improved body weight in broiler chickens (Cabuk et al., 2004). The present study aimed at evaluating productive performance, egg quality, feed conversion ratio and immune status of the laying hens fed a diet supplemented with varied concentrations of Yucca extract.

MATERIALS AND METHODS

Study Flock Husbandry:

In the current study, Two hundred and seventy (270) laying hens from Saudi local breed were experimented for the effect of two levels of yucca extract (0.25%, 250 g/ ton and 0.50%, 500 g/ ton) compared to the control group. Each treatment has 9 replicates; the number of birds within each replicate is 10 birds. The active compound of Yucca extract (YE) is Saponine with a concentration of 10.5g / 100 g YE incorporated in a commercial product named (Bio IM Dry) produced by IDPCO company for feed additives. Table (1) shows the experimental design of the study. The experimental unit was 2 birds/ cage; birds were placed in wire cages (60 cm × 45 cm × 43 cm, L × W × H) under lighting schedule of 17 h/d light cycle. The average of the ambient temperature during the whole experimental period was 34 ± 1.5° C. All birds were reared and brooded in the similar nutritional, environmental and biosecurity conditions. Feed and water were delivered *ad libitum* throughout the experiment. The diet was formulated to contain approximately 18 % crude protein and 2858 kcal/kg ME in a standard layer diet (NRC, 1994) and was mixed every week. The composition and calculated chemical analysis of the laying diet is presented in table (2). The care and handling of the laying hens were in accordance with regulations of animal care committee of Qassim University.

Measurements and Observations:

Egg production parameters:

Main parameters of egg production (number of produced eggs, egg weight and egg mass) were individually recorded within each treatment throughout two months. Egg numbers were individually recorded daily for each hen within treatments. Eggs were individually weighed and recorded for each hen within treatments using electronic second decimal scale balance. Egg mass in grams for each hen within treatments was calculated by using the following equation: Egg Mass = [Egg number x Egg weight]. Damaged eggs, including broken, cracked and shell-less eggs, were collected and recorded on a daily basis.

Egg Quality Measurements:

During the experimental period, two hundred and seventy (270) intact eggs from each treatment were collected to assess internal and external egg quality characteristics. The lengths of major and minor axis or egg dimensions (longitudinally and transversely) were measured in (mm) using a digital caliper. Then shape index calculated by: SI = [Breadth / length] x 100 (Carter, 1968). Shell strength of uncracked eggs was measured using an Egg Force Reader™ Machine, Orka Food Technology Ltd., USA. The data of breaking force was digitally recorded for each tested specimen.

A rod of the machine is lowered until it rests on the shell. A small pressure is then applied to the egg via this rod until the first crack occur, the force of breaking strength was digitally recorded and saved into the machine memory in Kg/cm^2. Yolk color was measured using DSM YolkFan™. Haugh units was measured by Egg Analyzer™, Orka Food Technology Ltd. via the equation HU=100* Log (h-1.7 (w)$^{0.37}$+7.6), Where HU= Haugh unit, h= albumen height in millimeters, w= egg weight in grams. After eggshell cracking. Fractured egg open to isolate the entire eggshell after emptying the egg's contents, shell fragments or pieces were maintained. All eggshell pieces were cleaned from the albumen remaining, rinsed free of external debris or internal egg contents. Washed under water distilled and air dried at room temperature. The weight for the dry eggshell was measured using second decimal scale. Shell percentage can be calculated using the following equation: Shell (%) = [dry eggshell weight / fresh egg weight] x 100. From the outset, eggshell cleaned from the albumen residue, washed under running water distilled and air dried at room temperature until constant weight. Then, Eggshell thickness was measured with a 0.01-millimeter accuracy using a digital micrometer "thickness measurer" (Ames Co., Waltham, Mass.) that hold eggshell between mobile pivot and stationary base. Average of three measurements (two at both pointed and broad polar and one at equator) were recorded.

