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Plumeria Obtusa Leaf Powder Supplemented in the Diet of Pekin Ducks: Effect on Growth Performance, Carcass Characteristics and Caecal Microflora Count

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A B S T R A C T

This experiment was carried out to evaluate Plumeria obtusa leaf powder supplemented in the diet of Pekin ducks: effect on growth performance, carcass characteristics and caecal microflora count. 400 Pekin ducklings (mixed sex) were used in the 42 days trial (Poultry Unit of Sumitra Research Institute, India) with an initial body weight of 42.55± 1.35 g were randomly distributed into five treatment groups with ten replicates (10 birds per replicate). An experimental bird (basal diet) was compounded following the requirement for ducks according Nutritional Research Council's recommendation in 1994. Ducks in group A which also served as the control, was fed basal diet only, group B received basal diet supplemented with Oxytet® Plus (synthetic antibiotics) at 0.25 g/kg diet while those in group C, D and E were fed same diet (basal diet) supplemented with Plumeria obtusa leaf powder at 20 g, 40 g and 60 g/kg diet respectively. Average daily weight gain and average daily feed intake were higher in birds fed Plumeria obtusa leaf powder (C, D and E), intermediate in group B and lowest in group A ($p<0.05$). Feed to gain ratio decreased as the level of Plumeria obtusa leaf powder increased in the diet ($p<0.05$). Dressed percentage, eviscerated weight were significantly ($p<0.05$) influenced by the diet except for the relative weights of heart, liver, spleen, head, back, thigh, drumstick, breast and wing ($p>0.05$). Escherichia coli, Pseudomonas spp, Staphyllococcus spp and Stereptococcus spp counts were higher in group A relative to the other treatments. Conversely, Lactobacillus spp count were higher in group C, D and E compared to the other groups

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INTRODUCTION

This overuse of antibiotics in the poultry industry can cause antimicrobial resistance, a considerable threat to the human population. Several non-antibiotic, plant-derived antimicrobial substances have been proposed as promising feed additives to ensure a high health status (Olujimi, 2024). The utilization of herbal plants has been scientifically confirmed to have no drug resistance, non-toxic side effects, can help to promote food security and environmental sustainability (Olujimi, 2024). Herbal plants contains several phyto-components with abundant pharmacological properties including, antimicrobial, antifungal, anti-inflammatory (Ojediran 2024a; Ojediran, 2024b), gastro-protective (Latanker et al., 2016; Nureni and Rustaman, 2019), antiulcer, immuno-modulatory (Singh et al., 2022), anticancer, cytotoxic, antioxidant (Muritala et al., 2022), anti-diabetic (Daniel et al., 2023), anti-helminthic, digestive stimulators, antiviral (Ojediran et al., 2024b), anti-diarrhea (Aguoru et al., 2016), and so on. *Plumeria obtusa* is one of the potential underutilized medicinal plant with therapeutic properties and also loaded with nutritional qualities (Bihani and Mhaske, 2020; Nittya, 2016).

LITERATURE REVIEW

Plumeria obtusa is a popular medicinal plant belonging to the family Apocynaceae. It is a large shrub that at times grows to a height of 5 to 6 metres tall found in most parts of Asia including, China, India, Bangladesh, Pakistan, North Central America and Africa (Kanlayavattanakul et al., 2013; Kamran et al., 2020). They comprises of over 28 species widely distributed in different parts of the world. The leaves are dark green in colour and characterized by a soft shine adaxially and paler with tertiary veins, flowers are white, waxy and fragrant with large deciduous bracts while the leaves, stem and branches possess milky sap (El-Kasshef et al., 2015; Devprakash et al., 2012). *Plumeria obtusa* leaves contains phytochemicals such as, flavonoids, terpenoids, steroids, glycosides, tannins, alkaloids, and phenolic compounds (Choudhary et al., 2014; Amaral et al., 2013).Traditionally, the leaves are used to treat skin infections, wounds, ulcer, pain, tooth ache, gastrointestinal disorders, diabetes, leprosy, cough, asthma, malaria, sexually transmitted infections, cardiovascular disease amongst others (Ali et al., 2013; Ali et al., 2014).

