Productive performance and some physiological parameters of Japanese quail-fed diets supplemented with different levels of white shaving protein wastes.

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ABSTRACT:

This study was conducted to investigate the effect of the inclusion of thermal white shaving protein (TWSP) and acidic white shaving protein (AWSP) in the diets of Japanese quail on growth performance and some physiological parameters. A total number of 315 unsexed Japanese quail chicks at 7th days of age were randomly distributed in a complete randomized block design into 7 dietary treatments of 45 birds each, with three replicates containing 15 birds each. Treatment 1 was fed a control diet, while treatments from two to seven were fed diets containing TWSP and AWSP at levels of 8, 10, and 12% of the total protein in the rations. The groups that fed a diet with 10, 8, and 12% TWSP and 8% AWSP showed higher body weight and body weight gain than the other dietary treatments or the control group ($P \leq 0.05$). However, there was a significant ($P \leq 0.05$) increase in blood constituents, except for PCV%, due to the addition of TWSP and AWSP in the diets compared to the control group. Although the weight of lymphoid organs decreased due to the inclusion of TWSP and AWSP, the immune response was higher in the treatment groups ($P \leq 0.05$) than in the control group. Compared to the control group, the best economic efficiencies were observed for the birds-supplemented diets inclusion of TWSP and AWSP. In conclusion, the addition of TWSP and AWSP was completely safe without adversely affecting productive performance, physiological parameters, immunity, and economic efficiency.

Keywords: (Japanese quail; white shaving protein; productive performance; physiological parameters).

INTRODUCTION

In general, slaughterhouse and poultry waste are pathogens capable of infecting humans and animals. Therefore, their safe disposal limits the disease spread after slaughtering animals (Mozhiarasi and Natarajan, 2022). In Egypt, there is a severe problem represented by the shortage of raw materials for feeding poultry and their high prices. Therefore, researchers seek cheap, reasonable, and unconventional alternative sources. Animal waste is considered one of the pollutants that are dangerous to the environment, where the waste of tanneries generates a large amount of solid and liquid waste, which contains harmful chemical compounds in the background, such as chromium, which is used in the tanning process (Parisi *et al*., 2021). The amount of solid waste generated by tanneries varies depending on the kind of leather treated, where the hides and skins come from, and the methods each tannery employs. Wet trimmings, dry trimmings, wet shaving, buffing dust, and wastewater treatment sludge are among the significant solid wastes (Kanagaraj *et al.,* 2006). Subsequently, finding environmentally sustainable and innovative alternatives to manage and dispose of this waste has become a substantial challenge for tanneries and researchers worldwide. In this context, Plavša *et al.* (2016) found that the disposal of animal waste is an important preventive measure, mainly aimed at preventing the spread of infectious diseases in humans and animals. Interestingly, Ahmed *et al.* (2017) showed that raw skin husks, wet blue shaving dust, and wet blue low chrome are used as one of the main ingredients for manufacturing poultry feed, which is considered high protein sources. Maurer *et al.* (2018) found that collagen is an animal source rich in protein, where it contains methionine (6%) and lysine (19%) and plays a significant role as a nutritional supplement in the poultry ration (Nazeer *et al.*, 2011). Indeed, Chaudhary and Pati (2016) showed that the hydrolysis and purification of protein derived from chrome-tanned waste could be a partial substitute for soybean meal for broiler chickens. They indicated that the birds fed 20 and 30% hydrolyzed protein consumed 9.5 and 17.5% more feed and gained 6.5 and 16.6% more weight than birds fed soybean meal alone. Studies have shown that protein hydrolysis is economically profitable and can replace about 75% of soybean meal in broiler chicken diets without affecting growth performance. Therefore, this study was conducted to investigate the effect of inclusion thermal (TWSP) and acidic (AWSP) white shaving protein in diets of Japanese quail on growth performance and some physiological parameters. Also, the economic efficiency of the experimental diets was studied.

MATERIALS AND METHODS

The site and the aim of the study

This study was carried out in the research unit of the Department of Environment and Bio-Agriculture, Faculty of Agriculture, Al-Azhar University, Naser City, Cairo, Egypt, to investigate the effect of adding thermal (TTSW) and acidic (ATSW) white shaving protein at different levels 8, 10 and 12% of the total ration protein on some productive and physiological parameters of Japanese quail.

Collection, preparation, and precipitation of white shaving protein

Thirty-five kg of white shaving protein was obtained from the 6th October tannery, Cairo, Egypt, and transferred to the laboratory, where they were separated from other wastes and then washed with water and dried by exposing them to air in a shaded open place in a degree (30 ± 2°C) for 3 days. After drying, the dry matter was ground mechanically and turned into a fine powder. Acid-treated white shaving protein was made by taking one hundred grams of waste and shaking it in one liter of water for 24 hours at room temperature. Then the mixture was filtered, and the residue was treated with 40 ml of 10 % sulfuric acid at 25 °C, with shaking for 30 minutes after filtration. The residue was treated again as above, and the precipitate was obtained (Khatoon *et al.,* 2017). The other treatment was thermal treatment, where white shaving protein was dried in an oven at 105°C until the final weight varied to less than 0.2%. The volatile matter was measured by recording the final weight of the sample after placing them in an oven for seven minutes at 950°C, according to ASTM E872 (Forero-Núñez *et al*.,2016).