Feed Consumption and Feed Conversion Ratio:

Feed consumption was measured and feed conversion ratio was calculated throughout 62 days of egg production. The birds were housed in individual cages. Feed consumption was measured for the whole experimental period as followed. Feed Consumption (F.C., g) = feed consumed during experimental period. Feed Conversion Ratio (FCR) = Feed Consumption (g)/ Egg Mass (g). Egg Mass (g) was calculated by summation of egg weights during the measured period.

Immunogenetic Profile Evaluation: Cell-mediated immunity assay response to injection with phytohemaglutinin-P (PHA-P):

The cutaneous basophil hypersensitivity test, a measure of T-cell mediated response, was evaluated in vivo by injection of the mitogen phytohemagglutinin-P (PHA-P) into the Toe-web between the second and the third digits (left foot). 54 birds were randomly assigned from the considered treatments (3 treatments/ 18 each). Each hen was intradermally injected in the toe web of foot with 100 µg phytohemagglutinin-P (Sigma Chemical Co., St. Louis, MO 63178) in 0.1 ml of sterile saline. The thickness of the toe-web was measured with a constant tension caliper pre-injection and at 24, 48 and 72 hours post-injection. The toe-web swelling was calculated as the difference between the thickness of the toe-web before and after injection.

<u>Statistical Analysis:</u>

Data was analyzed using one-way analysis of variance (ANOVA) with the Yucca level effect using (SAS, 2001). According to the following model:

$Y_{ij} = \mu + T_i (\%) + e_{ij}$

Where;

Y_{ij} = The observation taken on the kth individual,

μ = Overall means,

T_i = a fixed effect of the ith Yucca level effect (i= 1, 2 and 3),

e_i = Random error assumed to be

j independent normally distributed with mean = 0 and variance = σ^2.

All results are presented as mean and the pooled SEM. When significant differences among means were found, means were separated using Duncan's multiple range test. Significance was set as P<0.05.

RESULTS AND DISCUSSION

Egg production measurements:

Egg mass grew linearly in response to nutrient density. The elevated egg weight was the primary factor influencing the greater egg mass (Wu et al., 2005). Egg production measurements were disclosed in table (3). Where highly significant differences among study treatments varied in Yucca supplementation were observed and recorded in regards to egg numbers and egg mass, birds supplemented with high level of Yucca produced higher egg number and mass among experimental groups, while the lower production rate and mass were recorded for the control group. A significant impact of Yucca addition on egg weight criteria, where birds fed Yucca, with high and low levels, produced larger eggs than control group, consecutively. Broken eggs didn't differ among treated groups. The advantages of adding yucca to the poultry diet on growth performance, laying performance, feed utilization, immune response, and health status of livestock animals might be attributed to the saponin components and several natural biosecurity elements (Piacente et al., 2005). Alagawany et al. (2018) noted that inclusion of yucca extract increased egg production, feed consumption and feed conversion ratio in Japanese quail. Dietary supplementation of yucca was shown to have a considerable favourable effect on performance of commercial laying flock through increasing productivity and finishing body mass (Gurbuz et al., 2016). These results are in agreement with Wang and Kim (2011) who stated that dietary yucca extract resulted in favorable impacts on feed efficacy and egg weight in laying hens. The improvement in the growth and laying performance due dietary yucca supplementation might be related to its contents of active components that enhance food use in the digestive tract by enhancing digestion, absorption, and nutrient availability (Almuhanna et al., 2011). Additionally, the improved egg production might be attributed to the beneficial impacts of steroid saponins presented in yucca on nutrients absorption in the gut.

In the poultry field, *yucca shidigera* extract has been applied positively as a dietary supplement, It increases broiler productivity and expansion (Sahoo et al., 2015). This plant extract improves egg weight, feed conversion, and productive performance when added to chicken diet.

Yucca's steroid saponins may have beneficial impacts on feed absorption from the gastrointestinal tract, which might explain why productive characteristics have improved greatly. The improvement of nutrient absorption via the intestinal tract by steroid saponins has been shown in prior research (Wang and Kim, 2011).

