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EFFECT OF REPLACING PEANUT MEAL BY NEEM (*Azadirachta Indica*) SEED KERNEL CAKE ON NUTRIENT INTAKE, DIGESTIBILITY AND RETENTION, AND ON BODY WEIGHT OF BROILER RABBITS

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ABSTRACT : Performance of broiler rabbits was assessed on equi-nitrogenous and equi-caloric composite diets (25 roughage : 75 concentrate) incorporated with graded levels (0, 5, 10 and 20%) of neem seed kernel cake (NSKC) in order to replace peanut meal (PNM) moiety of reference diet. Twenty-four Soviet Chinchilla and 24 White Giant rabbits were assigned to treatments in a randomized block design between 6 and 12 weeks of age. Dietary variation did not significantly influence the digestibility (8 rabbits /diet) of most of the nutrients except ADF (from 20.6% in the control down to 17.7% with 20% of NSKC). Though rabbits fed NSKC beyond 10% retained lesser ($P<0.01$) nitrogen, all the animals on various NSKC diets retained less DE and DCP, but ME content was significantly lower ($P<0.01$) in the NSKC containing diets (2.17 à 2.17 Mcal/kg DM) as compared to control (2.57 Mcal) The intake of DM, protein (CP and DCP) and digestible energy per unit metabolic body size ($kgLW^{0.75}$), though lower than the stipulated requirements, was similar on all the diets. The rabbits utilized the nutrients with similar efficiency irrespective of dietary treatment. Thus, NSKC can be incorporated up to 10% in rabbit diets without any adverse effect on palatability and performance to spare costs in the developing countries.

RESUME : Effet du remplacement du tourteau d'arachide par du tourteau de graines de "neem" (*Azadirachta indica*) sur la consommation, la digestibilité, la rétention et le poids vif de lapins de chair.
Dans des aliments composites (1/4 fourrage et 3/4 concentré), iso-azotés et ayant une même teneur en énergie brute ont été incorporées des quantités croissantes (0, 5, 10 et 20 %) de tourteau de graine de "neem" [un grand arbre à feuilles persistantes de l'Asie du Sud] (NSKC) pour remplacer progressivement le tourteau d'arachide de l'aliment témoin. Ces aliments ont été distribués à 48 lapins (24 Soviet Chinchilla et 24 Géant Blanc, répartis selon un schéma aléatoire) de 6 à 12 semaines d'âge pour étudier les effets de cette incorporation sur leurs performances. Les différents régimes n'influencent pas significativement la digestibilité (8 lapins par aliment) des différents nutriments excepté pour l'ADF (réduction de 20,6% à 17,7% lorsque le taux de NSKC passe de 0 à 20%). Les lapins ayant reçu le régime contenant 20 % d'NSKC ont eu une rétention azotée plus faible ($P<0.01$) ; par contre tous les animaux soumis aux différents régimes NSKC ont eu des rétentions de l'énergie digestible et de protéines inférieures à celle observée chez le témoin. Enfin, la teneur des aliments en énergie métabolisable était significativement inférieure ($P<0.01$) dans les régimes contenant NSKC (2,17 à 2,17 Mcal/kg MS) comparés au régime témoin (2,57 MCal). Les ingestions de matière sèche, de protéines (brutes et digestible) et d'énergie digestible par unité de poids métabolique ($PVif^{0.75}$). , bien qu'inférieurs aux besoins reconnus, ont été identiques pour tous les régimes. Les lapins ont utilisé les nutriments avec une efficacité similaire quel que soit l'aliment expérimental. Par voie de conséquence, le tourteau de graine de "neem" peut être incorporé jusqu'à 10 % dans l'alimentation sans effets contraires sur l'appétence et les performances, ce qui permet une économie pour les producteurs des pays en voie de développement.