Birds, husbandry, experimental procedure, and productive performance

One-day-old chicks were purchased from a local hatchery. Chicks were raised together during the first 7th days of age to avoid any mortalities that occurred during the first life of age. At the end of the 7th day of the period, all chicks were individually weighed at the start of the experiment to the nearest gram to avoid the differences in weight at the beginning of the investigation and the average weight was found to be 27.03 to 27.04 ± 0.003 g. A total of 315 chicks at 7th days old were randomly distributed into 7 groups containing 45 birds each. Each group was represented by 3 replicates, each with 15 birds. The birds were housed in enclosed houses and maintained under similar environmental and management conditions. Chicks were housed in batteries provided by incandescent bulbs with 22 lx of light intensity. Birds were reared under similar environmental, managerial, and hygienic conditions. The temperature and relative humidity were recorded as averages during the experimental period. From 1 to 7th days of age all chicks were fed on the same basal diets containing the requirements of different nutrients required for growing Japanese quail. While at the 7th day of age (start of the experiment) thermal (TTSW) and acidic (ATSW) white shaving protein were added at levels of 8, 10, and 12% of the total ratio protein. All experimental rations were isocaloric and isonitrogenous and formulated to contain almost 24 % of CP and 2900 Kcal ME /Kg of the diets according to NRC (1994). Feed and water were offered *ad libitum* during the experimental period. The chicks were weighed at weekly intervals, and the average live body weight was recorded. Body weight gain, feed intake, feed conversion ratio (g feed /g gain), protein intake, energy intake, and protein and energy efficiency ratio were recorded.

Proximal chemical composition of diets, TWSP and AWSP, and faeces.

Proximate chemical compositions including moisture, dry matter, organic matter, ash, crude protein, and ether extract, were performed of TWSP, AWSP, diets, and feces according to AOAC (1994) as in Tables (1 and 2). Furthermore, gross energy (GE) was determined with a pump calorimeter (Parr Instrument 6772, USA).

Blood constituents and immunity titer response

At 42 days of age, approximately 4.0 mL of blood was collected from alive 3 males and 3 females after 14 hours of fasting from the jugular vein using 5 ml disposable sterile syringes for each treatment alone. Each blood sample from each individual was divided into two samples in heparinized tubes. One was to study hematological parameters. However, packed cell volume (Schalm *et al*., 1975), and hemoglobin (Young, 2001) were determined. The other was to study blood biochemical constituents including total protein (Gornall *et al.,* 1949) albumin (Doumas *et al.,* 1971), and

ALT and AST (Henery *et al.,* 1960). The samples were centrifuged at 3000 rpm for 15 minutes. Samples were stored in a deep freezer at -20°C until the time of analysis. The globulin values were obtained by subtracting the values of albumin from the corresponding values of total protein. Also, albumin/ globulin (A/G) ratio was obtained by dividing the values of albumin by the values of globulin. All tests were analyzed by using the Spectrophotometer apparatus (Model 722 GRATING).

Lymphoid organs and titer immune response

At the end of the growing period the lymphoid organs and titer immune response were studied, where 6 birds whose body weights were closest to the average of treatment were chosen. Birds fasted for approximately 14 hours before slaughter. To measure the antibody titer response blood samples were collected from the jugular vein for HI test (OIE, 2012). The immunoglobulin's G (IgG), M (IgM), and A (IgA) were determined according to Granfors (1979).

Digestibility trial

For the digestibility trial, 21 males were randomly selected and divided into 7 uniform groups based on body weight. Birds were housed in cages equipped with a wire-mesh floor and removable aluminum tray at the bottom to facilitate the collection and record of spilled feed. Samples were then ground to ensure a homogeneous mixture. Digestibility of different nutrients and AME were determined using the feed and excreta chemical analyses. Triplicate 1.0 g samples of feed and excreta were analyzed for gross energy (GE) using an adiabatic oxygen bomb calorimeter (Parr Instruments, Moline, IA). The following equation was used to calculate the digestibility coefficient:

Digestion coefficient% = Nutrient intake (g) – Fecal nutrient content (g) / Nutrient intake (g) ×100.

However, the AME digestibility values were calculated according to Cole and Haresign (1989).

AME/g of feed = (Fi x GE f) - (E xGE e)/ Fi

Where Fi is the feed intake (g); E is the excreta output (g); GE f is the gross energy/ g of feed, and GE e is the gross energy /g of excreta.

Economic efficiency:

The economic efficiency of the experiential diets was estimated by calculating the differences between the inputs and the analysis of the output as described by Bayoumi (1980).

Statistical Model

Data analysis according to Snedecor and Cochran (1982) was performed using General Linear Models (GLM) procedure of the SPSS software program package) Version 16 (SPSS, 2010). All data were analyzed based on a completely randomized design using one way ANOVA. Data were presented as means ± SEM. When the treatment effect was significant at P≤0.05. Duncan's test was applied to identify significant differences among groups (Duncan's, 1955). Data were analyzed by using the following model:

$X_{ijk} = M + \alpha_i + e_{ijk}$

Where, M = General mean, α_i = Effect of TWSP and AWSPlevels, e_{ijk}= Stander error for the observations.

RESULTS

Productive performance

The results of the productive performance of Japanese quails as affected by the inclusion of TWSP and AWSP are shown in Table (3). The initial live body weight at the start ranged between 27.03 to 27.04 ± 0.003 g as the average reflecting the absence of significant differences among the experimental groups. While, at 42 days of age the final body weight ranged from 232.17 to 220.23 ± 0.80 g, where the statistical analysis indicated that birds fed a diet inclusion of 10 % TWSP showed the highest final weight and body weight gain followed by groups fed 8% TWSP, 12% TWSP, 8% AWSP, 12% AWSP, 10% AWSP, and the control group respectively. However, birds fed the 10 % TWSP consumed higher feed intake than the other dietary treatments or the control group. Data concerning FCR showed that the best value observed for birds fed the diets inclusion 10 % TWSP and 8% AWSP than groups fed 10%TWSP, 8% AWSP, 10%AWSP, 12% AWSP and the control group respectively (p ≤ 0.05). On the other hand, protein intake recorded higher values for birds fed the control diet compared to the other dietary treatments. While emery intake showed the opposite trend, where birds fed diet incorporated with 10 % TWSP recorded the highest values than those observed for the other dietary treatments. The values of PER and EER exhibited (p ≤ 0.05) significantly higher trends for groups fed diet supplemented with % 12% TWSP, 8 % AWSP, 10% TWSP, and 8% TWSP than those values observed for birds fed diets inclusion 10%AWSP, 12%AWSP and the control group (Table 3).