Previous scientific studies have shown that medicinal plants had positive influence on the digestive system increasing appetite and gastrointestinal secretions (Botsoglou et al., 2002), they stimulate enzyme secretions and the peristalsis improving digestion (Abudabos et al., 2017) and assimilation of nutrients of birds (El-Sabrout and Saleh, 2014). Phytogenics also have the potential to support gut health under challenging stress conditions due to the presence of phenols and flavonoids (Ahmed et al., 2019). They can also promote better balance the gut microflora and to stimulate digestive process of broiler chickens (Garcia et al., 2016). Ao and Kim (2020), reported that grape seed extract supplemented in the diet of Pekin ducks at 0.02 % was capable of scavenge the activities of free radicals and improving their immune parameters. Ralph and Sance (2024) also observed that meat quality of Muscovy duck was enhanced through the supplementation of oregano extract. However, there is little or no information about the effect of *Plumeria obtusa* leaf powder. This information is timely because the livestock industry has turned against the use of antibiotic growth promoters due to its numerous negative effect on health and environment. Therefore, this study was designed to determine the effect of dietary supplementation of *Plumeria obtusa* leaf powder on the growth performance, carcass characteristics and caecal microflora count of Pekin ducks.

METHODOLOGY

Ethical Approval, Experimental Location and Duration

All the experimental procedures was approved by the Animal Research and Welfare Committee of Sumitra Research Institute, Gujarat India (FT/009-24/SMT/9002). The study duration was 42 days.

Plumeria Obtusa Leaf Collection, Processing and Analysis of Phyto-Components

Fresh leaves of *Plumeria obtusa* leaves were collected from Orthur village in India and sent to the department of Agronomy at Sumitra Research Institute, Gujarat, India for proper identification (DF/09/2025-08A) before it was shade dried for 12 days to retain the phyto-constituents in the plant. Thereafter, milled into powder using an electronic blender before it was stored in an air tight labeled polythene and stored under room temperature. 200 g of the powdered sample (*Plumeria obtusa* leaf powder) was sent to the laboratory for the evaluation of phyto-components using portable deck high frequency gas chromatography/mass spectrometry (Model: LD/09A/2081). Composition of flavonoids, phenolic compound, tannins, alkaloids, steroids, terpenoids and saponins were assessed at different optical density according to procedures outlined by Alagbe (2024).

Care, Housing and Experimental Design

400 Peckin ducklings (mixed sex) were used in the 42 days trial (Poultry Unit of Sumitra Research Institute, India) with an initial body weight of 42.55± 1.35 g were housed in a galvanized battery cage measuring (400 cm × 310 cm × 155 cm) equipped with nipple drinker and aluminum feeder. The initial body weight was recorded using a digital sensitive scale on arrival before they were randomly distributed into five treatment groups with ten replicates (10 birds per replicate). An experimental bird (basal diet) was compounded following the requirement for ducks according Nutritional Research Council's recommendation in 1994. Ducklings were given a mixture of water soluble vitamins with glucose in the ratio of 1:2 for 5 days. 200 watt bulb was constructed with the cage was used to supply heat to birds. Ducks in group A which also served as the control, was fed basal diet only, group B received basal diet supplemented with Oxytet® Plus (synthetic antibiotics) at 0.25 g/kg diet while those in group C, D and E were fed same diet (basal diet) supplemented with Plumeria obtusa leaf powder at 20 g, 40 g and 60 g/kg diet respectively. Birds were fed thrice (5:30 H, 11:30 H and 3:00 H) and had unlimited access to clean fresh water and feed. Final body weight gain was recorded at the end of the experiment while average body weight gain was calculated as the difference between the average final body weight and average initial body weight. Feed consumption was recorded per pen and per phase. Feed to gain ratio and average

daily weight gain and average daily feed consumption were calculated according to the feeding phases.