INTRODUCTION

Rabbit rearing gained momentum in the recent past among the developing countries owing to biological features such as prolificacy, shorter life cycle, faster growth and efficient feed utilization (even on diets with reasonable proportion of roughages) which makes rabbits an economical meat producer (FAO, 1987). Rabbit meat is relatively rich in protein and low in fat comprising 60% unsaturated fatty acids (CHEEKE, 1980). Rabbit can thus play crucial role in mitigating the chronic shortage of meat in developing countries (OWEN, 1981). But severe shortage of feeds and fodder for livestock feeding in developing countries diverted the attention of animal nutritionists to search for unconventional agro-industrial by-products during the last two decades.

Neem (*Azdirachta indica*) seed kernel cake (NSKC), a by-product of neem oil industry, has a great potential in livestock feeding and is available to the tune of 0,9 million tones in India (SINGH, 1993). It is normally utilized as a pesticide for cash crop (MITRA, 1963), but the cake as such is bitter in taste and possesses characteristic odour due to the presence of limonoids which are tri- or tetra terpenoids (DEVAKUMAR and SUKHDEV, 1993). The NSKC, however, would be a good substitute of scarce and costly conventional vegetable protein cakes as most of the bitter principles concentrated in the outer coat are removed during decortication (MITRA, 1963). Depending upon method of oil extraction, the cake contains 33,5% CP, 10,4% EE, 11,4% CF, 29.7% NFE and 15% ash on DM basis (NATH *et al.*, 1983). Relatively to protein quality, negligible quantities histidine, lysine and tyrosine are present. The gross protein value of NSKC ranges from 55-59% as compared to 64% of peanut meal (TEWARI, 1992). Therefore, studies were carried out at Indian Veterinary Research Institute to investigate the feasibility of feeding NSKC by replacing peanut meal (PNM) at graded levels in the diets to assess the performance of broiler rabbits in terns of food intake, digestibility, nutrient utilization and live weight.

MATERIALS AND METHODS

Animals and Management

Forty eight, 6-week old Soviet Chinchilla (SC, 24) and White Giant (WG, 24) rabbits were randomly allotted equally to four dietary treatments in a randomized block design (RBD). All the rabbits were reared under hygenic and uniform managerial conditions by housing them individually in clean metallic cages, fitted with feeders and waterers, located in well ventilated cement floored shed. Clean

Table 1 : Ingredient and chemical composition of diets.

Ingredient/constituent	Diet*			
	D1	D2	D3	D4
Ingredients, % air dry feed				
Maize hay (ground)	25	25	25	25
Yellow maize	35	35	35	35
Deoiled peanut meal	18	13.5	9	0
Neem seed kernel cake	0	5	10	20
Meat meal	8	8.5	8.5	9.5
Wheat bran	5.5	4	3	0
Molasses	5	5	5	5
Tallow	1.0	1.5	2.0	3.0
Mineral mixture	2.0	2.0	2.0	2.0
Sea salt	0.5	0.5	0.5	0.5
Chemical composition, % dry matter				
Organic matter	89.3	89.2	88.8	87.5
Crude protein	16.5	16.2	16.5	16.4
Ether extract	5.3	5.7	6.7	8.7
Crude fibre	10.7	10.3	10.7	12.0
Nitrogen Free Extract	56.8	57.1	54.9	50.5
Ash	10.7	10.8	11.2	12.5
Neutral detergent fibre	43.7	43.6	44.1	43.2
Acid detergent fibre	16.6	15.6	16.1	17.1
Gross energy (kcal/g DM)	4.5	4.4	4.3	4.5

*Added 30g Vitablend (M/s Glaxo, Bombay) containing 50,000 IU and 5000 IU of Vitamin A and D per g respectively, 50 g Tetracycline HCl (50 µg/g) (M/s Hoechst India Ltd., Bombay) and 50g Duocoxin (Sulpha-Quinoxaline, 16.67%; Amprolium HCl 16.67%) as Coccidiostat (M/s Dynamic Pharmaceutical Pvt. Ltd., Bombay).

drinking water was provided *ad libitum*. Rabbits were dewormed with Mebex (Mebendazole-IP-40 µg/g; M/S CIPLA Ltd., Bangalore, India) at fortnightly intervals.

