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Optimization of Dietary Protein and Energy Requirement of Kadaknath Chicken During the Starter Phase

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ABSTRACT

The 300 day old Kadaknath chicks were randomly distributed into five treatment groups A, B, C, D and E with three replicates having 20 birds in each and reared up to 6th weeks. The treatment groups were viz., control group A: birds fed diet CP 18%, ME 2700 kcal/kg, Methionine 0.38%, Lysine 0.85%; B: diet CP 19%, ME 2800 kcal/kg, Methionine 0.40%, Lysine 0.90%; C: diet CP 20%, ME 2900 kcal/kg, Methionine 0.48%, Lysine 1.00%; D: diet CP 21%, ME- 3000 kcal/kg, Methionine 0.45%, Lysine 1.10%; E: diet CP 22%, ME 3100 kcal/kg, Methionine 0.50%, Lysine 1.20 %. The body weights and weight gain in group D were significantly ($P<0.01$) higher than other treatment groups except group B at 6th week. The significantly lower feed intake was observed in group D compared to control group at 1st and 3rd weeks. The feed conversion ratio was significantly ($P<0.01$) better in groups B (3.74±0.06), D (3.70±0.10) and E (4.18 ±0.13) compared to control group (4.70±0.25). The antibody titres against Ranikhet disease were non-significant in all treatments at 3rd and 6th weeks. The cost of production in rupees per kg live weight was recorded lowest in group D (217.56) followed by groups B (218.62), C (255.39), E (256.23) and A (261.11). It may be concluded that the rearing of Kadaknath chickens under intensive system fed starter diet containing ME 3000 kcal/kg, CP 21%, Lysine 1.10% and Methionine 0.45% recorded best growth performance, better immune response and lowest cost of production at the end of 6th week.

Keywords: Economics, Growth performance, Immune response, Kadaknath, Nutrients

Backyard poultry farming is a traditional system of rearing average flock size of 5-15 non-descript fowls by small families to meet their dietary and cash needs. It is eco-friendly approach as desi birds are helpful in worm, pest and insect control and provide manure for field. Rearing of birds is advantageous as it provide supplementary income in shortest possible time with very minimum investment and ensures availability of egg and meat in remote areas. Indigenous germplasm birds have better adaptability in tropical areas; protect themselves from predator, comparatively disease resistant to protozoon and ecto-parasites. However, Indigenous chicken breeds are good source of animal proteins (Singh *et al.,* 2017) and could be very helpful in combating the nutritional deficiencies and generating income for the rural masses, especially in the developing countries.

India is home track of nineteen breeds of indigenous fowl along with various exotic-indigenous and inter-exotic crosses. Out of many indigenous chicken breeds registered, one well known native breed is 'Kadaknath' the same breed also known as Kalamasi due to its black-colored meat. The breed is native of Jhabua and Dhar districts in Western parts of Madhya Pradesh and also found in adjoining areas of the states of Gujarat and Rajasthan. The skin, beak, shanks, toes and sole of the feet of Kadaknath birds are slate like in colour. Most of the internal organs of Kadaknath birds exhibit intense black colouration, which is due to the deposition of melanin pigment, a genetic condition called "Fibromelanosis" (GIJ, 2018). The bird is mostly reared by tribes without any vaccination and hygiene. The bird is very popular due to adaptability to local environment, resistance to certain diseases, meat qualities and many other criteria specific to breed type. Kadaknath bird lays apparently 80-90 eggs annually (Rahangdale *et al.,* 2017) and the bird has poor mothering ability as broody hen. The available broiler and egg type chick mash was the option for feeding; certainly the nutrient requirement of Kadaknath is differ than the broiler birds. Scare information was available on nutrient requirement of Kadaknath birds. Hence, the experiment was planned to know the nutrient requirement of Kadaknath breed during starting phase (0-6 week) to optimize the growth performance, immune response and economics of production.

MATERIALS AND METHODS

Ethical approval

This study was approved by Institute Animal Ethics Committee (IAEC) of Nagpur Veterinary College, MAFSU, Nagpur.