Carcass Characteristics Evaluation

On the 42th day of the experiment, four birds per replicate were randomly selected, weighed and slaughtered by cutting the jugular veins in the neck allowed to bleed, scalded in warm water (70°C) and manually de-feathered. Eviscerated and dressed weight was also recorded before it was cut into various parts and organs were separated before its measurement was taken using a digital sensitive scale. The weight of the cut-up parts (drum stick, back, head, wing, breast and thigh) and organs (liver, spleen, heart, kidney and gizzard) were expressed percentage of live weight while the dressing percentage was calculated as:

Dressing % = Eviscerated weight divided by Live weight multiplied by 100

Caecal Microflora Count

At the end of the study, four birds were randomly selected per replicate (same birds used for carcass evaluation) for caecal microbial count. Samples from the caecum was collected into plain sample bottles (well labeled) followed by the addition of 10 % peptone reagent before it was transferred immediately to the microbiology department of Sumitra Research Institute for further studies. Count of organisms were done using Lethal® Microtech (Model: DV/009L, China). All other procedures were strictly followed according to the standard kit operation manual of manufacturers.

Analysis of Experimental Diet

Proximate components of experimental diet was carried out using Niabor 567® automated feed analyzer (Model; PP/2056A-11T, Netherlands). Percentage of calcium and phosphorus in diet was evaluated using Spectra® atomic absorption spectrometer (model SFG-588/09C, India).

Statistical Analysis Used for the Experiment

Data obtained on growth performance, carcass characteristics and ceacal microflora evaluation were subjected to one -way analysis of variance using SPSS (version 25). Significant differences among the groups were subjected to comparisons using the Duncan multiple range test of the same software. All differences were considered to be statistically significant when $p < 0.05$

RESULT

Nutrient levels of experimental diet fed to Peckin ducklings at the beginning (starter: 0-21d) and finisher (22-42 d) is displayed in Table 1 and 2. Crude protein (23.12 % and 20.92 %), crude fibre (3.73 % and 3.96 %), crude fat (4.05 % and 3.88 %), calcium (1.19 % and 1.20 %), phosphorus (0.54 % and 0.61 %), lysine (1.35 % and 1.32 %), methionine (0.60 % and 0.59 %) and energy [(2991.2 and 3096.7 Kcal/kg)] in that order. Values recorded was consistent with Nutritional Research Council's standard (1994).

The phyto-components in *Plumeria obtusa* leaf powder is presented in Table 3. Seven bioactive compounds were discovered including, phenols (906.75 g/kg), flavonoids (818.92 g/kg), terpenoids (462.33 g/kg), steroids (103.86 g/kg), alkaloids (57.81 g/kg), glycosides (40.42 g/kg) and tannins (30.45 g/kg).

Growth performance records of Peckin ducklings fed diet supplemented with *Plumeria obtusa* leaf powder is presented in Table 4. The overall effect on starter and grower phase confirms that average daily weight gain and average daily feed consumption whose values varied from 48.40 - 66.67 g/b and 120.29 to 136.1 g/b higher among birds which received diet C (20 g Plumeria obtusa leaf powder/kg diet), D (40 g *Plumeria obtusa* leaf powder/kg diet) and E (60 g *Plumeria obtusa* leaf powder/kg diet), intermediate among birds fed diet B (0.25 g Oxytet Plus®/kg diet) and lowest in control (diet A, without *Plumeria obtusa* leaf powder) (p<0.05). This outcome follow similar pattern in the starter and grower phase as average daily weight gain and average feed consumption values were higher (p<0.05) among birds fed diet C, D and E compared to the other groups. Similarly, best overall feed to gain ratio was recorded among birds fed diet C, D and E which were similar (p>0.05) compared to those on diet B and A. This trend was also observed in the starter and grower phase as increase in dietary supplementation of *Plumeria obtusa* leaf powder decreased feed to gain ratio (p<0.05). Birds on diet C, D and E also recorded an overall higher values of protein intake (1107.7 to 1254.2 g/b) and energy intake [(15492.0 to 17521.7 (ME/kcal/bird)] compared with birds on diet B and A (control), these variation was also observed in the starter and grower phase where protein and energy intake of birds on diet C, D and E were similar (p>0.05) but higher than those which received diet A and B (p<0.05).

Carcass characteristics of birds fed diets supplemented with *Plumeria obtusa* leaf powder (Table 5). Dressed weight, eviscerated weight and dressing percentage among birds on diets C, D and E were similar (p>0.05) but were higher significantly (P<0.05) when compared with those of the birds on diet A and B. Dietary supplementation of *Plumeria obtusa* leaf powder had no significant (p>0.05) influence on the relative weights of liver, kidney, spleen, heart, thigh, head, drumstick, wing, back and breast of carcass in all the groups.

