The Pharma Innovation Journal 2020; SP-9(7): 146-150

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2020; SP-9(7): 146-150

www.thepharmajournal.com
Received: 13-05-2020
Accepted: 15-06-2020

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Effect of feeding termites (*Neotermes assamensis*) as protein source on carcass traits of Japanese quail

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Abstract
A study was conducted with 180 numbers of day old unsexed Japanese quail chicks from a single hatch and was randomly divided into four equal groups i.e. T_0 (control), T_1 (5% dried termite), T_2 (10% dried termite) and T_3 (15% dried termite) containing 45 numbers of chicks in each group which was further subdivided into 3 replicates of 15 chicks in each, to study the effect of termites (*Neotermes assamensis*) as a protein source on the carcass traits of Japanese quails. At the end of experiment, Carcass traits results revealed that dressed weight and dressing percentage differed significantly ($P \leq 0.05$) among the treatment groups (T_3 and T_0). The per cent yield of cut- parts like neck, wings, back, breast and thighs except drumsticks, did not differ significantly ($P > 0.05$) among the different treatment groups. The physico-chemical properties of Japanese quail meat viz. pH, water holding capacity (WHC) and fibre diameter (FD) from breast muscle were estimated. The water holding capacity and pH of meat showed no significant ($P > 0.05$) differences, however the highest fibre diameter was recorded in T_3 group followed by T_2 group which differed significantly ($P \leq 0.05$) from T_0 and T_1 groups.

Keywords: Carcass traits, fibre diameter, Japanese quail, organoleptic evaluation, termites

Introduction
Indian poultry industry has made the fastest and most remarkable growth ever since its inception and is emerging as a sunrise sector with a growth rate of 8-12% as against 1.5%-2% for agricultural crops, posting an annual turnover of 10,000 million dollar and satisfying the hungers of 20 million people through employment.
The poultry industry is sole source of animal protein in both developed and developing countries. However, the scarcity of the conventional animal protein source and cost of their feed which accounts for more than 75% of total cost of production is major drawback due to this the progress in the poultry sector is currently being undetermined. Therefore, efforts are to be made to have good quality, low cost renewable protein to substitute expensive protein. Termites can be used as a valuable source of protein, fat and essential amino acids. Termites are a valuable source of protein, fat and essential amino acids in the diet for both primates and humans. As a high source of protein termites can be used in poultry diets to support growth and maintenance of the body of poultry. Keeping this in view, the present study was conducted to evaluate the effect of termites on the carcass traits of Japanese quails.

Materials and Methods
An experimental trial was conducted in the experimental shed of Instructional Poultry Farm Department of Poultry Science, College of Veterinary Science, Assam Agricultural University, and Khanapara for a period of six weeks, to study the effect of termites (*Neotermes assamensis*) as a protein source on the carcass traits of Japanese quail meat. For the present study 180 numbers of day old unsexed Japanese quail chicks from a single hatch was procured and randomly divided into four equal groups i.e. T_0 (control), T_1 (5% dried termite), T_2 (10% dried termite) and T_3 (15% dried termite) containing 45 numbers of chicks in each group which was further subdivided into 3 replicates of 15 chicks in each. The chicks were given identification marks using wing bands and maintained following standard feeding and uniform managemental practices under cage system of rearing.

Experimental Diet: The experimental diets were designed as diet T_0, T_1, T_2 and T_3. Diet T_0 served as control (with no termite supplementation) while diet T_1, T_2 and T_3 contained 5%, 10% and 15% of dried termite, respectively. The Japanese quail chicks were fed quail starter (0-3 weeks) and finisher (4-6 weeks) diets as per Indian Council of Agricultural Research

(2013) containing the feedstuffs namely maize, rice polish, soya bean meal, ground nut cake, mineral mixture and common salt at the recommended levels.

Feeding Trial: The feeding trial was conducted for a period of six weeks using quail starter (0-3 weeks) and quail finisher (4-6 weeks) with the experimental diets (Table I).