Other scientists however have reported no influence on turkey, laying quail, or laying chickens production characteristics (Dziuk et al., 1985; Kutlu et al., 2001 and Kaya et al., 2003). According to Kutlu et al. (2001), feeding White Hy-Line laying hens yucca powder with a 10.76% saponin concentration at levels of 0, 30, 60, and 120 ppm had no impact on their feed consumption, egg yield, feed efficiency, and quality indices of eggs. Same findings have been reported in turkey poults and laying quails fed doses of 0, 100, and 200 ppm of yucca powder, respectively (Kaya et al., 2003). Moreover, feed efficiency didn't significantly affected by these levels. When yucca was supplemented to the broiler ration at a level of 60 or 120 ppm, there had been beneficial effects on growth rate and Feed efficiency (Lundeen, 2000). Ayasan et al. (2005) determined that supplementation of Yacca extract in the feed of layers may influence production and quality of eggs. The Yucca extract powder fed laying birds showed increased in feed conversion ratio and weight gain. While egg production and feed intake are not influenced. Similar findings regarding the dietary supplementation of *Yucca shidigera* extract powder fed to layers were reported by Tugay et al. (2005). *Yucca shidigera* extract supplementation to the birds' diet does not favor the performance and feed consumption (Guclu, 2003). *Yucca shidigera* improve overall production performance of layers. Use of *Yucca shidigera* also supports digestibility, and that might have contributed for performance and production (Khaskheli et al., 2020). Egg weight and feed conversion were improved by adding 120 ppm of yucca extract (Wang and Kim, 2011).

Egg quality measurements:

Eggs possess functional characteristics that include thickening, foaming, coating, binding, a nd emulsifying ability, as well as the ability to control crystallization (Meszaros et al., 2006).

Data of egg quality measurements were summarized in table (4). Shape index values are varied considerably among tested groups. Low Yucca level and Control groups owned the higher shape index value than group fed high level of yucca in their diet. Both groups fed high and low levels of Yucca have higher Haugh unit and shell thickness values than control group. Shell % was higher significantly for birds fed high level of Yucca in their ration compared to control and low Yucca level, successively. No significant differences were observed among experimental groups regarding egg fracture force (eggshell strength), yolk color and shell weight. Alagawany et al. (2016) pointed out that supplemental dietary yucca extract up to 100 mg/kg diet enhanced egg number, egg mass and eggshell thickness significantly. Our results disagree with Grunder et al. (1991), who stated that greater egg production was related to poor shell quality. As they can be used to indicate shell integrity characteristics (Narushin, 2001), and interior egg parameters, egg geometrical estimates that encompass volume (V) and shape index (S) estimations are essential for the poultry industry and in biological investigations (Narushin and Romanov, 2002). The variation in egg weight between the groups may have contributed to the shape index divergence.

For evaluating the albumen quality of chicken eggs, the Haugh unit is the recognized as a commercial and scientific standard unit. The main purpose of determining the albumen quality in the poultry sector is to estimate egg freshness. The albumen of a freshly broken egg is determined using the logarithm of the height of the internal dense albumen, which has been adjusted for egg weight. Each egg is weighed before being broken, the height of the thick albumen then is measured, and both variables are combined in the Haugh unit equation. The accepted commercial and scientific index for determining the albumen quality of chicken eggs is the Haugh unit (Silversides, 1994).

In layers, egg production, egg weight, egg white index, yolk, shell thickness, feed intake and feed conversion efficiency are considerably improved as caused by adding *Yucca shidigera* to laying hens diet, therefore it is considered the best support for the production and overall performance of laying hens (Khaskheli et al., 2020). Kutlu et al. (2001) studied effect of *Yucca shidigera* powder on the performance and cholesterol content of eggs in laying hens. Experiment was conducted by providing 0.30 and 60 ppm L20 powder of *Yucca shidigera* in the diet. They reported Yucca supplementation in the diet positively influenced the eggs production, feed conversion efficiency, body weight, egg shell, egg white, egg weight and egg yolk. Investigations have shown that feeds with 30, 60, and 90 ppm of *Yucca shidigera* extract enhance egg production, feed utilization, egg weight, Haugh unit, egg yolks, and shell thickness, but decrease body weight (Guclu, 2003).