Blood constituents

The results of plasma hematological and biochemical parameters as affected by the inclusion TWSP and AWSP are given in Table (4). Blood RBCs concentration showed a higher ($p \leq 0.05$) value for quail fed 12% TWSP, followed by groups fed 12% AWSP, 8% AWSP, 10% AWSP, 10% TWSP, and 8% TWSP than quail fed the control diet. While WBCs scored a higher trend for the groups fed 10% AWSP, 12 AWSP, and 8% AWSP than values recorded for birds fed different levels of TWSP or the control group ($p < 0.05$). In the same direction hemoglobin concentration also showed the highest ($p \leq 0.05$) records for groups fed 10% AWSP, 12% AWSP, and 8 % AWSP, followed by birds fed 12% TWSP, the control diet, 10 %TWSP and 8 % TWSP respectively. While the opposite trend was detected for PCV %, where insignificant differences was observed among the experimental groups due to the addition of AWSP and TWSP in the diets. Concerning total plasma protein, albumin, and globulin birds fed either AWSP or TWSP have higher values than birds fed the control group. While A/G ratio recorded a higher trend when birds fed the control diet or when fed diet supplemented with 8 % AWSP than values recorded for the other groups. Concerning liver function including ALT and AST data indicated that ALT values recorded the highest trend when birds fed the control diet or when fed the diet inclusion 8 % TWSP than those values detected for the other groups. While AST values showed the lowest trend when birds fed a diet incorporated with 12 %AWSP and 12 % TWSP compared to the values observed for other dietary treatments or the control group ($p \leq 0.05$).

Lymphoid organs and immune response

The results of lymphoid organs and immune response are affected by the inclusion of TWSP and AWSP in the diets are shown in Table (5). From these results, it is observed that the bursa of Fabricius, liver and spleen weights recorded higher weights for birds fed the control diet than values detected for the birds fed diets inclusion different levels of TWSP and AWSP ($p \leq 0.05$). While, thymus gland showed the opposite trend, where birds fed a diet supplemented with 8 % TWSP have higher values than birds fed the other dietary treatments or the control group. Interestingly, although the decrease of most lymphoid organs weight due to supplementation of TWSP and AWSP in the diets, the immune titer response recorded higher trend when birds fed either TWSP or AWSP, except for 8% TWSP group, than values observed for the control group. With respect of immunoglobulin classes including IgG, IgM, and IgA, results indicated that birds fed the diets inclusion TWSP and AWSP recorded the highest concentration of than values recorded for the control group ($p \leq 0.05$).

Digestibility coefficient

Table (6) shows the digestibility of different nutrients as affected by the inclusion of TWSP and AWSP in the diets. From the present results, it is interesting to note that the digestibility coefficient of the dry matter %, organic matter %, crude protein % and ether extract % significantly improved when birds fed a diet supplemented with 10% TWSP, followed by the birds fed diet inclusion 8% TWSP, 12%TWSP, 8%AWSP, 12%AWSP, 10%TWSP and the control group respectively ($p \leq 0.05$). While the AME values, statistical analysis indicated that insignificant differences observed among the experimental groups due to the inclusion of TWSP and AWSP in the diets.

Economic efficiency

The economic efficiency of the experimental diets is presented in Table (7). The obtained data indicated that quails fed on diets containing different levels of TWSP and AWSP recorded lower feed costs and higher economic efficiency than the quails fed on the control diet. It is clear from these results that the addition of TWSP and AWSP in quail diet resulted in higher economic efficiency than the birds fed the control diet.

DISCUSSION

Productive performance

It is noted that no health problems occurred during the experiment due to the nutritional supplementations. Therefore, the present study reported that there was a significant increase in weight and gain ($p \leq 0.05$) with diet inclusion TWSP at 10%, followed by groups fed 8% TWSP, 12% TWSP, 8% AWSP, 12% AWSP, 10% AWSP and the control group respectively. In this respect, the difference in gain due to supplementation of TWSP and AWSP is likely attributable to the fact that additional protein via the diet promotes growth because bird growth is directly proportional to feed components, species, and age of the bird (Zampiga *et al.,* 2022). In other words, collagen is a rich source of methionine (6%) and lysine (19%) Nazeer *et al*., 2011), in addition to glycine, which is another important amino acid that acts as an anti-inflammatory and protects against various diseases (Wang *et al.,* 2013). Collagen also contains proline, which is important in giving a high growth rate compared to other amino acids. This result is consistent with Nurubhasha *et al*. (2019) showed that collagen protein provides higher quality amino acids than those found in the traditional ration, where feeding broilers with the traditional diet supplemented with 10% collagen showed a significant increase in body weight compared to other dietary treatments or the control group. They also added that collagen can play an important role in enhancing muscle content; improve the health of birds when they are included in the diet. Accordingly, Riaz and Alam (2006) found that the growth performance of quail chicks improved when fed different levels of chromium and chromium-tanned skin shavings. However, it is of interest to mention that feed intake, significantly increased with the diet inclusion TWSP at a level 10% compared to the other dietary treatments or the control group. While the values of PER and EER recorded the highest records for birds fed diets supplemented with 8 ,10 and 12 % TWSP and 8 % AWSP compared with 10 and 12% AWSP and the control group. Obviously, feed conversion ratio was significantly better when birds fed diets inclusion either TWSP or AWSP compared to the control group. This may be due to essential amino acid play a major role in improving the feed conversion ratio, which allows better absorption of all nutrients present in the diet. Interestingly, a lower feed conversion ratio is a positive sign that maximum utilization of available nutrients and conversion of birds into useful energy through regular metabolism may avoid feed wastage and thus reduce cost. The results obtained by Chaudhary and Pati (2016) found that birds fed 20 and 30 % protein hydrolysate consumed 9.5 and 17.5 % higher amount of feed and gained 6.5 and 16.6 % higher than birds fed soyabean meal diet. No mortality was observed, because collagen being a potential antioxidant which can inhibit oxidative reaction of free radicals viz., reactive oxygen/nitrogen species which can cause cells death (Sarma *et al*., 2010), for this reason the experimental birds were healthy along the experimental period. Indeed, the better survival rate may be attributed to other management factors that favored health and hygiene, where frequent manure removal facility in multitier cage ensured cleanliness and uniform feed allowance per bird, being more particularly required for the nutrition of less active birds to maintain sound health. No mortality was recorded during the experiment because collagen is a potential antioxidant that can prevent the oxidative reaction of free radicals, i.e., reactive oxygen/nitrogen species that can cause cell death (Sarma *et al.,* 2010), and for this reason the experimental birds were healthy along the experiment. In fact, the better survival rate may be attributed to other management factors that favored health and hygiene.