Caecal microflora of *Plumeria obtusa* leaf powder supplemented in the diet of birds (Table 6). Birds that received diet A displayed higher (p<0.05) count in *Escherichia coli, Pseudomonas spp, Staphyllococcus spp* and *Stereptococcus spp* in the caecum compared to other groups. *Lactobacillus spp* count among birds on diets C, D and E were similar (p>0.05) but were higher significantly (p<0.05) when compared with those of the birds on diet A and B.

DISCUSSION

The presence of phyto-components (flavonoids, tannins, alkaloids, terpenoids, glycosides, steroids and phenols) in *Plumeria obtusa* leaf indicates that it contains numerous pharmacological properties including, anti-inflammatory, antioxidant, antifungal, anti-helminthic, immune-modulatory, gastro-protective, antifungal, cytotoxic, antimicrobial, antiviral, amongst others (). The composition of these compounds can be influenced by age of plant, specie, geographical location and processing methods (Singh et al., 2022; Ojediran et al., 2024). The outcome of this result aligns with the previous study by (John, 2024e). Overall result on growth performance of birds fed *Plumeria obtusa* leaf powder had the highest average daily body weight suggesting that herbal plants with its potential phyto-components could positively influence the activities of digestive enzymes in the gastro intestinal tract, possibly by reducing the retention time of feed thereby increasing nutrient absorption and reducing stress that could hinder metabolic process in animals (John, 2024c; John, 2024d). This result may be attributed to the antimicrobial, anti-inflammatory and antioxidant activities of *Plumeria obtusa* leaf powder (Alagbe, 2024). Though birds fed diet B performed better compared to those in control (diet A), this outcome suggests that Oxytet® Plus possess antimicrobial properties (Daniel et al., 2023). The major advantage of supplementing *Plumeria obtusa* leaf powder is that it has no withdrawal period, pose no toxic residue products and will help to promote a sustainable environment (John, 2024a; John, 2024b). Average daily feed intake were highest among birds which received *Plumeria obtusa* leaf powder implying that it was well accepted and palatable for birds. Result obtained in this study is in consonance with the reports of Kasiyati et al. (2019); Pramestya et al. (2021), when plant extract was included in the diet of pennging duck. Overall protein and energy intake range (1107.7 to 1254.2 g/b) and [(15492.0 to 17521.7 (ME/kcal/bird)] obtained in this experiment was higher than values reported by Olamuyiwa et al. (2021) who recorded 970.14 - 1155.08 g/b and [(14265.9 - 16893.27 (ME/kcal/bird)] range when broilers were fed diet supplemented with ginger meal and monosodium glutamate. The increase in dietary supplementation of *Plumeria obtusa* leaf powder significantly decreased feed to gain ratio, this result implies efficient utilization and absorption of nutrient among birds which in turn positively influence average weight gain of birds. Overall feed conversion ratio range (2.04 to 2.45) recorded in this study was similar to those discovered by Ao and Kim (2020) who recorded a range of 2.40 to 2.55 when grape seed extract was fed to Pekin ducks.

Dressed percentage of birds in group 3, 4, and 5 being higher than group 2 and 1 indicates that *Plumeria obtusa* leaf powder at 20 g, 40 g and 60 g/kg diet had a significant influence on the meat yield of birds. The result can be attributed to the presence of bioactive compounds in *Plumeria obtusa* leaf powder as stated in Table 3. Previous study by Diaz-Sanchez et al. (2015) revealed that herbal plants has a positive influence on the overall meat yield of broiler chickens. Relative weights of organs and cut parts were not influenced across the group implying the absence of inflammation or toxic substance in their body (Olafadehan et al., 2024). Inflammation of the liver can affect the production of some blood products and metabolism (Shittu et al., 2024). Impairment of the heart can affect the regulation of blood flow and can result in the death of animals (Musa et al., 2021). The result obtained in this study is in agreement with the Lokapirnasari and Agustono (2022) when *Moringa olifera* and probiotics were supplemented in the diet of Peking duck.