The addition of *yucca shidigera* to the poultry diet showed no obvious influence on feed consumption, egg yield, eggshell weight, total eggs laid in 42 days, shape index and weight gain. Egg weight and feed efficiency did tend to enhance with yucca addition, while shell thickness did not (Ayasan et al., 2005). According to Cabuk et al. (2004), adding yucca extract to the broiler ration at a level of 120 ppm had no impact on feed intake. On eggshell weight, *Yucca shidigera* had no noticeable beneficial effect. When laying hens were fed a basal diet, a similar result was observed (Kutlu et al., 2000). The optimum egg shape index was achieved by the group receiving 120 ppm of *Yucca shidigera*, while the highest shell thickness was achieved by the control group of *Yucca shidigera*. The control group of *Yucca shidigera* had thicker egg shells than the yucca supplemented groups (Kutlu et al., 2000; Nazeer et al., 2002; Guclu, 2003).

Feed consumption and feed conversion ratio:

The physical attributes of the feed, viscosity, saliva secretion, nutritional value, and particle size of the feed are among the variables that affect feed consumption (Blair, 2008). Table (5) shows the average values of feed consumption and feed conversion ratios for the studied groups. Highly significant differences were detected as regards to daily and accumulative feed consumption, where control group fed higher daily and accumulative quantities of feed, followed by those take low level of Yucca, while the lowest quantity of feed was taken by birds fed high level of Yucca in their diets. Therefore, feed conversion ratio values were better for birds fed high and low levels of Yucca, simultaneously. Growth rate, feed efficacy, and animal health are all improved by nutritional enrichment with Yucca extract (Colina and Chang, 2001; Duffy et al., 2001; Flaoyen et al., 2002; Kaya et al., 2003; Liang et al., 2009). Also, in laying Japanese quails Ayasan et al. (2005) documented that yucca supplementation significantly improved feed conversion ratio and egg weight. Moreover, yucca had phenolic compounds such as yuccaols and resveratrol which enhance feed efficiency leading to enhance laying performance (Bozin et al., 2006). The use of medicinal herbs in poultry feed has been related to higher body weight gain, enhanced feed efficiency, and decreased feed costs (Azoua, 2001; Abdel-Azem, 2006).

Egg production plays a vital role in how feed intake varies (Fairfull and Chambers, 1984). There is still a significant differential between birds even after accounting for these factors. That portion that is left over is known as residual feed consumption (Gabarrow et al., 2000). Residual fed consumption is described as the difference between actual feed intake and that expected based on demands for producing and maintaining body weight (Bentsen, 1983; Luiting and Urff, 1991; Kennedy et al., 1993; van Eerden et al., 2004).

In comparison to the control group, diets containing 100 and 200 mg/kg YE improved FE during the entire trial (Su et al., 2016). At 42 days of age, feed conversion ratio was enhanced by the inclusion of YE to the broiler's diet (Alfaro et al., 2007). Another way to lessen pollution of nutrient to the environment is to improve nutrient efficiency. Supplementing with 750 mg/kg of Yucca shidigera extract for six months led to improved final body weight, feed and protein efficiency rate, lowered FCR and enhanced the digestibility of protein, fat and energy (Gaber, 2006).

By consuming lower feed amount than the reference group, the Yucca inclusion can successfully stimulate growth of 173 g in the sixth week, demonstrating improved FCR, protein utilization ratio, and energy efficiency ratio in broiler production (Sahoo et al., 2015). Both in the starting and finishing periods of growth, the nutrient usage effectiveness of the Yucca group was considerably higher than that of the control group, This caused an FCR value of 1.91 in Yucca group which was considerably higher than the control group (2.10). (Sahoo et al., 2015). The addition of natural saponins from *Y. schidigera* to the basal diet was suggested to have improved the feed conversion ratio in the Yuccas' added group by emulsifying lipids, facilitating their digestion, and improving the absorption of minerals and vitamins (Alfaro et al., 2007; Cabuk et al., 2004).