Experimental Design and Management of the birds

The present experiment was conducted on 300 day old Kadaknath chicks for period of six weeks to investigate the nutrient requirement of Kadaknath chickens during the starter phase (0-6 weeks) and to optimize the growth performance, immune response and economics of production. The day old chicks of Kadaknath chicks were randomly distributed into five treatment groups A, B, C, D, and E having three replicates containing 20 birds in each. The different dietary treatment groups were viz., control group A: birds fed diet CP 18%, ME 2700 kcal/kg, Methionine 0.38%, Lysine 0.85%; B: birds fed diet CP 19%, ME 2800 kcal/kg, Methionine 0.40%, Lysine 0.90%; C: birds fed diet CP 20%, ME 2900 kcal/kg, Methionine 0.48%, Lysine 1.00%; D: birds fed diet CP 21%, ME-3000 kcal/kg, Methionine 0.45%, Lysine 1.10%; E: birds fed diet CP 22%, ME 3100 kcal/kg, Methionine 0.50%, Lysine 1.20%.

The experimental chicks were reared on deep litter system and all the groups were provided similar environmental and managemental condition throughout experimental period of 0-6 weeks. The standard management and brooding practices was carried out to optimize the performance. The birds were offered *ad-lib* fresh and clean drinking water throughout the experiment. The birds were vaccinated against Ranikhet disease (Lasota strain) on 7th day of age and further booster of Ranikhet disease (Lasota strain) was carried out on 28th day of experiment.

Experimental diets and nutrient composition

The formulating experimental diets, the control diet was prepared as per standards available in Nutrient requirement of animals-poultry book published by Indian Council of Agriculture Research (ICAR), New Delhi (Singh, 2013). Considering the control diet as basal feed other dietary treatment groups were formulated. The experimental feed formulation and calculated nutritional composition for different dietary treatment groups during the starter phase (0-6 weeks) was presented in Table 1.

Table 1: Feed ingredients (%) and nutrient composition of different treatment groups

Feed Ingredients (%)	Treatments groups				
	A	B	C	D	E
Maize	58.33	61.85	65.97	64.06	59.40
Soya DOC (45%)	24.30	28.50	12.50	0.00	0.00
Soya DOC Hypro	0.00	0.00	17.00	28.00	29.34
Wheat bran	13.00	5.30	0.00	0.00	0.00
Maize glutean (65%)	0.00	0.00	0.00	2.00	3.10
Vegetable oil	0.00	0.00	0.10	1.50	3.70
Monocalcium phosphate	1.50	1.50	1.50	1.50	1.50
Limestone powder (LSP)	1.90	1.90	1.90	1.90	1.90
Salt (NaCl)	0.40	0.40	0.40	0.40	0.40
Trace mineral mixture	0.12	0.12	0.12	0.12	0.12
Vitamin premix	0.05	0.05	0.05	0.05	0.05
DL- Methionine	0.10	0.10	0.18	0.14	0.16
L-Lysine	0.02	0.00	0.00	0.05	0.05
Choline chloride (75%)	0.05	0.05	0.05	0.05	0.05
Toxin binder	0.10	0.10	0.10	0.10	0.10
Coccidiostat	0.03	0.03	0.03	0.03	0.03
Sodium bircabonate	0.10	0.10	0.10	0.10	0.10
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Nutrient Composition					
Metabolizable energy (kcal/kg)	2707	2812	2919	3009	3103
Crude protein (%)	18.01	19.17	20.06	21.06	22.03
Ether extract (%)	3.01	2.89	2.95	4.31	6.35
Crude fibre (%)	4.77	4.2	3.82	3.81	3.81
Total lysine (%)	0.86	0.92	1.06	1.17	1.22
Total methionine (%)	0.38	0.4	0.49	0.47	0.51
Calcium (%)	1.06	1.07	1.06	1.05	1.06
Available phosphorous (%)	0.45	0.44	0.45	0.45	0.46

Parameters studied

Data was collected on weekly weight changes determined by weighing the birds on weekly basis and replicate wise weight gain was calculated by subtracting the weight of the previous week from that of the current week. The feed intake was determined by subtracting the left-over feed from the feed offered, while feed conversion ratio was calculated as average feed intake divided by average weight gain taking into consideration of mortality, if any. The birds under the experimental trials were assessed for the antibody titer against the New Castle Disease Virus (NCDV). Two birds from each replicate and a total of six birds from each treatment group were randomly selected for the blood collection at the end of 3rd and 6th week of age. These serum samples were used for Haemagglutination Inhibition (HI) test to detect the antibody titres against New Castle Disease Virus by Beta procedure (Allan *et al.,* 1978). The cost of rearing the Kadaknath birds for experiment was calculated by considering the prevailing costs of chicks, feed, litter and vaccine etc.

