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Response of Growing Japanese Quails to Different Types of Some Natural Seed Meals on Performance, Carcass Traits and Some Bbiochemical Parameters

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Abstract

A TOTAL OF 450 unsexed Japanese quail (one-week-old) were raised in cages until they were seven weeks old. The purpose of this experiment was to find out how the growth of Japanese quail responds to different types of medicinal seed meals. All birds were divided and distributed into five equal treatments (90 birds/treatment), with three replicates of 30 birds each. The control group (T1) was fed a basal diet without any additives, while the other three groups (T2, T3, and T4) were fed the same basal diet with a 1% addition of black seed meal (BSM), sesame seed meal (SSM), and radish seed meal (RSM), respectively, while group five (T5) was fed a basal diet with a mixture of BSM, SSM, and RSM at a level of 1/3% of each. All diets contained 24% crude protein and iso-caloric (2900kcal ME/kg). The results obtained revealed that both LBW and WG were surpassed and had better by using natural additive meals as feed enhancers compared to the control. Also, FI was nearly similar for all treatments, but feed conversion ratio (FCR) improved in all periods due to a rise in the synthesis of digestive enzymes, enhanced nutritional digestibility, and improved growth efficiency. Also, it is observed that the insignificant effect on Alb., Glob., A/G ratio, ALT and glucose levels may indicate that the addition of natural meals did not have any negative impacts on the components of blood, nor did they have any negative effects on liver function (as indicated by ALT activity).

Keywords: Black seed meal, Physiological responses, Radish seed meal, Sesame seed meal.

Introduction

In recent years, there has been an increasing interest in natural growth stimulants, such as medicinal seed plants and herbs, which can take the place of synthetic chemicals in some additives, but that, have natural sources of antioxidants and antibacterial play an important role due to its content of biological active compounds [1]. Some reports showed that supplementing poultry diets with herbs which, due to their antibacterial properties, are showing greater benefits [2 & 3]. It has been found that herbs have active substances content stimulate body metabolism, improve digestion, have bacterial, immune stimulant action and improve productivity [4 & 5].

Recently, scientists have been seeking natural additive ingredients such as various medicinal plants that could be beneficial because of their microbes' resistance [6&7]. Black cumin is enriched with carbohydrates, protein, amino acids and lipids [8] and has some minerals [9], pharmacologically bioactive compounds as thymoquinone, carvecrol and thymol [10]. Also, it may have an impact on broiler performance and be utilized as a growth promoter [11]. Among natural additives, when used with Japanese quails, black seed meal (BSM) significantly improved feed conversion ratio and body weight gain [12].

Moreover, BSM components have many pharmacological properties including antimicrobial [13], antioxidant activity [14] and anti-flammatory effect supplement and functional cosmotic, it has hypertensive, carminative and anthelminthic properties [15]. In addition, it can be used in feed as a stimulant and could be making progress in raising the performance of broilers [11]. However, sesame seed meal (SSM) is a protein - rich by-product and can be used as a natural feed for poultry [16] and has an amino acid composition similar to that of soybean meal [17].

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Also, it contains polyunsaturated fatty acids (Linoleic and oleic) and saturated fatty acids (Palmitic and stearic) [18&19]. However, SSM in poultry diets should be limited because of its high fibre content associated with phytates and oxalates [20], in which is considered an issue for poultry feeding and can restrict its use in practical diets. Naturally occurring, radish (*Raphanus sativus*) seed meal (RSM) is fed to farm animals as a nutritional supplement. Because phenolic components such as tri-terpenoids, alkaloids, and flavonoids are present, it has been demonstrated to have antioxidant properties [21].