Carcass Traits: At the end of the experiment, 12 birds per treatment were slaughtered in the department of Poultry Science. The birds were kept on fasting for overnight and then slaughtered as per standard method. The live weights of the birds were recorded before slaughtering. The dressed weight of the carcasses was recorded after removal of shank, tips of wings, head and internal organs and the dressing percentage was expressed in terms of pre- slaughter live weight. The breast meat was collected separately for further analysis of fiber diameter, meat pH and water holding capacity.

$$\text{Dressing percentage} = \frac{\text{Dressed weight}}{\text{Pre-slaughter live weight}} \times 100$$

Meat Ph: The pH values of breast muscles were determined on post slaughter using a pH meter "Consort C 532". Five grams of meat sample was homogenized with 45 ml of distilled water for one minute. The pH of the meat was recorded by immersing glass electrode and temperature probe of the digital pH meter directly into the meat suspension. The reading of pH meter was recorded.

Water Holding Capacity: The water holding capacity of pectoralis major muscle was estimated by measuring the amount of water released from muscle protein by the application of force. It measures the ability of muscle protein to retain water in excess and under the influence of internal force. The water holding capacity of breast muscle was determined using a modified version of the method. For these 300 mg of meat sample was placed on filter paper arranged between two glass slides. On the top of the upper glass slide 100 gm weight was placed for 3 minutes. The released water from the meat sample was absorbed in the filter paper and leaves an impression. With the sharp pencil the boundary of the impression was clearly demarcated. The area of two resulted impression left as each half of the filter paper on account of oozing of fluid by application of force (outer circle) and the area of the meat (inner circle) were measured by using graph and the percentage was calculated by using the following formula.

$$\%\text{WHC} = \frac{\text{Area of inner circle (area of meat)}}{\text{Area of outer circle (impression of fluid from meat)}} \times 100$$

(As per Karthika *et al*., 2016) [3]

Fibre Diameter: The average cross sectional dimensions of muscle fibre was measured for estimating fibre diameter. Fibre diameter was measured at the end of 24 hrs of storage at refrigeration temperature. For these 5 grams of the breast meat (*Pectoralis superficialis*) were cut into small cubes and placed in a jar containing fixing solution of 40% formaldehyde, distilled water, sodium acetate and sodium chloride. After that it was placed in warring blender and blended at slow speed about 50 rheostats for 30 seconds. The contents were then poured on to petri dish and observed through microscope at 100 X. The fibre diameter was calculated by multiplying the number of small divisions covered by individual muscle fibre by the factor 4.25 (correction factor of ocular microscope). The fibre diameter was expressed in terms of micron.

Results and Discussion

Dressed Weight: The mean (+SE) dressed weight under different treatment groups have been presented in Table II and their statistical analysis are presented in Table III. Analysis of variance showed significant ($P \leq 0.05$) difference in among the groups T_3 and T_0. However, the groups T_2 and T_1 did not differ significantly ($P > 0.05$). Similar findings were also recorded by Ketaren *et al.* (2001) [4] and they studied significant ($P < 0.05$) difference in carcass weight of broiler chicken fed with diet containing 1.5% of dried termites or improved carcass percentage of about 4.4%.

Dressing Percentage: The percent dressing yield under different treatment groups were recorded as given in Table II and their statistical analysis are presented in Table III. The dressing percentage of T_0 and T_3 groups of Japanese quails differed ($P \leq 0.05$) significantly. However, the groups T_1 and T_2 did not differ significantly ($P > 0.05$). These findings are also in accordance with Saker *et al*. (2015) [6], they found that dressing percentage, weight of breast muscles and leg muscles were increased significantly ($P < 0.05$) as crude protein level increased in the diet.