Blood constituents

No available data concerning the effect of white shaving protein on blood constituents of Japanese quail. It is known that blood reflects the pathological health of animals exposed to toxins and other conditions (Olafedehan *et al.,* 2010). Interestingly, blood biochemical parameters are usually related to health status, where these parameters are indicator of the nutritional and physiological status of birds. Accordingly, birds with a good blood composition are likely to perform well. Accordingly, Togun *et al.* (2007) reported that hematology studies are useful in diagnosing many diseases as well as investigating the extent of blood damage. Under the conditions of the present results, it is evident that the addition of TWSP and AWSP in the diets led to a significant improvement in the hematological traits, where all the results were within the normal range of blood values in Japanese quail, indicating the absence of any health problems. However, the change in hematological parameters is often used to determine the different state of the body and to identify stress due to environmental, nutritional, or pathological factors. The RBCs count is an indicator of the oxygen-carrying capacity of the blood, where it is used as an indicator of the health of the birds (Sergent *et al.,* 2004). It might be expected from these results that birds fed TWSP and AWSP achieved a higher number of RBCs, WBCs, and hemoglobin concentration at 42 days of age than birds fed the control diet. The high RBCs and Hb concentration are evident, where they are closely related to each other in the blood. Nevertheless, birds that were characterized by a greater number of RBCs could have high Hb contents. Further, the quail fed TWSP and AWSP had the highest peripheral blood WBCs compared to birds fed the control diet. However, WBCs respond to pathogens or stress environments and participate in innate immune responses according to both nonspecific and specific immune responses, accordingly, the results showed significantly higher levels of WBCs when birds fed TWSP and AWSP in this study. This can be attributed to the increase of WBCs in the blood, which leads to an immune control effect, but due to the lack of prior research, careful study is needed. This finding is agreed with An *et al.* (2019) showed that broilers fed the control diet, 0.1% fish collagen powder, and 0.1% pig skin collagen diets had higher ($p \leq 0.05$) white blood cell than the broilers fed the control and basal diet+ 0.1% fish collagen. However, it is notice that blood protein profiles significantly affected by the dietary supplementation, where it is in the normal rang reflecting that the liver is not affected by the incorporating of TWSP and AWSP in the diets. The data Obtained showed a tendency of gradual increase of protein profile concentrations by supplementation of TTSW and ATSW in the diets. The results of Filipović *et al.* (2007) showed a significant increase in serum protein concentrations in chickens from the 14th to the 42nd days of age, which was related to the processes of growth and feeding with protein-rich diets during the fattening period. This period is characterized by an ample supply of amino acids for very intense somatic growth, thus the liver increases serum protein synthesis resulting in increased total protein concentrations in the blood (Szabó *et al.,* 2005). Moreover, the intensity of protein build-up in tissues may significantly influence blood protein concentrations, as well as their composition (Scanes, 2015). On the other hand, it was observed from this study that the inclusion of TWSP and AWSP in the diets was safe without any harmful side effects on liver function, which is evident from the normal values of liver enzymes, which ultimately reflected in the productive performance. Accordingly, Kaplan *et al.* (2003) indicated that because the liver contains enzymes named ALT and AST, these enzymes are released into the blood when liver damage occurs. Therefore, the rise in AST and ALT reflects changes due to an increase in the permeability of the hepatocyte membrane due to hypoxia in the circulatory system, exposure to toxins, metabolic disorders, or proliferation of hepatocytes (Rani *et al.,* 2011). Thus, the presence of significant decreases of either ALT or AST among the experimental groups may reflect normal liver function for birds fed TWSP and AWSP compared to the control diet. Generally, it is clear that quails fed TWSP and AWSP did not adversely affect hematological or biochemical measures which was ultimately reflected in a better growth response.