When adding radish to a diet-containing enzyme, improved broiler feed conversion and showed that radish may raise the activity of exogenous enzyme through affecting the phenolic compounds, which act as enzyme inhibitors [22]. In addition, radish extract with enzyme improved the digestibility of all nutrients and adding sodium sulphate with radish improved feed conversion [23]. However, the benefits of Japanese quails which have been broadly utilized for biological and hereditary studies, it has a small body size which make it easy to care and because a large number of birds can be kept in a small space [24]. Therefore, the purpose of this study was to provide some insight into how some medicinal seed meals, such as BSM, SSM, and RSM, and their mixtures, affect the antioxidant status, blood biochemical parameters, carcass characteristics and performance of Japanese quail diets.

Material and Methods

Experimental design and dietary treatments

The present study was performed at the Agricultural Research and Production Station of the National Research Centre, Al-Nubaria, Al-Beheira Governorate, Egypt. Un-sexed 7-day-old Japanese quail birds (totalling 450 birds) were randomly assigned to five treatment groups (90 bird/treatment), with three replicates (30 birds each) in each group. All of the chicks were raised until the end of the growing trial period in cages that were heated electrically.

Daily records of the temperature and humidity were made to alter the environmental conditions, and the lighting schedule was changed to provide 24 hours of light every day. Every bird was kept in identical administrative and sanitary circumstances. Water and feed were available for consumption at all times during the seven-week trial. The chicks received the following nutritional treatments in addition to their basic diet.

The first treatment group of birds was fed basal diet without any additive to act as a control group (T1), while the other three groups were fed the same basal diet with BSM, SSM and RSM addition at level of 1% (T2, T3 and T4 respectively, the group of T5 was fed a basal diet with a mixture of the previous additives at level of 1/3% of each additive.

Feeding and Management

The diets used in the experiments (Table 1) were designed approximately to be iso-nitrogenous (24% CP) and iso-caloric (2900Kcal ME/Kg diet) to meet the requirement of quail [25]. A table (1) displays the chemical analysis and composition of the basal experimental diets. Chemical analyses were determined according to the procedures outlined by the Association of Official Analytical Chemists [26]. While the chemical composition of feed additives and experimental diets were presented in Table (2), biweekly records were made of feed intake (FI) and body weight (BW). In the same previous periods, estimates of body weight gain (BWG) and feed conversion ratio (FCR) were done.

Total antioxidant capacity (TAC), the Catalase (CAT) were analyzed using spectro-photo-metrically by available commercial kits.

Slaughter traits

Six birds from each treatment group that responded on average BW were weighed and slaughtered at the final stage of the experiment, and their carcasses were evaluated. Carcasses were removed from their heads and manually dissected to identify edible parts (heart, liver, and gizzard) and specific traits of the carcass (eviscerated carcass without head, neck, legs, and dressing percentage).

Biochemical characterization of blood

During slaughtering, blood samples were collected in heparinized test tubes and collect blood plasma, centrifuged for 15 minutes at 3500 rpm. Blood plasma was then refrigerated at -20 C^0 until analysis. Plasma total protein (TP), albumin (AL), creatinine (CR), alanine amino-transferase (ALT), Total cholesterol (Cho), Triglycerides, Glucose conc., G-S-Transferase, Lipid peroxidase (LPO),

Statistical analysis

The statistical analysis system software SPSS [27] version 20 for Windows was used to examine all of the collected data, the used model was:

$$Y_{iJ}=U+T_i+e_{ij}$$

Where: Y = the observed value = population means.

T= the effect of nutritional treatments.

E =the standard error.

The means of the various nutritional groups' parameters were compared using one way analysis of variance and Duncan's Multiple Range tests [28]. At the 0.05% level, the differences were significant.