Statistical analysis

Data obtained from the experiment were subjected to one way analysis of variance (ANOVA) using the using Complete Randomized Design (Snedecor and Cochran, 1994).

RESULTS AND DISCUSSION

Live body weights and weight gain

The results of live body weight and weight gain (g/bird) at weekly interval in different treatments groups are presented in Table-2. The average day-old weight of Kadaknath chick in all treatment groups was 29 g/chick in all treatment groups. The live body weights and weight gain was significantly (P<0.01) higher in treatment groups B and E as compared to groups A (control) and C at 1st week. At 2nd and 3rd week of age, there was non-significant difference in all treatment groups. The live body weight and weight gain in treatment groups B and D were significantly (P<0.01) higher as compared to control group at 4th and 5th weeks. At 6th week, the mean live body weight in group D was significantly (P<0.01) higher than all treatment groups except group B, whereas, the mean live body weight was significantly (P<0.01) higher in treatment groups C and E compared to control group. The findings are in accordance with a researcher Tandekar (2012) reported that the diet containing 20% of CP observed higher average live body weight compared to diets containing 18% and 16% CP in cockerels. Similarly, Miah *et al.* (2014) reported that the body weight was significantly (P<0.01) improved in high energy density (ME-3000 kcal/kg, CP-23%) in starter phase and moderate energy density (ME-2800 kcal/kg, CP-23%) diets than low energy density (ME-2400 kcal/kg, CP-23%) and (ME-2600 kcal/kg, CP-23%) diets during the period of 3-14 weeks of age in indigenous (Desi) chickens. Perween *et al.* (2016) the body weight and body weight gain in birds was found to be significantly higher (P<0.05) containing 19% and 21% crude protein with ME 3000 kcal /kg compared to 17% CP and ME 2600 Kcal/kg in Vanaraja birds. However, chicks fed diet with 21% CP with ME 3000 kcal /kg utilized feed more efficiently than the lower level of protein and energy in the diet. As reported by Haunshi *et al.* (2012) that different ME levels had a significant effect on body weight gain and FCR.

Table 2: Weekly live body weight and weight gain (g/bird) of Kadaknath chicken in different dietary treatment groups

Treatment groups	Age (weeks)					
	1st	2nd	3rd	4th	5th	6th
Live body weights (g/bird)						
A	44.89^{bc} ± 0.96	66.41 ± 2.11	93.68 ± 3.17	138.84^{c} ±2.40	197.99^{c} ±2.80	251.74^{d} ±3.81
B	49.63^{a} ± 0.77	70.01 ± 2.81	104.62 ± 2.90	158.45^{ab} ± 4.55	231.62^{ab} ± 8.49	303.92^{ab} ± 11.60
C	42.74^{c} ± 1.40	67.81 ± 1.16	101.57 ± 3.62	141.56^{c} ± 3.45	202.81^{c} ± 7.75	266.76^{cd} ± 4.69