Lymphoid organs and immune response

The liver, spleen, and bursa of Fabricius are the major immune-related organs and as the weight increases, the immune function improves (Rivas and Fabricant, 1988). The data indicated that bursa of Fabricius, liver and spleen weights recorded significantly ($p \leq 0.05$) higher weights of quails fed the control diet than birds fed diets inclusion different levels of TWSP and AWSP. While, thymus gland showed the opposite trend, where birds fed a diet supplemented with 8 % TWSP have higher values than birds fed the other dietary treatments or the control group. The results obtained are partially agree with An *et al.* (2019) found that there were no significant differences in the organ weights of broiler chickens fed basal diet, basal diet supplemented with fish collagen powder 0.1%, basal diet supplemented with pig skin collagen 0.1%, basal diet supplemented with pig skin collagen 0.5%, and basal diet supplemented with pig skin collagen 1.0%. The data obtained showed that there was a trend for a decrease in most of the weight of lymphoid organs because of the addition TWSP and AWSP in the diets. It is evident that, there was a gradual increase in the concentration of IgG, IgM and IgA, when TWSP and AWSP increased in the diet. Interestingly, IgG produced in B cells in bone marrow, where it is the highest concentration of immune proteins and is mainly responsible for in vivo immunity (Kim *et al*., 2009). There are reports that higher serum IgG levels improve growth performance (Cetin *et al.,* 2005), and thus there was a significant increase in immunoglobulin classes in this study. Results of Carsetti *et al.* (2004) found that IgG, IgM, and IgA are produced at the highest levels in the peripheral blood of poultry and are important indicators of the functional status of the humoral immune system. This study indicated that the quail immune response was stronger, and the levels of IgG, IgM and IgA were higher for quail fed diets supplemented with TWSP and AWSP compared to the birds fed the control diet.

Digestibility coefficient

It is well known that, acid and thermal hydrolysis are methods used to degrade collagen from complex to simple form, resulting in improved nutritional value as well as amino acid availability in animal by-products. (Moritz and Latshaw 2001; Dai *et al.,* 2014). No data information is available on the use of AWSP and TTWSP to enhance the digestion of nutrients in Japanese quail. In this study, it was observed that the digestion of DM, OM, CP, and EE% was significantly improved due to the addition of 10% TWSP compared to the other dietary treatments or the control diet. The significant improvement in digestibility values, especially at the level of 10% TWSP, is due to the nutritional effect of collagen, and this may be due to the availability of nutrients such as essential amino acids (Nurubhasha *et al.,* 2019), unsaturated and polyunsaturated fatty acids, along with the necessary essential vitamins and minerals. In this context, León-López *et al*. (2019) indicated that collagen is characterized by a high concentration of three major amino acids, glycine, proline, and hydroxyproline, which create its characteristic triple helix structure. Also, Araníbar-Araníbar *et al*. (2020) indicated that the hydrolyzed sheep and alpaca skins have a high content of macronutrients with acceptable digestibility of the nutrients, making them a viable alternative to improve the nutritional value of rainbow trout rations. In addition, results of Iwai *et al.* (2005) showed that the collagen is enzymatically hydrolyzed, and this breaks it down into smaller peptides (the primary complementary form of collagen) that are easily absorbed within the digestive tract before entering the circulation. Also, Holwerda and Van Loon (2022) indicated that the hydrolysis of dietary protein into peptides increases the postprandial rate of appearance of amino acids derived from dietary protein in the plasma circulation after protein ingestion. Further, Lis and Baar (2019) showed that ingestion of 15 grams of hydrolyzed collagen and gelatin produced nearly identical postprandial plasma concentrations of glycine, leucine, proline, and hydroxyproline, but not leucine, 1 hour after protein ingestion.

Economic efficiency

From an economical point of view, the new trend of using alternative and cheap protein sources to the currently expensive soybean meal may lead to a reduction in the production cost of balanced poultry feed while at the same time reducing dependence on soybean meal. Therefore, one of the new and unknown alternatives to partial replacement of soybeans meal in poultry feed is the addition of white shaving protein wastes, (TWSP and AWSP), in diets as a new sources of animal protein origin. Nevertheless, the data presented in Table 7 indicated that both net revenue and economic efficiency were increased by the inclusion of TWSP and AWSP in the diets compared to the control group, this may be attributed to the greater weight gain and an improved FCR. Subsequently, the addition of TWSP and AWSP in quail diets lowered fed cost and improved economic efficiency. The results obtained are similar with results obtained by Caires *et al*. (2010) indicated that the inclusion of feather meal in broiler diets reduces the relative cost per unit weight gain. Also, Hasni *et al*. (2014) reported that feeding broiler chickens with diet supplemented with100% feather meal as an alternative to fishmeal proved to be more economical to raise, without any negative effect on their performance.

CONCLUSION

In general, it can be concluded that replacing part of the total protein ration with white shaving protein wastes significantly improved productivity and did not adversely affect the physiological function of the body. In addition, there is a positive effect of the inclusion of white shaving protein wastes on the immune response of birds, and this is evidenced by an increase in the immune titer response, and then TWSP or AWSP can be used as an alternative and effective source in the manufacture of poultry rations.

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Table 1: Nutrient compositions of the experimental diets.