Y. schidigera extract maintain metabolic activities controls environmental ammonia levels, improves feed conversion and production (Guclu, 2003). Wang and Kim (2011) reported that there was improvement in feed conversion efficiency and egg weight when diet was supplemented with *Yacca schidigera* extract. It has been observed that dietary *Yucca shidigera* extract affect the growth, blood physiology and egg quality in laying hen. In this regards study was carried out, whereby diet of layer birds was containing 0, 100 and 200 ppm Yucca extract. Body weight gain, egg yield, feed consumption and efficiency of using feed were improved with supplementation compared to control (Khaskheli et al., 2020). Preston et al. (1999) revealed that using of *Yucca shidigera* enhanced feed conversion efficiency. Guclu (2003) demonstrated that the performance of laying quail was not noticeably influenced by applying Yucca shidigera extract to their diet, But there has been a 7.20 % reduction in feed consumption and an enhancement in feed efficiency.

With addition of *Yucca shidigera* extract, the average feed conversion ratio was 5.28 comparing with 5.95 for the control group. This improvement in feed conversion ratio was mostly attributed to improved feed usage as a consequence to Yucca feeding (Ayasan et al., 2005). Malecki et al. (1995)

and Nazeer et al. (2002) noticed that adding *Yucca Shidigera* to the feed enhanced feed conversion ratio. In contrast, Kaya et al. (2003) showed that there was no difference in the feed conversion ratio across tested groups.

Cell mediated immunity:

Medicinal herbs have immune-modification characteristics on both cellular and humoral immunity (Niizawa et al., 2003). Effect of adding Yucca extract to laying hens ration on cellular immune response was shown in table (6). Toe-web swelling after injection with PHA-P substance clarified the cellular immune response, where highly significant impact for the high and low levels of Yucca added to laying hen diet was observed on cellular immunity after 24 hours post injection, while no significant influence was seen after 48 and 72 hours of injection with PHA-P among the various levels of Yucca addition on cellular immune response. The immune system could be activated by saponins, which also promotes tolerance to disease invasion (Cheeke, 2001). Moreover, it has been shown that YE added to the diet positively influences non-specific immunity (Yang et al., 2015). Interestingly, the phenolic compounds (such as yuccaols and resveratrol) had antimicrobial, antioxidant, immunomodulatory, anti-inflammatory, anti-carcinogenic, antifungal, antiviral and health-promoting activities (Cheeke et al., 2006; Ashour et al., 2014). In poultry industry, the immune response immune systems and protect against Pathogenic invasion (Berezin et al., 2010). Comparing to the control group, supplementation of diets with yucca improved IgG level (Alagawany et al., 2016). The cellular and plays a vital role in reducing or preventing infectious diseases. It is likely that natural phytogenics may be involved in stimulating the humoral immune response. Moreover, Palatnik de Sousa et al. (2004) suggested that yucca saponins could enhance humoral and cell-mediated immune responses, induce cytokine production, and stimulate inherent immune system. Su et al. (2016) confirmed that the inclusion of yucca powder in broiler ration stimulated cellular and humoral immune responses. It has been demonstrated via extensive research that the T-lymphocyte-dependent PHA intradermal reaction is a valid predictor of *in vivo* cellular immunity in chicken (Goto et al., 1978, McCorkle et al., 1980). In chickens, intradermal injections of PHA cause macrophage invasion and extensive perivascular abundances of lymphocytes 24 hours after injection because PHA is extremely mitogenic to T-lymphocytes (Goto et al., 1978, McCorkle et al., 1980). Basophil hypersensitive reaction has been identified as the cause of the enhanced basophil and eosinophil infiltration 24 hours after injection (Stadeckerm et al., 1977). Cellular immunity appears to be vital in regulating and eliminating intracellular bacteria (Kogut et al., 1994). In order to increase resistance to a disease threat, saponins can enhance the immune system (Cheeke, 2001). Furthermore, it has been demonstrated that YE introduced to the ration helps white shrimp to develop positive non-specific immunity (Yang et al., 2015). Immunizing hens with immunostimulating mixtures including pure saponins considerably improves their humoral immune system's responses could be strengthened by saponins. (Palatnik de Sousa et al., 2004). According to Su et al. (2016) findings, YE had a favorable effect at doses of 100 or 200 mg/kg on both cellular and humoral immune responses.