D	46.81^{ab} ± 0.90	71.91 ± 0.83	106.89 ± 2.54	167.84^{a} ± 7.03	245.08^{a} ± 3.04	322.44^{a} ± 5.86
E	49.22^{a} ± 1.16	69.06 ± 2.07	97.56 ± 2.15	147.13^{bc} ± 5.74	215.73^{bc} ± 11.54	282.64^{bc} ± 11.37
CD	4.754**	NS	NS	22.025**	33.670**	36.663**
CV %	3.940	4.846	5.016	5.646	5.952	4.963
Weight gain (g/bird)						
A	15.89^{bc} ±0.96	37.41 ±2.11	64.68 ±3.17	109.83^{c} ±2.40	168.99^{c} ±2.80	222.74^{d} ±3.81
B	20.63^{a} ±0.77	41.01 ±2.81	75.62 ±2.90	129.45^{ab} ±4.55	202.62^{ab} ±8.49	274.92^{ab} ±11.60
C	13.74^{c} ±1.40	38.81 ±1.16	72.58 ±3.62	112.6^{c} ±3.45	173.81^{c} ±7.75	237.76^{cd} ±4.69
D	17.82^{ab} ±0.90	42.91 ±0.83	77.89 ±2.54	138.8^{a} ±7.03	216.08^{a} ±3.04	293.44^{a} ±5.86
E	20.22^{a} ±1.16	40.06 ±2.07	68.56 ±2.15	118.13^{bc} ±5.74	186.73^{bc} ±11.54	253.64^{bc} ±11.37
CD	4.757**	NS	NS	22.025**	33.670**	36.663**
CV %	10.411	8.357	7.041	6.991	6.862	5.524

Means bearing different superscript within a column differ significantly. **P<0.01, NS- Non-significant, CD-Critical difference, CV-Coefficient of variance.

Feed Intake

The results of feed intake and FCR are presented in Table 3. The significantly higher (P<0.05) cumulative feed consumption was observed in treatment groups B and C as compared to D and E at the 1st week. At the 3rd week of age, the feed intake was significantly higher (P<0.01) in control group A (270.00±5.01g) as compared to all other treatment groups except group B. There were non-significant differences for mean cumulative feed consumption in all treatment groups at 2nd, 4^{rth}, 5th and 6th week of age. The non-significant difference was observed for feed intake in different dietary protein and energy levels in all treatment groups at 6th week. The results of the present study concur with the findings of Magala *et al.* (2012) reported that the feed intake in cockerels were not significantly affected by the dietary regimes which include protein levels (18 and 20% CP) and three energy levels (2800, 2900 and 3000 kcal/kg ME). Similar findings observed by Nguyen *et al.* (2010) stated that the feed intake was not significantly affected by the four dietary protein levels (15, 17, 19 and 21% CP) and two energy levels (3000 and 3200 ME kcal/kg) in Betong chickens. However, Kingori *et al.* (2003) stated that the birds fed on diet containing 160 and 180 g CP/kg showed non-significant (P>0.05) difference for feed intake indigenous chickens and Elangovan *et al.* (2004) reported no significant influence of feed intake in Naked Neck x CARI Red chicks due to dietary treatments with crude protein of 18, 16, 14 and 12 per cent.

Feed conversion ratio

The cumulative FCR was significantly (P<0.01) better in treatment groups B, D and E compared to control group C at the 1st week (Table 3). The significantly (P<0.01) better cumulative FCR was recorded in treatment groups B and D as compared to control group from 2nd to 4th and 6th week of age, whereas, the FCR was significantly (P<0.05) better in groups B and D than control group at 5th week. There was non-significant difference for cumulative FCR in treatment group C and control group A at 2nd, 4th, 5th and 6th week of age. However, cumulative FCR was significantly better (P<0.01) in treatment group C as compared to control group at 3rd week. The significantly (P<0.01) better cumulative FCR was observed in treatment group E compared to control group at 2nd, 3rd and 6th week of age, whereas, there was non-significant difference at 4th and 5th weeks. The feed conversion ratio was significantly (P<0.01) better in treatment groups B (3.74±0.06), D (3.70±0.10) and E (4.18 ±0.13) compared to control group (4.70 ±0.25) at 6th week. The present result agreed well with the finding of Mahore (2013) and Haunshi *et al.* (2012) also reported significantly better feed conversion ratio in higher dietary energy levels. Similarly, Miah *et al.* (2014) reported that the feed conversion ratios were similar in moderate energy density (ME-2800 kcal/kg, CP-23%) and high energy density (ME-3000 kcal/kg, CP-23%) treatment groups but differed significantly (P<0.05) from very low energy density (ME-2400 kcal/kg ,CP-23%) groups. Similarly, Rao *et al.* (2014) reported that feed efficiency improved and feed intake reduced with increasing dietary concentrations of these nutrients. However, an Energy:Protein ratio of 62 MJ ME Kg^{-1} protein supported most favorable feed conversion ratio in Venda chickens aged between one to six weeks of age reported by Mbajiorgu *et al.* (2012). Thus, a proper calorie protein ratio is needed in the ration for optimum intake of nutrient through feed consumption.