In this experiment, increasing the dietary supplementation of *Plumeria obtusa* leaf powder from 20 - 60 g/kg diet significantly lowered the population of *Escherichia coli*, *Pseudomonas spp*, *Staphyllococcus spp* and *Stereptococcus spp* count compared to the other group. The outcome of this result suggests that the mode of action of *Plumeria obtusa* leaf powder is based on competitive exclusion including removing undesirable bacteria that competes with nutrients and space in the gastrointestinal tract (Daniel et al., 2023). The presence of flavonoids and phenolic compounds can produce a strong antimicrobial properties favoring the multiplication of beneficial bacteria such as *Lactobacillus spp* (Alagbe, 2024). Conversely, *Lactobacillus spp* count increases as the level of *Plumeria obtusa* leaf powder increased across the group. According to Omokore and Alagbe (2019), lactic acid producing bacteria's can modulate the host microbiota by inhibiting pathogenic organisms in the gut. Though, Oxtet® Plus (group 2) supplementation also able to reduce the activities of pathogenic organisms. However, there its efficacy is lower compared with *Plumeria obtusa* leaf powder group and continuous and indiscriminate usage could promote antimicrobial resistance or multi drug resistance in birds. The result obtained is in agreement with the reports Hajati et al. (2015); Wu et al. (2018) when botanical polyphenols was supplemented in the diet of ducks.

CONCLUSIONS AND RECOMMENDATIONS

It was concluded that *Plumeria obtusa* leaf powder is abundant in several phyto-components with high medicinal value and can be explored in the treatment of some pathogens in ducks. Result on growth performance, carcass characteristics and ceacal mircoflora revealed that *Plumeria obtusa* leaf powder had positive influence or impact on the digestive system increasing appetite and stimulating the secretions of enzymes thus allowing assimilation of nutrients of birds. It can be supplemented up to 60 g/kg in the diet of ducks without causing any negative effect on their health status.

Table 1: Nutrient Composition of Experimental Diet Given to Pekin Ducklings (Starter Diet) (0-21 D)

Ingredient/Item	Content (%)	Content (%)	Content (%)	Content (%)	Content (%)
Maize	51.4	51.4	51.4	51.4	51.4
Rice bran	5.00	5.00	5.00	5.00	5.00
Soybean meal	32.0	32.0	32.0	32.0	32.0
Fish meal	3.00	3.00	3.00	3.00	3.00
Calcium carbonate	2.50	2.50	2.50	2.50	2.50
Bone meal	5.00	5.00	5.00	5.00	5.00
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Sodium chloride	0.35	0.35	0.35	0.35	0.35
Oxytet powder	0	0.25	0.00	0.00	0.00
Plumeria obtusa leaf powder (g/kg diet)	0	0	20.0	40.0	60.0
Total	100	100	100	100	100
Nutrient levels (%)					
Crude protein	23.12	23.12	23.12	23.12	23.12

Crude fibre	3.73	3.73	3.73	3.73	3.73
Crude fat	4.05	4.05	4.05	4.05	4.05
Calcium	1.19	1.19	1.19	1.19	1.19
Phosphorus	0.54	0.54	0.54	0.54	0.54
Lysine	1.35	1.35	1.35	1.35	1.35
Methionine	0.60	0.60	0.60	0.60	0.60
Energy (Kcal/kg)	2991.2	2991.2	2991.2	2991.2	2991.2

Table 2: Nutrient Composition of Experimental Diet Given to Pekin Ducklings (Grower Diet) (22-42 D)

Ingredient/Item	Content (%)	Content (%)	Content (%)	Content (%)	Content (%)
Maize	52.4	52.4	52.4	52.4	52.4
Rice bran	6.50	6.50	6.50	6.50	6.50
Soybean meal	30.0	30.0	30.0	30.0	30.0
Fish meal	2.00	2.00	2.00	2.00	2.00
Calcium carbonate	3.00	3.00	3.00	3.00	3.00
Bone meal	6.00	6.00	6.00	6.00	6.00
Lysine	0.20	0.20	0.20	0.20	0.20
Methionine	0.20	0.20	0.20	0.20	0.20
Premix	0.25	0.25	0.25	0.25	0.25
Sodium chloride	0.35	0.35	0.35	0.35	0.35
Oxytet powder	0	0.25	0.00	0.00	0.00
Plumeria obtusa leaf powder (g/kg diet)	0	0	20.0	40.0	60.0
Total	100	100	100	100	100
Nutrient levels (%)					
Crude protein	20.92	20.92	20.92	20.92	20.92
Crude fibre	3.96	3.96	3.96	3.96	3.96
Crude fat	3.88	3.88	3.88	3.88	3.88
Calcium	1.20	1.20	1.20	1.20	1.20
Phosphorus	0.61	0.61	0.61	0.61	0.61
Lysine	1.32	1.32	1.32	1.32	1.32
Methionine	0.59	0.59	0.59	0.59	0.59
Energy (Kcal/kg)	3096.7	3096.7	3096.7	3096.7	3096.7