Results and Discussion

Live body weight (LBW) and Weight gain (WG)

Relative percentage of live body weight (LBW) and weight gain (WG) are shown in Table (3). A significant variation in the average of LBW among different treatments was observed during all seven weeks of the experiment. Either BSM or SSM treatments surpassed and had better than the others and the control group. It is worth noting that LBW was improved by using some natural meals as feed enhancers. Moreover, the improvement of WG may be attributed to the biologically active compounds of these additives. The better results of quails by feeding BSM may be due to its pharmacological bioactive compound such as thymoquinone, carvacrol and thymol [10] that can enhance growth performance, nutrient digestibility, and the generation of digestive enzymes [29&30]. The broiler performance improved by offering BSM in feed [31]. Similar reports agreed while using of BSM in the Japanese quail diet [12]. However, in contrast, WG reduced due to BSM attributed to the high fiber contents of the meal, while a significant effect of black cumin (BC) powder supplemented group compared to the control [30&32]. Also, birds given 2% BC powder had the highest weight growth [33]. In this level, LBW and WG followed the same trend where, quails fed SSM detected higher values compared with other treatments and control group. This is may be attributed to its protein content as soybean meal with exception of lysine [17&16]. Likewise, it contains poly-unsaturated fatty acids (as linoleic and oleic) and saturated fatty acids (as palmitic and stearic) [18]. However, the presence of phytic acid, oxalates and anti-trypsin inhibit the performance and health status of birds. But, phytic acid reduces the biological availability of calcium and phosphorous [18&34]. Therefore, SSM should be limited because of its fiber content besides the possible availability problems associated with phytates and oxalates [35]. On the other hand, responses of Japanese quail chicks fed a diet added with RSM showed higher LBW and WG being significantly similar to those of the control diet. This increase may be due to its antioxidant properties and its phenolic compounds as alkaloids, flavonoids and tri-terpenoids [21], so the increase in WG may be due to the presence of such biologically active compounds which may increase WG. Therefore, adding radish extract increased WG and succeeded in improving the digestibility of all nutrients [36]. These outcomes correspond with the observation of that natural feed additives enhance Japanese quails' BW and WG [37].

Feed intake (FI) and Feed conversion ratio (FCR)

Feed intake (FI) and feed conversion ratio (FCR) are presented in Table (4). The result of FI was not significantly influenced by using the testing additive meals as compared to the control with exception of some periods during the experiment. FI was nearly similar for all treatments, but was lower for T5 (mixture diet) compared to the control. Moreover, significant improvement in FCR was observed at all periods. This means that FCR improved by adding BSM,SSM and RSM, in this level**.** adding black cumin powder to quail diets enhanced the synthesis of digestive enzymes, the digestibility of nutrients, and growth performance [29&30].

Furthermore, the enhancement of gastric pancreatic digesting enzymes and/or phytogenetic product induced microbial population regulation may be responsible for the improvement in FCR by increasing the absorption of vital nutrients [38&39]. Similar results were also reported [40]. Although results showed that SSM containing fed diet was significantly better than the control. Similar performance showed that SSM may be lower in phytates or oxalates [41]. In this respect, controversy results were observed in the literature, [34&42] reported that the high amount of phytate may reduce the protein and mineral availability because of the amount of oxalates, which have detrimental effects on birds' health and performance. In addition, SSM consists of poly-unsaturated fatty acids (linoleic, oleic) and saturated fatty acids (palmitic and stearic) [18].

Carcass characteristics

Table (5) displays the results of carcass characteristics expressed as a percentage of final body weight. Our data showed significant variations among treated groups. Significant differences were noted in the LBW, carcass and dressing%, while, the other parameters were not affected. BSM addition to the quail diet did not influence carcass and dressing % values as compared to the control. In addition, no observable changes in the relative weight of giblets and offal's, these results are in the same trend with the inclusion of black seed powder extract (100-300mg/kg) hadn't significant effect on carcass and dressing %of quails compared to the control [33,43 & 44].

However, SSM followed the same trend for slaughtering trait carcasses. The similar results between carcass and dressing % to that found in the control diet may be attributed to that SSM leads to an increase in the size of the digestive system and thus decreases carcass weight [45] as a result of high dietary fiber level in SSM diet for quails than the control diet. Also, results of giblets were not significantly affected by the SSM diet [46]. However, carcass and dressing %of quails fed RSM and mixture meal diets(T4,T5) were significant improved than those the control and other diets. These results were similar to a partial replacement of SBM with RSM had a significant increment of carcass characteristics with RSM in rabbits [47].