Ingredients	Control diet (0.0%)	Levels of AWSP[1]			Levels of TWSP[2]		
		8%	10%	12%	8%	10%	12%
Yellow corn (8.5 % CP)	51.00	50.00	50.00	50.00	50.00	50.00	50.00
Soybean meal (44 % CP)	28.47	22.10	22.10	20.00	24.50	23.00	22.20
Gluten meal (60% CP)	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Wheat bran (15.7%)	4.14	8.87	8.84	10.34	7.00	7.90	8.19
White shaving protein	-	1.92	2.40	2.88	1.92	2.40	2.88
Corn starch (0.062% CP)	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Sunflower oil	0.00	1.20	0.90	0.90	0.50	0.62	0.65
Calcium carbonate ($CaCo_3$)	1.20	1.26	1.20	1.20	1.26	1.26	1.26
Sodium chloride (Na Cl)	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Mineral and vitamin pre-mix[3]	0.40	0.40	0.40	0.40	0.40	0.40	0. 40
Choline chloride $Cl(3NCH_2CH_2OH)$	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Di-calcium phosphate ($CaHPO_4$)	1.00	0.60	0.50	0.50	0.76	0.76	0.76
L- lysine	0.53	0.39	0.40	0.52	0.40	0.40	0.40
Total (Kg)	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated diet compositions[4]							
Crude protein (%)	24.00	24.00	24.00	24.00	24.00	24.00	24.00
Metabolizable energy (Kcal/Kg)	2900.0	2900.0	2900.0	2900.0	2900	2900.0	2900.0
Ether Extract (%)	2.53	2.66	2.69	2.69	2.65	2.67	2.70
Calcium (%)	0.80	0.82	0.82	0.82	0.85	0.85	0.86
Available phosphorus (%)	0.33	0.30	0.30	0.30	0.32	0.33	0.33
Arginine (%)	1.30	1.18	1.20	1.20	1.24	1.26	1.28
Lysine (%)	1.32	1.32	1.33	1.33	1.38	1.39	1.40
Methionine (%)	0.57	0.56	0.58	0.58	0.57	0.58	0.59
Methionine + Cysteine (%)	0.47	0.59	0.96	0.96	0.97	0.98	0.98
ME/CP ratio[5]	120.83	120.83	120.83	120.83	120.83	120.83	120.83
Analyzed (AOAC, 1994):							
DM (%)	88.43	88.50	88.51	88.26	88.33	88.22	88.24
OM (%)	82.14	82.25	82.33	82.36	82.30	82.41	82.43
CP (%)	24.08	24.03	24.05	24.02	24.09	24.06	24.04
EE (%)	3.03	2.92	2.88	2.75	2.66	2.80	2.77
GE (Kcal/kg)	3775	3773	3776	3777	3775	3776	3777

AWSP= Acid white shaving protein., TWSP= Thermal white shaving protein.

Each 3kg of growing pre-mixes contains:Vita A 12000000.u-vita D 2000000-vita E 10000 –vita K 1000mg –vita B_1 1000mg –B_2 5000mg -1500mg – B_{12} 10mg-pantothenic acid- folueic acid 1000mg- biotin 50mg – niacin 20000mg- fe 30000- mn 60000- cu 4000mg- zn 5000mg-130000mg- selenium 100mg .

Calculated diet compositions was performed according to (NRC, 1994).

Metabolizble energy/ crude protein ratio.

Table 2: Chemical composition of acidic and thermal white shaving protein

Items	AWSP[1]	TWSP[2]
DM%[3]	94.69	92.06
MO%[4]	5.31	7.94
CP %[5]	96.0	79.35
GE kcal/kg[6]	2931.5	2931.5
ME kcal/kg[7]	2255	2255
Ash%	1.84	13.92
EE%[8]	1.3	3.88
CF[9]	0.85	2.72
NFE[10]	0.01	0.13

AWSP= Acid white shaving protein. TWSP= Thermal white shaving protein, 3-DM=dry matter, 4-MO=moisture, 5-CP=crude protein, 6-GE=gross energy, 7-ME=metabolizable energy, 8-EE=ether extract, 9-CF=crud fiber, 10-NFE=nitrogen free extract.

Table 3: Effect of the inclusion thermal and acidic white shaving protein on the productive performance of Japanese quail for whole period (Means ±SE).

Treatments	Traits								
	IBW[1]	FBW[2]	BWG[3]	FI[4]	FCR[5]	PI[6]	EI[7]	PER[8]	EER[9]
C (0.0%)	27.03	220.23^{b}	193.20^{b}	674.76^{b}	3.49^{a}	162.48^{a}	1956.8^{b}	1.18^{b}	9.87^{b}
C+ 8 % TWSP	27.03	232.0^{a}	204.96^{a}	662.51^{d}	3.23^{d}	159.21^{c}	1921.13^{d}	1.28^{a}	10.66^{a}
C+ 10 % TWSP	27.03	232.17^{a}	205.13^{a}	678.39^{a}	3.30^{c}	163.15^{a}	1967.30^{a}	1.25^{a}	10.42^{a}
C+ 12% TWSP	27.03	228.87^{a}	201.83^{a}	656.41^{e}	3.25^{d}	157.67^{d}	1903.60^{e}	1.27^{a}	10.60^{a}
C+ 8 % AWSP	27.04	227.50^{a}	200.46^{a}	662.79^{d}	3.30^{c}	159.67^{c}	1922.10^{d}	1.25^{a}	10.43^{a}
C+ 10 % AWSP	27.03	221.03^{b}	193.99^{b}	670.55^{c}	3.38^{b}	161.34^{b}	1944.60^{c}	1.20^{b}	9.97^{b}
C+ 12% AWSP	27.03	221.37^{b}	194.33^{b}	664.56^{d}	3.42^{b}	159.76^{c}	1927.20^{d}	1.21^{b}	10.08^{b}
Pooled SEM[10]	0.003	0.80	0.80	0.62	0.07	0.15	1.82	0.005	0.04
F-value	1.000	6.963	6.693	35.846	45.363	39.081	35.846	9.294	8.960
Sig. [11]	0.425	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

^{ab} Means with different superscripts within a column are significantly different at $P < 0.05$.

* $P < 0.05$.

IBW=Initial body weight, 2-FBW=Final body weight, 3-BWG=Body weight gain, 4-FI=Feed intake,
5-FCR=Feed conversion ratio, 6-PI=Protein intake, 7-EI=Energy intake, 8-PER=Protein efficiency ratio,
9-EER=Energy efficiency ratio, 10-SEM = Standard error of means, 11-Sig. test= Significant test at ($p < 0.05$)

Table 4: Effect of the inclusion thermal and acidic white shaving protein on the hematological and biochemical blood parameters of Japanese quail at the end of the experimental period (Means ±SE).