Table 3: Phyto-Components in Plumeria Obtusa Leaf Powder

Phyto-components	Concentrations (g/kg)
Terpenoids	462.33
Flavonoids	818.92
Phenols	906.75
Steroids	103.86
Glycosides	40.42
Alkaloids	57.81
Tannins	30.45

Table 4: Growth Performance of Peking Ducklings Fed Diet Supplemented with Plumeria Obtusa Leaf Powder

Variables	A	B	C	D	E	SEM	*P-value*
Starter phase (0 - 21 d)							
Experimental period	42	42	42	42	42	-	
Number of birds	60	60	60	60	60	-	
Average initial body weight (g/b)	43.9	43.08	42.55	42.86	42.95	0.21	0.01
Average final body weight (g/b)	554.11^{c}	610.5^{b}	710.4^{a}	719.6^{a}	724.4^{a}	0.52	0.13
Body weight gain (g/b)	510.21^{c}	567.42^{b}	667.85^{a}	676.74^{a}	681.45^{a}	0.47	0.10
Daily weight gain (g/b)	24.3^{c}	27.02^{b}	31.8^{a}	32.22^{a}	32.45^{a}	0.02	0.21
Total feed intake (g/b)	1456.7^{c}	1660.3^{b}	1692.1^{a}	1698.5^{a}	1700.2^{a}	10.07	0.62
Daily feed intake (g/b)	69.37^{c}	79.06^{b}	80.58^{a}	80.88^{a}	80.96^{a}	0.01	0.16
Feed to gain ratio	2.86^{a}	2.71^{b}	2.51^{c}	2.50^{c}	2.50^{c}	0.01	0.01
Protein intake (g/b)	338.25^{c}	385.52^{b}	392.91^{a}	394.39^{a}	394.79^{a}	0.17	0.02
Energy intake (ME/kcal/bird)	4357.28^{c}	4966.29^{b}	5061.41^{a}	5080.55^{a}	5085.64^{a}	18.72	0.25
Grower phase (22-42 d)							
Body weight gain (g/b)	1522.7^{c}	1760.91^{b}	2100.5^{a}	2111.9^{a}	2118.7^{a}	9.72	0.18
Daily weight gain (g/b)	72.51^{c}	83.85^{b}	100.0^{a}	100.6^{a}	100.9^{a}	0.46	0.10
Total feed intake (g/b)	3595.7^{b}	3700.6^{b}	4006.8^{a}	4010.5^{a}	4015.9^{a}	17.54	0.30
Daily feed intake (g/b)	171.22^{c}	176.22^{b}	190.80^{a}	190.77^{a}	191.23^{a}	0.07	0.20
Feed to gain ratio	2.36^{a}	2.10^{b}	1.91^{c}	1.90^{c}	1.90^{c}	0.01	0.01
Protein intake (g/b)	769.48^{b}	791.94^{b}	857.46^{a}	858.25^{a}	859.40^{a}	1.23	0.06
Energy intake (ME/kcal/bird)	11134.8^{b}	11459.8^{b}	12407.9^{a}	12419.3^{a}	12436.0^{a}	34.93	0.40

Overall production (0-42 d)							
Average final body weight (g/b)	2032.91^{c}	2328.33^{b}	2768.35^{a}	2788.64^{a}	2800.15^{a}	16.20	0.27
Daily weight gain (g/b)	48.4^{c}	55.44^{b}	65.91^{a}	66.40^{a}	66.67^{a}	0.09	0.02
Total feed intake (g/b)	5052.4^{c}	5360.95^{b}	5698.9^{a}	5709^{a}	5716.1^{a}	19.05	0.33
Daily feed intake (g/b)	120.29^{c}	127.64^{b}	135.69^{a}	135.93^{a}	136.1^{a}	0.06	0.02
Feed to gain	2.45^{a}	2.30^{b}	2.06^{c}	2.05^{c}	2.04^{c}	0.01	0.08
Protein intake (g/b)	1107.7^{c}	1177.4^{b}	1250.4^{a}	1252.6^{a}	1254.2^{a}	35.87	0.42
Energy intake (ME/kcal/bird)	15492.0^{c}	16426.1^{b}	17469.3a	17499.9^{a}	17521.7^{a}	41.22	0.92