Cut-up Parts: The mean per cent yield of neck under different treatment groups were recorded as 4.56 ±0.19, 4.83 ±0.37, 4.94 ±0.26 and 5.02 ±0.30 for T_0, T_1, T_2 and T_3 groups, respectively. Among the different groups, mean per cent yield of neck did not differ significantly ($P > 0.05$). The mean per cent yield of wings under different treatment groups were recorded as 6.88 ±0.26, 6.93 ±0.19, 7.14 ±0.36 and 7.73 ±0.36 for T_0, T_1, T_2 and T_3 groups, respectively. Among the different groups, mean per cent yield of wings did not differ significantly ($P > 0.05$). The mean per cent yield of back under different treatment groups were recorded as 14.13 ±0.60, 15.05 ±0.45, 15.59 ±0.80 and 15.60 ±0.41 for T_0, T_1, T_2 and T3 groups respectively. Among the different groups, mean per cent yield of back did not differ significantly ($P > 0.05$). The mean per cent yield of breast under different treatment groups were recorded as 23.64 ±0.73, 24.44 ±1.44, 25.27 ±1.40 and 27.27 ±0.65 for T_0, T_1, T_2 and T_3 groups, respectively. Analysis of variance showed no significant ($P > 0.05$) difference in per cent yield of breast among the various groups. However the group T_3 (27.27 ±0.65) showed the highest per cent yield of breast among the groups. The mean per cent yield of thigh under different treatment groups were recorded as 9.23 ±0.31, 9.61 ±0.61, 9.89 ±0.19 and 9.89 ±0.24 for T_0, T_1, T_2 and T_3 groups, respectively. Among the different groups, mean per cent yield of thigh did not differ significantly ($P > 0.05$). The mean per cent yield of drumsticks under different treatment groups were recorded as 6.27 ±0.27, 6.70 ±0.53, 6.67 ±0.13 and 7.56 ±0.19 for T_0, T_1, T_2 and T_3 groups, respectively. Analysis of variance showed significant ($P \leq 0.05$) difference in percent yield of drumsticks (Table IV), among the treatment groups (T_0 and T_3). However, the groups T_1 and T_2 did not differ significantly ($P > 0.05$). Higher per cent yield of drumsticks can be attributed to the higher protein level in the diet which has positively influenced the growth of muscles in the carcass (Marcu *et al.*, 2011).

Organoleptic Evaluation

Colour: The mean scores for colour of Japanese quail meat for different treatment groups were recorded as 5.10 ±0.23, 5.50 ±0.31, 5.80 ±0.25 and 5.70 ±0.26 for T_0, T_1, T_2 and T_3 groups, respectively. Statistical analysis revealed no significant difference. However the group T_2 showed the best colour (5.80 ±0.25) among the treatment groups.

Flavor: The mean scores for flavor of Japanese quail meat of T_0, T_1, T_2 and T_3 groups were recorded as 5.20 ±0.29, 5.30 ±0.21, 5.80 ±0.25 and 5.70 ±0.15, respectively. Data revealed no significant difference among the treatment groups. However the group T_2 showed the best flavor (5.80 ±0.25) among the treatment groups.

Juiciness: The mean scores for juiciness of Japanese quail meat for different treatment groups were recorded as 5.30 ±0.26, 5.70 ±0.26, 5.20 ±0.29 and 5.90 ±0.23 for T_0, T_1, T_2 and T_3 groups, respectively. Statistical analysis revealed no significant difference. However the group T_3 showed the best juiciness (5.90 ±0.23) among the treatment groups.

Texture: The mean scores for texture of Japanese quail meat for different treatment groups were recorded as 5.50 ±0.17, 5.50 ±0.31, 5.90 ±0.28 and 5.80 ±0.20 for T_0, T_1, T_2 and T_3 groups, respectively. Data revealed no significant difference among the treatment groups. However the group T_2 showed the best texture (5.90 ±0.28) among the treatment groups.