Blood parameters

For plasma biochemical parameters, results in Table (6) showed that different feeding additives did not exert any significant effect on some studied parameters, while total protein (TP), creatinine (Cre) and G-S-transferase showed significant variation for all treatments and control group. However, plasma TP significantly increased by adding BSM (T2) and was higher for all treatments, besides, T5 followed the same trend whereas, SSM and RSM tended to increase compared with the control. This increase for BSM could be the reason for the activation of the pancreatic digesting enzymes [38] and microbial population which leads to more absorption of essential nutrients [39]. These results are in harmony with TP concentration was higher for group fed 2-3% *Nigella sativa* [48 & 49].

Also, plasma albumin (Alb), globulin (Glo) and A/G ratio were not affected by feeding natural additives comparing with the control. Data showed that all natural additives enhanced Alb, Glo and A/G ratio. The higher values of the Alb and Glo were associated with addition different meals. However, the highest values of Glo as an indicator of good immunity status of the bird. Increased GLo may be due to the immune stimulant effect of the *nigella sativa* [48]. In addition, A/G ratio was increased may be due to the increasing Glo as a result of natural additives. These results are in harmony with that Alb and Glo were affected by using a diet containing SSM at 12.5% level [50]. The results of A/G ratio showed that the group fed SSM (T3) and RSM (T4) showed the highest values of A/G ratio, while BSM group (T2) tended to increase compared to the control ones.

Concerning, plasma total cholesterol (T.cho) and triglycerides (Trig) values were found to be insignificantly reduced due to tested additives, this decrease may occur in the rate of T.cho. The absorption through intestinal villi reflected as a decreased level in the blood [51]. In the same way increasing phytogenic feed concentration in the broiler chickens and dietary natural additives decreased T.cho and Trig levels have been reported to have a hypo-cholesterolaemic effect in broilers [52, 53&54]. In this respect, [11] found that feeding 3% crushed and not crushed sativa seeds reduced plasma T.cho and Trig concentration and demonstrated that the active compounds, such as thymoquinone, and substances, such as mono-unsaturated fatty acids, reduce the fractional absorption of cho from the small intestine and the hepatocytes' cho-synthesis [55], also, reducing T.cho when fed *Nigella sativa* meal (NSM) may be linked to the NSM's active ingredients, nigellone, which is what causes this depression in 3-hydroxy-3methyl coA reductase [56]. However, there were significant effects on plasma creatinine (Cre). The result of ALT concentration showed insignificant effects among treatments quails fed SSM (T3) exhibited higher value compared to the others and control ones. This confirms the previous study of [57] which mentioned that changes in the blood transaminase level may depend on the rate of protein metabolism which may be a function of birds' age rather than other factors.

However, it's crucial to remember that glucose (Glu) level showed no significant higher values during the experiment. The group fed BSM (T2) detected slightly higher Glu concentration than the other and control. The immunostimulant properties of *Nigella sativa* could be the cause of this rise. Glu concentration increased for the group fed 2-3% *Nigella sativa* [48]. No significant effects for quail fed SSM on plasma Glu concentration [45 & 49].

On the other hand, it is known that glucose levels showed no significantly higher values during the experiment. The group fed BSM (T2) detected slightly higher glucose than the others and the control group.

On the other hand, the antioxidant data decreased for all natural additives compared to the control implying that GSH attempts to achieve the control value for preventing oxidative damage to activate the liver's antioxidant system. Authors have reported the antioxidant effects of *Nigella sativa* which, when exposed to carbon tetra chloride, decreased the lipid peroxidation activities of liver enzymes and strengthened the antioxidant defense system [58]. However, all antioxidant status indicators, including MDA, TAC, CAT, and GSH enzymes, showed a significant difference between treatments [59]. Moreover, [33] showed that the AOC of black seed powdered was efficient in avoiding oxidation in the breast flesh.