Table 3: Feed consumption (g/bird) and feed conversion ratio of Kadaknath chicken in different dietary treatment groups

Treatment groups	Age (weeks)					
	1st	2nd	3rd	4th	5th	6th
Feed consumption (g/bird)						
A	34.67^{ab} ±0.88	121.74 ±3.84	270.00^{a} ±5.01	444.91 ±10.14	720.23 ±28.26	1045.83 ±40.59
B	36.67^{a} ±0.88	117.75 ±2.83	264.14^{ab} ±6.25	446.56 ±7.27	719.98 ±11.71	1026.96 ±25.59
C	36.76^{a} ±2.32	116.29 ±5.31	252.57^{b} ±6.69	440.65 ±8.90	714.88 ±16.25	1035.01 ±17.57
D	31.00^{b} ±0.58	104.85 ±4.80	232.68^{c} ±5.77	419.95 ±12.22	723.72 ±36.77	1085.37 ±49.57
E	31.67^{b} ±1.45	112.42 ±5.49	247.02^{bc} ±3.19	450.80 ±9.38	732.53 ±36.77	1059.57 ±34.07
CD	4.312*	NS	24.749**	NS	NS	NS
CV %	6.941	6.897	3.776	3.821	5.439	5.820
Feed conversion ratio (FCR)						
A	2.19^{b} ±0.08	3.27^{a} ±0.09	4.19^{a} ±0.18	4.05^{a} ±0.14	4.27^{a} ±0.22	4.70^{a} ±0.25
B	1.78^{c} ±0.06	2.89^{b} ±0.13	3.50^{b} ±0.06	3.45^{b} ±0.06	3.56^{bc} ±0.09	3.74^{cd} ±0.06
C	2.71^{a} ±0.24	3.00^{ab} ±0.08	3.50^{b} ±0.18	3.92^{a} ±0.06	4.14^{ab} ±0.26	4.35^{ab} ±0.08
D	1.75^{c} ±0.10	2.44^{c} ±0.07	3.00^{c} ±0.16	3.03^{c} ±0.07	3.35^{c} ±0.16	3.70^{d} ±0.10
E	1.57^{c} ±0.02	2.81^{b} ±0.04	3.61^{b} ±0.08	3.83^{a} ±0.16	3.95^{abc} ±0.25	4.18^{bc} ±0.13
CD	0.566**	0.389**	0.640**	0.487**	0.647*	0.630**
CV %	10.938	5.226	6.945	5.142	9.221	5.891

Means bearing different superscript within a column differ significantly. *P<0.05, **P<0.01, NS- Non- significant, CD-Critical difference, CV-Coefficient of variance.

Mortality (%)

The mortality showed normal pattern in all treatment groups. The mortality from 0-6 weeks of age in different treatments from groups A to E was 10.00, 8.33, 11.66, 5.00 and 10.00% respectively. The post mortem examination revealed that the mortality occurred was not due to the dietary treatments. Most of the mortality occurred at initial stage of experiment. It has observed that weak chicks had bacterial infections which lead to mortality figure high in groups A, B, C, and E. The present findings are in accordance with researcher Miah *et al.* (2014) reported that energy levels of diet had no effect on survivability. Similarly, Mahore (2013) observed the mortality percent in cockerels was well within the limit and not affected with different levels of dietary energy in feed.