Overall acceptance: The mean scores for overall acceptance of Japanese quail meat for different treatment groups were 5.27 ±0.35, 5.5 ±0.5, 5.6 ±0.4 and 5.7 ±0.21 for T_0, T_1, T_2 and T_3 groups, respectively. There was no significant ($P>0.05$) difference in overall acceptance of the quail meat among the different treatment groups. Thus the various organoleptic parameters of quail meat like colour, flavor, texture and juiciness were not affected due to incorporation of termites in the diet. The mean overall acceptance of various groups of meat ranged from 5.27 to 5.7 and hence according to the hedonic scale, the meat can be considered of good quality.

Water Holding Capacity: The mean (±SE) water holding capacity of Japanese quail meat under different experimental groups were recorded as 55.43 ±0.93, 56.24 ±1.09, 56.95 ±0.71 and 57.03 ±0.70 percent for T_0, T_1, T_2 and T_3 groups, respectively. The mean values of water holding capacity of Japanese quail meat under different experimental groups were found to be almost similar which showed no significant ($P>0.05$) differences among the experimental groups. However, the higher percentage of water holding capacity in the Japanese quail meat samples might be due to high meat pH which results in high water holding capacity. Similar observation was recorded by Awan *et al* (2017) [1].

Meat Ph: The mean pH values of Japanese quail meat under different treatment groups were recorded as 6.43 ±0.09, 6.51 ±0.13, 6.58 ±0.11 and 6.60 ±0.10 for T_0, T_1, T_2 and T_3 groups, respectively. Analysis of variance showed no significant ($P>0.05$) difference among the treatment groups. The mean values of pH in all the groups were almost similar. Similar findings were recorded by Awan *et al*. (2017) [1], they documented an average pH of 6.44 in quails less than 6 weeks of age which is slightly acidic in nature. This variation might be due to the time of slaughter, species variation, feeding practices of the birds and different agroclimatic conditions of rearing.

Fibre Diameter: The mean (±SE) fibre diameter of Japanese quail muscle under different experimental groups have been presented in Table V and their statistical analysis are presented in Table VI. The fibre diameter of T_3 (43.74 ±2.14) group was significantly ($P\leq0.05$) higher as compared to T_1 and T_0 groups. However, there were no significant ($P>0.05$) differences in fibre diameter among the treatment groups (T_2 and T_3). The higher fibre diameter in treatment groups (T_2 and T_3) might be due to faster growth rate due to incorporation of higher per cent of dried termites in the diet which contains comparatively higher protein content. This is in agreement with Karthika *et al*. (2016) [3].

Table 1: Percent ingredient composition of Japanese quail starter and finisher ration

Ingredient	Quail Starter (0-3 weeks)				Quail Finisher (4-6 weeks)			
	T_0	**T_1**	**T_2**	**T_3**	**T_0**	**T_1**	**T_2**	**T_3**
Maize	33.00	37.50	40.10	39.50	43.50	44.10	43.30	44.50
Rice Polish	6.35	6.00	5.00	4.00	6.30	5.60	6.00	5.50
Ground nut cake	7.15	4.00	5.40	6.00	4.00	4.00	4.00	4.00
Soya bean meal	43.00	37.00	30.00	26.00	33.50	29.00	25.00	19.00
Wheat Bran	7.00	6.00	6.00	6.00	7.20	6.80	6.00	7.00
Termite meal (%)	-	5.00	10.00	15.00	-	5.00	10.00	15.00
Vegetable oil	1.00	2.00	1.00	1.00	3.00	3.00	3.20	2.50
Mineral mixture	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Common salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
TOTAL	100	100	100	100	100	100	100	100
Crude protein (%)	25.1	25.3	25.4	25.3	22.2	22.4	22.5	22.5
Metabolizable energy (kcal/kg) *	2808.09	2802.01	2801.02	2804.00	2901.04	2903.02	2907.01	2912.00

* calculated values

(N.B. Vitamin premix Provita M was added @ 20g per quintal in both starter and finisher diet.)