However, no significant effect in lipid formation in blood plasma was noted in the present study between treatments compared to the control. Previously as shown lipid peroxidation is the process by which free radicals attack unsaturated fatty acids in a lipid membrane. So, it is worth to mentioning that the control detected a marked increase of lipid formation in plasma equal to the tested groups. Therefore, it could be attributed that adding natural additives BSM, SSM, RSM, or mix increased the activity of GSH px in Japanese quail tissues in our study, [60] showed that a diet supplied with 0.5 and 0.1% black seed led to significant decrease production of lipid peroxidases compared to the control.

For, Glutathione -s-transferase, the tested additives to quail diets showed a significant increase of several enzymes as glutathione-s-transferase and catalase which result in reducing the oxidative stress on the liver by the use of black cumin (3,5, and 7%) [61]. The highest value was detected by RSM followed by BSM and SSM respectively. In addition, compared to the control group, the meal

supplemented with 0.5 and 0.1% black seeds significantly reduced the quantity of malondialdehyde (MDA), produced more glutathione, and produced lipid peroxidases [62]. Moreover, black seed might decrease the production of hydrogen peroxide (H2O2), hydroxyl (OH) and superoxide (O2) radicals that the process of aerobic respiration produces [60].

It is evident from the minor impacts on Alb, Glo, A/G ratio, ALT, and glucose levels that adding natural plants had no negative effects on blood components and no detrimental effects on liver function (as determined by ALT activity).

Conclusions

Al natural plant seed meals that were used, especially black seed, sesame seed meals and the mixture of meals, improved and enhanced growth and some physiological responses, which are reflected in the productive performance of Japanese quail.

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Conflicts of interest

The authors declare that they have no conflict of interest

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Ethical considerations

Had a final approval from the Medical Research Ethics Committee, National Research Centre (ethics approval number; 07451223).

TABLE 1. Composition and calculated analysis of the basal diet used in the study

Ingredients	%
Yellow corn	56.00
Soya meal (44%)	34.85
Corn gluten meal (62%)	6.00
Di-Calcium Phosphate	1.5
Limestone	1
Sodium Chloride	0.30
Vit. Min. Premix	0.30
DL-methionine	0.05
Total	**100**
Calculated analysis:	
Crude protein%	23.89
ME. K cal/Kg	2878.2
Lysine%	1.145
Methionine%	0.455
Cysteine%	0.392
Calcium%	0.846
Available – Phos. %	0.417

TABLE 2. Proximate chemical analysis (%)of BSM, SSM and RSM used in the experimental diets (on dry matter (DM) basis)

Item	Black Seed meal	Sesame Seed Meal	Radish Seed Meal
Moisture	7.25	6.97	7.03
Organic Matter (OM)	93.92	90.21	93.87
Crude Protein (CP)	26.37	41.47	34.40
Crude Fiber (CF)	13.83	17.76	16.07
Ether Extract (EE)	24.33	16.41	11.26
Ash	6.08	9.79	6.13
Nitrogen Free Extract (NFE)	29.39	14.61	32.14

Experimental diets	Moisture %	Content % on DM basis					
		OM	CP	CF	EE	NFE	Ash
Control	11.08	93.99	23.85	2.65	3.21	64.28	6.01
Black seed meal diet	10.44	93.54	23.32	3.14	2.43	64.65	6.48
Sesame seed meal diet	11.84	91.04	22.67	2.69	2.63	63.05	8.91
Radish seed meal diet	11.91	89.99	23.12	3.09	2.87	60.91	10.01
Mixed diet	13.15	92.34	24.09	2.84	2.46	62.95	7.66

TABLE 3. Response of growing Japanese quails to different types of natural seed meals on Body weight and body weight gain