Treatments	Parameters									
	RBCs[1] (x103 mm3)	WBCs[2] (x106 mm3)	Hb[3] g/dL	PCV[4] %	TPP[5] g/ dL	TPA[6] g/ dL	TPG[7] g/ dL	A/G[8] ratio	ALT[9] U/L	AST U/L[10]
C (0.0%)	3.60^{c}	20.47^{bc}	13.78^{ab}	48.72	6.50^{c}	3.19^{b}	3.31^{c}	0.96^{a}	23.30^{a}	11.70^{a}
C+ 8 % TWSP	3.62^{c}	20.50^{bc}	13.51^{b}	48.59	6.62^{b}	3.18^{b}	3.44^{a}	0.92^{c}	22.88^{a}	11.43^{a}
C+ 10 % TWSP	3.67^{b}	20.22^{c}	13.90^{b}	48.19	6.64^{ab}	3.19^{b}	3.44^{a}	0.92^{c}	21.62^{b}	11.43^{a}
C+ 12% TWSP	3.72^{a}	20.93^{b}	14.05^{ab}	48.67	6.65^{ab}	3.20^{b}	3.45^{a}	0.92^{ab}	20.91^{b}	11.39^{a}
C+ 8 % AWSP	3.67^{b}	21.14^{a}	14.24^{a}	48.79	6.65^{ab}	3.26^{a}	3.39^{b}	0.96^{a}	21.26^{b}	11.38^{a}
C+ 10 % AWSP	3.67^{b}	21.51^{a}	14.46^{a}	48.82	6.67^{a}	3.23^{a}	3.44^{a}	0.94^{bc}	21.54^{b}	10.86^{b}
C+ 12% AWSP	3.69^{b}	21.27^{a}	14.28^{a}	48.72	6.68^{a}	3.25^{a}	3.42^{ab}	0.95^{ab}	21.45^{b}	10.87^{b}
Pooled SEM[11]	0.007	0.09	0.08	0.11	0.01	0.006	0.009	0.004	0.16	0.06
F-value	10.220	5.903	2.618	0.502	20.855	8.090	4.727	3.132	7.985	6.932
Sig. [12]	0.000	0.000	0.033	0.803	0.000	0.000	0.001	0.015	0.000	0.000

^{ab} Means with different superscripts within a column are significantly different at $P < 0.05$.

RBCs= red blood cells, 2- WBCs =White blood cells, 3-Hb= Haemoglobin, 4- PCV= Packed cell volume,
5- TPP= Total plasma protein, 6-TPA= Total plasma albumin, 7- TPG= Total plasma globulin,
8-A/G = Albumin / globulin ratio, 9- ALT= Alanine aminotransferase, 10-AST= Aspartate aminotransferase,
11-SEM = Standard error of means, 12- Sig. test= Significant test at ($p < 0.05$).

Table 5: Effect of the inclusion thermal and acidic white shaving protein on lymphoid organ weights and immunity titer response (log ^{2} value) of Japanese quail at the end of the experimental period (Means ±SE).

Treatments	Traits							
	Bursa of Fabricius	Liver	Thymus	Spleen	Immunity response (HI Titer log^{-2} value)	Immunoglobulin's classes (mg / dL)		
						IgG	IgM	IgA
C (0.0%)	0.56^{a}	7.42^{a}	0.24^{abc}	0.52^{a}	5.01^{b}	944.03^{c}	180.99^{c}	95.42^{b}
C+ 8 % TWSP	0.39^{b}	6.05^{ab}	0.29^{a}	0.26^{c}	5.28^{b}	947.67^{bc}	183.33^{b}	97.28^{a}
C+ 10 % TWSP	0.38^{b}	4.71^{b}	0.26^{abc}	0.38^{b}	6.10^{a}	953.47^{a}	183.30^{b}	97.77^{a}
C+ 12% TWSP	0.30^{b}	4.49^{b}	0.19^{c}	0.22^{c}	6.20^{a}	954.17^{a}	183.93a^{b}	97.85^{a}
C+ 8 % AWSP	0.37^{b}	4.51^{b}	0.20^{bc}	0.18^{c}	6.21^{a}	954.52^{a}	184.76^{a}	97.79^{a}
C+ 10 % AWSP	0.35^{b}	4.76^{b}	0.20^{bc}	0.25^{c}	6.27^{a}	952.01^{ab}	183.58^{ab}	96.48^{ab}
C+ 12% AWSP	0.32^{b}	4.36^{b}	0.27^{ab}	0.24^{c}	6.22^{a}	952.82^{ab}	184.72^{a}	97.32^{a}
Pooled SEM[1]	0.016	0.33	0.01	0.02	0.06	0.91	0.23	0.19
F-value	7.728	1.901	2.995	9.182	18.972	5.104	10.104	4.234
Sig. [2]	0.000	0.108	0.018	0.000	0.000	0.001	0.000	0.002

^{ab} Means with different superscripts within a column are significantly different at P < 0.05.

1-SEM = Standard error of means, 2- Sig. level= Significant test at (p < 0.05).

Table 6: Effect of inclusion thermal and acid white shaving protein on digestibility coefficient of Japanese quail at the end of the experimental period (Means ±SE).