Values followed by different letters were significantly different ($p<0.05$); diet A: basal diet only (control); B: basal diet supplemented with Oxytet® at 0.25 g/kg diet while C, D and E: basal diet supplemented with Plumeria obtusa leaf powder at 20 g, 40 g, 60 g and 80 g per kg respectively; SEM: standard error of mean

Table 5: Carcass Characteristics of Peking Ducklings Fed Diet Supplemented with *Plumeria Obtusa* Leaf Powder

Variables	A	B	C	D	E	SEM	*P-value*
Live weight	2059.39^{c}	2306.71^{b}	2753.4^{a}	2801.2^{a}	2822.8^{a}	18.22	0.56
Dressed weight	1669.21^{c}	1952.2^{b}	2371.1^{a}	2501.0^{a}	2518.1^{a}	15.31	0.41
Eviscerated weight	1369.40^{c}	1622.6^{b}	2071.5^{a}	2171.9^{a}	2208.5^{a}	12.74	0.68
Dressing percentage	66.49^{c}	70.34^{b}	75.23^{a}	77.51^{a}	78.25^{a}	0.03	0.01
Organ weights expressed in % live weight							
Liver	2.06	2.11	2.13	2.15	2.18	0.06	0.21
Kidneys	0.21	0.22	0.25	0.26	0.26	0.01	0.01
Spleen	0.13	0.15	0.16	0.18	0.19	0.03	0.01
Heart	0.52	0.55	0.56	0.58	0.59	0.61	0.01

Gizzard	3.01	3.04	3.11	3.13	3.15	0.91	0.02
Cut parts expressed in % live weight							
Thigh	10.45	10.68	10.85	10.91	10.93	0.07	0.01
Head	3.02	3.15	3.17	3.21	3.23	0.02	0.05
Drumstick	10.23	10.75	10.88	10.92	11.05	0.03	0.02
Wing	8.02	8.13	8.22	9.05	9.11	1.55	0.01
Back	14.22	16.73	19.98	20.72	20.73	2.71	0.02
Neck	3.12	3.17	3.23	3.34	3.45	0.04	0.22
Breast	17.33	20.94	25.33	26.03	26.17	6.49	0.03

Values followed by different letters were significantly different ($p<0.05$); diet A: basal diet only (control); B: basal diet supplemented with Oxytet® at 0.25 g/kg diet while C, D and E: basal diet supplemented with Plumeria obtusa leaf powder at 20 g, 40 g, 60 g and 80 g per kg respectively; SEM: standard error of mean

Table 6: Caecal Microflora of Peking Ducklings Fed Diet Supplemented with Plumeria Obtusa Leaf Powder

Variables (Log 10 CFU)	A	B	C	D	E	SEM	*P-value*
Escherichia coli	4.05^{a}	2.83^{b}	2.57^{b}	2.52^{b}	2.51^{b}	0.22	0.13
Pseudomonas spp	3.42^{a}	2.62^{b}	2.11^{b}	2.03^{b}	2.01^{b}	0.18	0.10
Staphyllococcus spp	3.77^{a}	2.91^{b}	2.33^{b}	2.21^{b}	2.16^{b}	0.19	0.05
Streptococcus spp	2.78^{a}	1.92^{b}	0.95^{c}	0.92^{c}	0.91^{c}	0.03	0.01
Lactobacillus spp	3.63^{c}	4.11^{b}	5.06^{a}	5.11^{a}	5.16^{a}	1.48	0.02

Values followed by different letters were significantly different ($p<0.05$); diet A: basal diet only (control); B: basal diet supplemented with Oxytet® at 0.25 g/kg diet while C, D and E: basal diet supplemented with Plumeria obtusa leaf powder at 20 g, 40 g, 60 g and 80 g per kg respectively; SEM: standard error of mean

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