Item	Control	Black seed meals	Sesame seed meals	Radish seed meals	Mixture	Overall mean
			Body Weight (g)			
1st Week	24.71	24.51	24.92	24.93	24.87	24.79 ± 0.12
3rd Week	80.27^{b}	90.33^{a}	89.72^{a}	89.41^{a}	92.57^{a}	88.46 ± 1.42
5th Week	177.38^{c}	196.02^{a}	200.95^{a}	185.32^{bc}	187.01^{b}	189.34 ± 2.44
7th Week	242.25^{d}	270.53^{a}	272.35^{a}	254.79^{b}	249.29^{c}	257.84 ± 3.22
			Body Weight Gain (g)			
1-3 Week	55.57^{b}	65.82^{a}	64.80^{a}	64.48^{a}	67.70^{a}	63.67 ± 1.44
3-5 Week	97.11^{b}	105.69^{ab}	111.23^{a}	95.91^{b}	94.44^{b}	100.88 ± 2.26
5-7 Week	64.86^{bc}	74.51^{a}	71.40^{ab}	69.46^{abc}	62.28^{c}	68.50 ± 1.54
1-7 Week	217.54^{d}	246.02^{a}	247.43^{a}	229.85^{b}	224.42^{c}	233.05 ± 3.23

$*^{a,b,c,d}$ in each row means having different superscripts are significantly different ($p<0.05$).

TABLE 4. Response of growing Japanese quails to different types of natural seed meals on Feed Intake and feed conversion ratio

Item	Control	Black seed meals	Sesame seed meals	Radish seed meals	Mixture	Overall mean
			Feed Intake (g)			
1-3 Week	189.69	181.62	184.41	177.39	179.36	182.49 ± 2.06
3-5 Week	266.09^{a}	267.42^{a}	270.59^{a}	263.31^{a}	225.38^{b}	258.56 ± 4.87
5-7 Week	392.07^{b}	519.75^{a}	481.95^{ab}	459.57^{ab}	514.99^{a}	473.67 ± 17.65
1-7 Week	922.74	965.09	934.06	896.14	899.71	923.55 ± 10.64
			Feed Conversion ratio (g/g)			
1-3 Week	3.45^{a}	2.77^{b}	2.85^{b}	2.75^{b}	2.65^{b}	2.89 ± 0.09
3-5 Week	2.75^{a}	2.54^{ab}	2.44^{ab}	2.75^{a}	2.39^{b}	2.57 ± 0.06
5-7 Week	6.03^{b}	7.01^{ab}	6.77^{ab}	6.63^{ab}	8.32^{a}	6.95 ± 0.29
1-7 Week	4.24^{a}	3.92^{ab}	3.78^{b}	3.90^{ab}	4.01^{ab}	3.97 ± 0.06

$*^{a,b}$ in each row means having different superscripts are significantly different ($p<0.05$).

TABLE 5. Response of growing Japanese quails to different types of natural seed meals on slaughter traits.

Item	LBW	Dressing %	Giblets %	Offals %
Control	236.67^{ab}	67.83^{ab}	6.20^{a}	25.98
Black seed meals	244.83^{a}	66.76^{ab}	5.58^{a}	27.65
Sesame seed meals	238.17^{ab}	66.40^{b}	5.78^{a}	27.82
Radish seed meals	220.50^{b}	69.50^{a}	4.92^{b}	26.30
Mixture	236.33^{ab}	69.52^{a}	4.70^{b}	25.78
Overall mean	235.30 ± 3.24	68.00 ± 0.46	5.44 ± 0.13	26.71 ± 0.43

$*^{a,b}$ in each row means having different superscripts are significantly different ($p<0.05$).

TABLE 6. Response of growing Japanese quail fed different meals on some blood parameters