Immune response

The antibody titers ($\log_2$ values) against New Castle Disease (ND) at 3rd and 6th week of age in Kadaknath chickens fed different dietary levels were non-significant in all treatment groups and presented in Table 4. However, numerically higher ND antibody titers were recorded in treatment groups D at 3rd week of age and treatment group B at 6th week of age compared to other treatment groups. The numerically better HI titres were observed in high protein and high energy diets at 3rd and 6th week. The present findings are in agreement with research worker Tandekar (2012) reported that there was non-significant difference in the HI titers in all treatment groups up to 3rd week of age in cockerels. As reported by Golian *et al.* (2010) did not find any significant change in antibody titer due to the feeding of low energy diet. Moreover, Perween *et al.* (2015) reported that the better immune response recorded in the study might be due to better nutrient utilization and its extension toward the better immune response.

Table 4: Antibody titres ($\log_2$ values) against ND in Kadaknath chicken at 3rd and 6th weeks of age

Treatment groups	ND Titres (Log_2 values)	
	3rd week	6th week
A	5.333±0.24	4.000±0.71
B	5.333±0.24	5.667±0.24
C	5.333±0.47	5.000±0.41
D	6.000±0.41	5.000±0.41
E	5.667±0.62	5.000±0.41
CD	NS	NS
CV%	18.665	22.813

Means bearing different superscripts within a column differ significantly. NS-Non-significant, CD-Critical difference, CV-Coefficient of variance.

Economics of production

The economics influenced by different dietary treatments is shown in Table 5. It was observed that the cost of production expressed in rupees per kg live weight (₹/kg live weight) in treatment groups A, B, C, D and E was 261.11, 218.62, 255.39, 217.56 and 256.23, respectively. The cost of production (₹/kg live weight) in treatment groups B, C, D and E was reduced by 16.27, 2.19, 16.68 and 1.87%, respectively over control group A. The cost of production (₹/kg live weight) was reduced in all treatment groups containing the high energy and protein diets as compared to control group in Kadaknath chickens. The dietary high protein and energy levels during starter phase in Kadaknath chickens were recorded better economics of production compared to control group. These results are in agreement with earlier researcher Perween *et al.* (2015) reported that the higher energy (3000 kcal/kg) with medium protein (19% CP) diet positively reflects to obtain desirable performance economically in Vanaraja chicken. The present study showed that the lowest cost of production attained with 21% CP and 3000 kcal/kg ME in starter phase diet with respect of the overall performance of Kadaknath chicken.

Table 5: Cost of production of Kadaknath chickens up to 6th week in different treatment groups

Particulars	Treatment groups				
	A	B	C	D	E
Chick cost (₹/chick)	40	40	40	40	40
Feed cost (₹/kg)	21.74	22.83	24.28	25.02	27.77
Total feed intake (g/bird)	1045.83	1026.96	1035.01	1085.37	1059.57
FCR	4.70	3.74	4.35	3.70	4.18
Live body weight (g/b)	251.74	303.92	266.76	322.44	282.64
Cumulative weight gain (g/b)	222.74	274.92	237.76	293.44	253.64
Mortality (%)	10	8.33	11.66	5	10
Total feed cost (₹/ b)	22.73	23.44	25.13	27.15	29.42
Miscellaneous cost (₹)	3	3	3	3	3
Cost of production (₹/b)	65.73	66.44	68.13	70.15	72.42
Production cost (₹/kg live weight)	261.11	218.62	255.39	217.56	256.23

CONCLUSION

It may be concluded that the rearing of Kadaknath chickens under intensive system fed starter diet containing ME 3000 kcal/kg, CP 21%, Lysine 1.10% and Methionine 0.45% recorded best growth performance, better immune response and lowest cost of production at the end of 6th week.

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Competing Interests: The authors declare that there is no conflict of interests.

REFERENCES

Allan, W.H., Lancaster, J.E. and Toth, B. 1978. Newcastle disease vaccines. FAO, Rome, Italy.

Elangovan, A.V., Chandra, D., Mandal, A.B., Singh, D.P. and Shrivastava, H.P. 2004. Protein requirements of growing (12-20 weeks) Naked neck x CARI-Red (Hitcari) and Frizzle x CARI-Red (Upcari) pullets. *Indian J. Poult. Sci.,* **39**(1): 61-65.