CONCLUSION

Attaining poultry production sustainability and immunological competences that diminishes environmental footmark of poultry breeding, in the same time covering the nutritional requirements is possible by inclusion of Yucca extract as a natural feed additive in poultry rations in a several amounts. Adding Yucca to laying hens diets leads to better egg production, egg mass, less feed consumption and therefore better feed efficiency and lower feed conversion ratio, better Haugh unit, increased shell % and shell thickness and enhanced sudden cellular immune response against injection with PHA-P. Generally, the enrichment of layer chickens ration with Yucca as one of the natural (phytogenic) feed additives could lead to many advantages such as improving the productivity of poultry industry and enhancing immune response profile. More studies are needed to emphasize these results and to evaluate the economic efficiency of using Yucca with high amounts in layers and broilers diets.

Table (1): The experimental design of the current study.

Yucca level									Total
Trt.	**Ctrl (0%)**	**Rep.**	**Trt.**	**0.25%**	**Rep.**	**Trt.**	**0.50%**	**Rep.**	
	10	R1		10	R10		10	R19	30
	10	R2		10	R11		10	R20	30
	10	R3		10	R12		10	R21	30
	10	R4		10	R13		10	R22	30
T1	10	R5	**T2**	10	R14	**T3**	10	R23	30
	10	R6		10	R15		10	R24	30
	10	R7		10	R16		10	R25	30
	10	R8		10	R17		10	R26	30
	10	R9		10	R18		10	R27	30
Total	**90**		**90**			**90**			**270**

Table (2): The composition and calculated chemical analysis of the laying diet.

Ingredient (%)	Laying diet
Yellow corn	52.00
Soybean meal (44%)	33.55
Sunflower oil	3.80
Wheat bran	--
Meat and bone meal (50%)	--
Limestone	8.15
Dicalcium phosphate	1.70
Vit-Min Me*	0.30
DL-Methionine	--
Lysine	--
Salt	0.50
Total	**100.00**
Calculated chemical analysis	
Crude protein, %	18.77
ME, Kcal/kg	2858
Calcium, %	3.50
Available phosphorus, %	0.46

* Each 2 kg contain Vit. A 0.96 mIU, Vit. E 0.16g, Vit B1 0.08g, Vit. B2 0.32g, Vit. B6 0.12g, Vit. B12 0.89g, Pantothenic acid 0.80g, Nicotinic acid 1.6g, Folic acid 80 mg, Biotin 4 mg, Choline chloride 40 mg, Cupper 0.8g, Iodine 0.08g, Iron 2.4g, Manganese 4.4g, Zinc 4.4 g and Selenium 0.008g.

Table (3): Average egg production traits for the experimental birds (2 birds/ cage) fed different levels of Yucca throughout 2 months of production.

Yucca level (L)	Egg Numbers	Egg Mass (g)	Egg weight (g)	Broken eggs
Ctrl.	54.36^{c}	1966.52^{c}	36.32^{b}	1.14
Low	61.58^{b}	2279.54^{b}	37.04^{ab}	1.54
High	79.77^{a}	3023.73^{a}	37.92^{a}	1.18
S.E.M.	1.84	72.85	0.25	0.14
Prob.	0.0001	0.0001	0.05	0.4

$^{a,\ b\ and\ c}$ Means within the same column with different superscript are significantly differed

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Table (4): Average of egg dimensions and quality measurements for the experimental birds.

Yucca level (L)	Shape index (%)	Fracture force (kg/cm^2)	Yolk color	Haugh unit	Shell weight (g)	Shell (%)	Shell thickness (mm)
Ctrl.	76.20^a	4.42	8.48	68.87^b	5.45	13.44^b	0.38^b
Low	75.76^a	4.45	8.38	70.56^a	5.54	13.36^b	0.39^a
High	74.76^b	4.55	8.23	71.97^a	5.55	13.54^a	0.39^a
S.E.M.	0.14	0.03	0.07	0.34	0.02	0.02	0.0009
Prob.	0.0001	0.2	0.4	0.0008	0.07	0.0007	0.0001

$^{a\ and\ b}$ Means within the same column with different superscript are significantly differed.