Item	Control	Black seed meals	Sesame seed meals	Radish seed meals	Mixture	Overall mean
Total protein (g/dl)	4.03^{b}	4.83^{a}	4.20^{b}	4.22^{b}	4.38^{ab}	4.33 ± 0.09
Albumin (g/dl)	1.81	2.00	1.99	2.07	1.61	1.90 ± 0.07
Globulin (g/dl)	2.22	2.83	2.21	2.15	2.78	2.44 ± 0.11
A/G ratio	0.87	0.72	0.95	0.97	0.58	0.82 ± 0.06
Total cholesterol (mg/dl)	156.37	158.83	174.13	147.23	161.70	159.65 ± 4.26
Triglycerides (mg/dl)	107.50	106.40	101.23	102.40	109.63	105.43 ± 1.88
Creatinine (mg/dl).	0.21^{a}	0.19^{ab}	0.17^{b}	0.20^{ab}	0.18^{b}	0.19 ± 0.01
ALT(I. U /L)	138.12	142.30	150.30	143.33	142.74	143.36 ± 2.25
glucose conc. (mg/dl)	57.60	70.19	55.79	59.60	55.69	59.77 ± 2.70
G-S-Transf. (mg/dl).	2.12^{b}	2.77^{ab}	2.55^{ab}	3.39^{a}	2.06^{b}	2.58 ± 0.17
LPO (nmol/ml).	9.94	9.98	9.96	9.95	9.93	9.95 ± 0.02
TAC (mM/L).	0.61	0.51	0.47	0.47	0.42	0.49 ± 0.05
CAT (mg/dl).	2.48	3.31	1.58	2.51	2.76	2.53 ± 0.33

$*^{a,b}$ in each row means having different superscripts are significantly different ($p<0.05$).

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استجابة السمان الياباني لبعض أنواع الأكساب الطبيعية المختلفة على الأداء الإنتاجي، صفات الذبيحة، وبعض القياسات البيو كيميائية

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الملخص

تم تربية 450 طائر سمان ياباني غير مجنس (عمر واحد أسبوع) في أقفاص حتى عمر سبعة أسابيع، وكان الغرض من هذه التجربة هو معرفة كيفية أستجابة نمو طيور السمان الياباني لأنواع مختلفة من أكساب البذور الطبية، وتم تقسيم جميع الطيور وتوزيعها على خمس معاملات متساوية (90 طائر/معاملة) بواقع ثلاث مكررات في كل منها 30 طائر. المعاملة الأولى (T1) تلقت العليقة الأساسيةبدون اضافة للاكساب المختبرة كمجموعة سيطرة؛ وفيالمجموعات الثلاثة التالية تم التغذية على العليقة الاساسية مع اضافة 1% من الاكساب المختبرة؛ المعاملة الثانية (BSM، T2) كسب بذور حبة البركة؛ المعاملة الثالثة (SSM، T3) كسب بذور السمسم؛ المعاملة الرابعة (RSM، T4) كسب بذور الفجل؛ أما المجموعة الاخيرة المعاملة الخامسة (T5) تم خلط 3/1٪ من كل كسب مضاف في العلائق الثلاثة السابقة. وكانت جميع العلائق تحتوي على 24% بروتين خام والطاقة متساوية (2900 كيلو كالوري/كجم). وأظهرت النتائج التي تم الحصول عليها أن كلا من وزن الجسم ومعدل الزيادة في الوزن كانا أفضل بإستخدام العلائق المضاف إليها الأكساب الطبيعية كمحسنات غذائية مقارنة بمجموعة السيطرة. وأيضًا، كانت كميات العلف المأكولة متشابهة تقريبًا لجميع المعاملات؛ ولكن معدل التحويل الغذائي تحسن في جميع الفترات بسبب زيادة تخليق الإنزيمات الهاضمة مما أدي إلي تحسن معدل الهضم وتحسين كفاءة النمو. كما لوحظ أنه هناك تأثير غير معنوي في نسب الألبيومين والجلوبيولين ونسبة الألبيومين للجلوبيولين وأنزيم الـALT ومستويات الجلوكوز وهذا يدل علي أن إضافة الأكساب الطبيعية لم يكن لها أي آثار سلبية على مكونات الدم، كما أنه لم يكن لها أي آثار سلبية على وظائف الكبد (كما هو موضح من خلال نشاط أنزيم الـ ALT).

الكلمات المفتاحية: كسب بذور حبة البركة، كسب بذور السمسم، كسب بذور الفجل، الأستجابات الفسيولوجية.