Treatments	Traits						
	DM%[1]	OM%[2]	CP%[3]	EE%[4]	GE[5]		AME[6]
					In diets	In excreta	
C (0.0%)	79.24^{d}	67.23^{e}	79.26^{e}	60.20^{d}	3775^{ab}	1526^{b}	2889
C+ 8 % TWSP	79.56^{b}	67.63^{b}	79.88^{b}	61.23^{b}	3773^{b}	1580^{ab}	2892
C+ 10 % TWSP	80.10^{a}	68.91^{a}	80.23^{a}	62.14^{a}	3776^{a}	1588^{ab}	2895
C+ 12% TWSP	79.45^{bc}	67.51^{c}	79.70^{c}	61.23^{b}	3777^{a}	1609^{a}	2894
C+ 8 % AWSP	79.45 ^{c}	67.38^{d}	79.43^{d}	61.09^{c}	3775^{ab}	1522^{b}	2892
C+ 10 % AWSP	79.41^{c}	67.20^{e}	79.25^{e}	61.15^{c}	3776^{a}	1535^{b}	2892
C+ 12% AWSP	79.59^{b}	67.24^{e}	79.13^{e}	61.15^{c}	3777^{a}	1527^{b}	2895
Pooled SEM[7]	0.056	0.125	0.083	0.116	0.39	9.95	0.74
F-value	279.163	1041.0	94.724	713.649	2.733	1.002	1.148
Sig. [8]	0.000	0.000	0.000	0.000	0.057	0.462	0.386

^{ab} Means with different superscripts within a column are significantly different at P < 0.05.

1-DM=Dry matter, OM-Organic matter, CP=Crude protein, 4-EE=Ether extract, 5-G= Gross energy,

6-AME (kcal/g) =Apparent metabolizable energy, 7-SEM = Standard error of means, 8- Sig. level= Significant test at P < 0.05.

Table 7: Economic efficiency of experimental diets.

Treatments	Traits						
	C (0.0%)	C+ 8 % TWSP	C+ 10 % TWSP	C+ 12% TWSP	C+ 10 % AWSP	C+ 10 % AWSP	C+ 12% AWSP
I BW (g/bird)[1]	27.04	27.03	27.04	27.04	27.03	27.04	27.04
FBW (g/bird)[2]	153.56	232.17	232.18	228.89	227.21	226.03	221.31
FI (g/bird/period)[3]	674.6	662.8	677.8	656.4	662.9	665.7	664.70
Feed cost (kg /LE)	18.8	18.7	18.2	18.5	18.5	18.3	18.1
Feed cost (LE/chick)[4]	12.67	12.3	12.3	12.14	12.26	12.18	12.03
Price of chick at 7 d (LE) [5].	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Cost of husbandry (LE)[6]	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Total cost (LE/chick)	18.6	18.3	18.3	18.1	18.2	18.1	18.03
Sale price of one bird (LE)[7]	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Net revenue (LE)/ bird[8]	1.4	1.7	1.7	1.9	1.8	1.9	1.7
REE (% control)[9]	100.0	121.43	121.42	135.71	128.57	135.71	121.42

IBW= Initial body weight
FBW=Final body weight
FI= feed intake
Accodring to the price of different ingredients available in Egypt at 2022
Fixed cost
Cost of husbandry comprise price of labor, light, drugs and etc.
Price of one bird at marketing = 20 LE.
Net revenue per unit total cost
REE= Relative economic efficiency, assuming that the relative economic efficiency of control group equals 100%.

الأداء الإنتاجي وبعض المقاييس الفسيولوجية للسمان الياباني المُغذى على علائق مدعمه بمستويات مختلفة من مخلفات بروتين جلد المدابغ

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الملخص العربي

هدفت هذه الدراسة إلى تقييم تأثير إضافة مخلفات بروتين جلد المدابغ المعامل حراريا (TWSP) او المعامل بالحامض (AWSP) في علائق السمان الياباني على الاداء الإنتاجي وبعض المقاييس الفسيولوجية. استخدم عدد ٣١٥ كتكوت مختلط الجنس بعمر ٧ أيام حيث تم توزيع هذا العدد عشوائيًا في تصميم عشوائي كامل إلى ٧ معاملات غذائية بواقع ٤٥ طائرً لكل معامله، واحتوت كل معامله على ثلاث مكررات بكل منها ١٥ طائرً. المعاملة الاولى غذيت على العليقة الكنترول بينما تم تغذية المعاملات ٢، ٣ ،٤، ٥، ٦، ٧ على علائق مدعمه بمستويات مختلفة من جلد المدابغ بمستويات ٨، ١٠، ١٢٪ من البروتين الكلي للعلائق على التوالي. وجد أن الطيور التي تم تغذيتها على TWSP بمستويات ١٠، ٨، ١٢٪، AWSP عند مستوى ٨٪ أظهرت زيادة معنوية في وزن الجسم ووزن الجسم المكتسب مقارنة بباقي المعاملات أو المجموعة الكنترول. لوحظ أن هناك زيادة معنوية في مكونات الدم باستثناء قيم PCV نتيجة اضافه TWSP وAWSP في الغذاء مقارنة بالمجموعة الكنترول. على الرغم من انخفاض وزن الأعضاء اللمفاوية نتيجة إضافة TWSPو AWSP إلا أن الاستجابة المناعية كانت أفضل بشكل ملحوظ في المعاملات مقارنة بالمجموعة الكنترول. لوحظ أن أعلى كفاءة اقتصادية كانت للمعاملات التي اشتملت على مستويات مختلفة من TWSP، AWSP مقارنة بمجموعة الكنترول. بناءً على النتائج الحالية يمكن التوصية بأن إضافة مخلفات بروتين جلد المدابغ في غذاء السمان الياباني كانت آمنة تماما دون حدوث أي آثار سلبية على الأداء الإنتاجي أو المقاييس الفسيولوجية والتي يمكن الحكم عليها من خلال الحالة الصحية حيث لم تسجل أي وفيات ولم يحدث أي خلل في المقاييس الفسيولوجية على طول الفترة التجريبية.

الكلمات الاسترشادية: (السمان الياباني، بروتين السلالة البيضاء، مخلفات بروتين جلد المدابغ ، الأداء الإنتاجي ، المعايير الفسيولوجية).