G. I. J. (Geographical Indications Journal). 2018. Government of India, *Geogr. Indic. J.,* **104**: 9-10.

Golian, A., Aami-Azghadi, M., Kermanshahi, H. and Sedghi, M. 2010. Comparison of dietary supplementation with cumin essential oil and prebiotic Fermacto on humoral immune response, blood metabolites and performance of broiler chickens. *Glob. Vet.,* **4**(4): 380-387.

Haunshi, S., Panda, A.K., Rajkumar, U., Padhi, M.K., Niranjan, M. and Chatterjee, R.N. 2012. Effect of feeding different levels of energy and protein on performance of Aseel breed of chicken during juvenile phase. *Trop. Anim. Health Prod.,* **44**(7): 1653-1658.

Kingori, A.M., Tuitoek, J.K., Muiruri, H.K. and Wachira, A.M. 2003. Protein requirements of growing indigenous chickens during the 14-21 weeks growing period. *S. Afr. J. Anim. Sci.,* **33**(2): 78-82.

Magala, H., Kugonza, D.R., Kwizera, H. and Kyarisiima, C.C. 2012. Influence of varying dietary energy and protein on growth and carcass characteristics of Ugandan local chickens. *J. Anim. Prod. Adv.,* **2**(7): 316-324.

Mahore, J.S. 2013. Study of energy levels in the diet of commercial cockerels. Unpublished M.V.Sc. thesis submitted to Maharashtra animal and fishery sciences university, Nagpur.

Mbajiorgu, C.A., Ngambi, J.W. and Norris, D. 2012. Effect of varying dietary energy to protein ratio level on growth and productivity of indigenous Venda chickens. *Asian J. Anim. Vet. Adv.,* **6**(4): 344-352.

Miah, M.Y., Chowdhury, S.D., Bhuiyan, A.K.F. and Ali, M.S. 2014. Effect of different levels of dietary energy on growth performance of indigenous Desi chicks reared in confinement up to target weight of 950 g. *Livest. Res. Rural Dev.*, **26**(7): 124.

Nguyen, T.V., Bunchasak, C. and Chantsavang, S. 2010. Effects of dietary protein and energy on growth performance and carcass characteristics of Betong chickens (*Gallus domesticus*) during growing period. *Int. J. Poult. Sci.,* **9**(5): 468-472.

Perween, S., Kumar, K., Chandramoni, Kumar, S., Singh, P.K., Kumar, M. and Dey, A. 2016. Effect of feeding different dietary levels of energy and protein on growth performance and immune status of Vanaraja chicken in the tropic. *Vet. World*, **9**(8): 893–899.

Perween, S., Kumar, K., Chandramoni, Kumar, S., Singh, P.K., Kumar, A., Paswan, J.K. and Kumar, M. 2015. Effect of feeding different dietary level of energy and protein on immune response of Vanaraja chicken. Proceedings of IX Biennial Conference of Animal Nutrition Association 22-24, January, 2015, Guwahati, India. NAH-02.

Rahangdale, P.B., Sahu, B. and Dange, A. 2017. Growth performance of Kadaknath poultry breed in intensive and backyard rearing. *Contemp. Res. Ind.,* **7**(3): 354-359.

Rao, S.V.R., Ravindran, V., Raju, M.V.L., Srilatha, T. and Panda, A.K. 2014. Effect of different concentrations of metabolisable energy and protein on performance of White Leghorn layers in a tropical climate. *Br. Poult. Sci.,* **55**(4): 532-539.

Singh, R. 2013. Indian Council of Agricultural Research, Nutrient Requirement of Animals-Poultry (ICAR-NIANP). 3rd Ed., New Delhi, pp. 22-23.

Singh, V., Pathak, V. and Kumar, A. 2017. Protein profile of meat produced by Aseel, Kadaknath and Vanraja indigenous chickens. *Int. J. Livest. Res.,* **7**(2): 64-70.

Snedecor, G.W. and Cochran, W.G. 1994. Statistical methods. 8th Ed., *J. Educ. Behav. Stat.,* **19**(3): 304-307.

Tandekar, S. 2012. Study of protein requirement on commercial cockerels. Unpublished M.V.Sc. thesis submitted to Maharashtra animal and fishery sciences university, Nagpur.