Table (5): Average of feed consumption and feed conversion ratio (FCR) for the experimental groups fed different levels of Yucca.

Yucca level (L)	Daily feed consumption (g)	Accumulative feed consumption (g)	Feed conversion ratio (FCR)
Ctrl.	83.31^a	5165.46^a	4.79^a
Low	83.20^b	5158.40^b	4.27^{ab}
High	83.08^c	5150.98^c	4.07^b
S.E.M.	0.02	1.34	0.12
Prob.	0.0001	0.0001	0.06

$^{a,\ b\ and\ c}$ Means within the same column with different superscript are significantly differed.

Table (6): Toe-web swelling after 24, 48 and 72 hours of injection with PHA-P as an indicator of cellular immune response for the experimental treatments.

Yucca level (L)	Cellular immune response (PHA-P), Toe web swelling (mm)		
	24 h post injection	**48 h post injection**	**72 h post injection**
Ctrl.	0.26^b	0.20	0.14
Low	0.32^a	0.21	0.16
High	0.31^a	0.23	0.14
S.E.M.	0.004	0.006	0.006
Prob.	0.0001	0.3	0.1

$^{a\ and\ b}$ Means within the same column with different superscript are significantly differed

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الملخص العربي

تأثير إضافة مستخلص نبات اليوكّا (يوكّا شيديجيرا) على إنتاج البيض، جودة البيض والإستجابة المناعية للدجاج البياض

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الحد من الآثار البيئية السلبية للإنتاج الداجني أمر حيوي في سبيل تحقيق الإستدامة لضمان الحصول على بروتين حيواني بأعلى إنتاجية وأفضل جودة وبأقل كلفة بيئية. وجد أن إضافة الأعشاب الطبيعية لعلائق الدجاج ضروري لإنتاج داجني نظيف صحي خالي من المتبقيات في اللحم والبيض. من تلك الإضافات العلفية العشبية وجد أن نبات اليوكا (يوكا شيديجيرا) يمكنه تحقيق تلك المعادلة خاصة أنه يمكن زراعته في الصحاري، مما يجعل له ميزة نسبية مرتبطة بالتغير المناخي وقلة موارد المياه. في هذه التجربة تم استخدام 270 دجاجة بياضة لدراسة تأثير إضافة مستويين من مستخلص اليوكا (0.25%، 0.50%) مقارنة بالمجموعة الحاكمة/ المقارنة (الكنترول) على إنتاج البيض، جودة البيض، معدل التحويل الغذائي والاستجابة المناعية الخلوية نتيجة الحقن بمادة PHA-P. وجد أن إضافة مستخلص اليوكا لعلائق الدجاج البياض أدى لتحسين إنتاج البيض، كتلة البيض، وزن البيضة، وحدة هوف (جودة البياض)، النسبة المئوية للقشرة، سمك القشرة، معدل التحويل الغذائي والاستجابة المناعية الخلوية نسبياً. وعليه فإنه يوصى بإضافة مستخلص نبات اليوكا لعلائق الدجاج لما له من تأثير إيجابي على زيادة إنتاج البيض، تحسين معايير الجودة، زيادة كفاءة استخدام العلف وأخيراً تحسين الخصائص المناعية بالإضافة لتقليل الأثر البيئي الناتج عن تربية الدواجن. ومع ذلك، تظهر نتائج هذه الدراسة الحاجة لمزيد من الأبحاث لدراسة التكلفة الإقتصادية لإضافة اليوكا لعلائق الدواجن ولتأكيد توصيات هذه الدراسة.

الكلمات المفتاحية: مستخلص اليوكا (يوكا شيديجيرا)، الأداء الإنتاجي، الاستجابة المناعية.