Composition of Provita M

Vitamin A	6,000 IU
Vitamin D3	2,500 IU
Vitamin E	1.5 IU
Thiamine	0.2 mg

Riboflavin	1 mg
Pantothenic acid	3 mg
Niacin	10 mg
Pyridoxine	0.5 mg
Folic acid	0.2 mg
Vitamin B_{12}	10 mcg
Choline	5 mg
Lactic Acid Bacteria*	100 million CFU**

Lactobacilllus acidophilus, Enterococcus faecium, Lactobacillus plantarum, Lactobacillus casei

Table 2: Mean ±SE of carcass characteristics of Japanese quails under different treatment groups

Groups parameters	T_0 (control)	T_1 (5% dried termite)	T_2 (10% dried termite)	T_3 (15% dried termite)
Dressed weight (g)	$126.41^{b} \pm 2.05$	$133.33^{ab} \pm 5.23$	$140.16^{ab} \pm 4.41$	$146.16^{a} \pm 5.70$
Dressing percentage (%)	$65.99^{b} \pm 2.12$	$66.03^{ab} \pm 2.08$	$68.14^{ab} \pm 1.21$	$73.13^{a} \pm 0.96$

Means bearing same superscripts in a row did not differ significantly ($P>0.05$).

Table 3: Anova of carcass characteristics of Japanese quails under different treatment groups

Parameters	S.V.	df	SS	MS	F value
Dressed weight (g)	Treatment	3	2623.06	874.35	3.48*
	Error	44	11052.92	251.20	
Dressing percentage (%)	Treatment	3	419.27	139.75	4.13*
	Error	44	1487.42	33.80	

*significant (P≤0.05)

Table 4: Anova of per cent cut-up parts of Japanese quails (LWB) under different treatment groups

Parameters	S.V.	df	SS	MS	F value
Neck	Treatment	3	1.43	0.47	0.46NS
	Error	44	45.36	1.03	
Wings	Treatment	3	5.53	1.84	1.33NS
	Error	44	60.89	1.38	
Back	Treatment	3	17.17	5.72	1.37NS
	Error	44	183.68	4.17	
Breast	Treatment	3	87.76	29.25	1.93NS
	Error	44	664.26	15.09	
Thigh	Treatment	3	76.12	1.19	0.68NS
	Error	44	38.06	1.73	
Drumstick	Treatment	3	10.60	3.51	2.84*
	Error	44	54.63	1.24	

NSNot significant, *significant (P≤0.05)

Table 5: Mean ±SE of fibre diameter of Japanese quails muscle under different treatment groups

Groups Parameters	T_0 (control)	T_1 (5% dried termite)	T_2 (10% dried termite)	T_3 (15% dried termite)
Fibre diameter (micron)	$34.71^{b} \pm 1.25$	$36.80^{b} \pm 2.35$	$39.95^{a} \pm 2.50$	$43.71^{a} \pm 2.14$

Means bearing same superscripts in a row did not differ significantly ($P>0.05$)

Table 6: Anova of fibre diameter of Japanese quails muscle under different treatment groups

Parameters	S.V.	Df	SS	MS	F value
Fibre diameter (micron)	Treatment	3	278.96	92.98	3.45*
	Error	20	538.57	26.92	

*Significant (P≤0.05)

Conclusion

So the present research provides new data and knowledge on the potential application and benefits of using termites (*Neotermes assamensis*) as feed ingredients for Japanese quails. Termite meal showed to be a promising feed ingredient (at 15% inclusion level) for Japanese quails, as a partial replacement to the soya bean meal. In fact, performance traits, carcass traits, economic traits and biochemical parameter were overall satisfactory. Further in depth studies may be required using different levels of dried termite as an alternative protein source in Japanese quail to validate the present results.

Conflict of Interest: The authors declare that they have no conflict of interest.

Ethical Standard: Work was conducted as per IAEC/CPCSEA guidelines information. CPCSEA/IAEC Committee members recommended it successfully.

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