Feeds and feeding

Rabbits were fed iso-nitrogenous and iso-caloric (evaluated by gross energy content) composite [25 parts ground maize (*Zea mays*) hay, 75 parts concentrate] diets (Table 1) in mash form containing graded levels (0, D_1; 5, D_2; 10, D_3; 20, D_4 % in the diet) of NSKC (g/kg DM : organic matter, 843 ; crude protein, 337 ; ether extract 86 ; crude fibre, 136 ; nitrogen free extract, 284 ; Ash, 157) by replacing 0, 25, 50 and 100 % of PNM (g/kg DM :organic matter, 911 ; crude protein, 450 ; ether extract, 46 ; crude fibre, 131 ; nitrogen free extract, 285 ; Ash, 88) nitrogen.

Weighed quantities of feed were offered daily so as to allow *ad libitum* intake. Leftovers of feed residues were weighed 24 hours post feeding to ascertain daily food consumption.

Body weight changes

The rabbits were weighed individually at weekly intervals before feeding and watering to determine live weight changes and growth rate throughout the experimental period of 6 weeks (between 6 and 12 weeks of age). Efficiency of feed and nutrient utilization was calculated as unit intake per unit gain. Feed cost per kg gain was derived by multiplying feed intake per unit gain with cost (Rs.) of kg feed.

Digestion metabolic trial

A digestion metabolic trial consisting of 4 days total collection of faeces, urine, feed and residues was preceded by 3 days preliminary period for adaptation. Metabolic cages with 8 representative rabbits (SC, 4 and WG, 4 of similar body weight nearer to group average) from each diet was conducted during the last week of the experiment. The total faeces voided by each rabbit during 24 hours was weighed and crushed to homogenous mixture for further aliquoting. An aliquot of the faeces voided was dried in hot air oven for DM estimation. Another aliquot of $1/5^{th}$ of faeces voided was dried at 60 ± 2°C for gross-energy (GE) estimation. For nitrogen estimation, $1/10^{th}$ of faeces voided was preserved individually in airtight pre-weighed containers after adding a suitable quantity of diluted sulphuric acid. At the end of the collection period, pooled aliquot of wet faeces was weighed and mixed well for re-aliquoting at $1/10^{th}$ of total pooled weight of wet faeces to estimate the nitrogen content. At the end of the trial, individually dried and pooled samples were ground and preserved for proximate analysis. Similarly, after measuring the total quantity of urine excreted daily by each rabbit, an aliquot of $1/10^{th}$ of total urine output was transferred individually in duplicate to Kjeldhal flasks containing requisite quantity of sulphuric acid for nitrogen estimation. Another aliquot of $1/10^{th}$ of urine output was stored at -20°C for estimation of GE.

Chemical analysis

The pooled and ground representative samples of feed offered, residues and faeces of each rabbit were subjected to the analysis of proximate principles (AOAC, 1980) and fibre fraction (GOERING and VAN SOEST, 1970). Gross energy content of feed, residues, faeces and urine was estimated by complete ignition of weighed amounts of pooled samples dried at 60°C under 25 atmospheres of oxygen using a Gallenkamp ballistic bomb calorimeter. For estimating energy content of urine, a fixed quantity of urine was dried after acidifying with few drops of sulphuric acid on a pre-weighed polythene paper. The GE content of urine was determined after substracting the GE contributed by the polythene paper. The metabolisable energy (ME) was obtained by deducting the energy loss through faeces and urine from GE intake. The nutrient retention (nitrogen and energy) was arrived at after subtracting the faecal and urinary losses from the intake ignoring all other losses if any.

Statistical analysis

The data were subjected to analysis of variance and treatment means were ranked using Duncan's multiple range test as per the methods of SNEDECOR and COCHRAN (1967) by programming and processing data in a Micro-32 Computer.

RESULTS AND DISCUSSION

Nutrient digestibility and retentions

Dietary incorporation of graded levels of NSKC had no significant effect on the digestibility of various nutrients except that of ADF (Table 2). The rabbits on D4 though digested significantly ($P<0.05$) less ADF. No significant diet and breed interaction was evident. Like any other species, the nutrient digestibility in rabbits is influenced by dietary ingredient composition, forage quality, level of intake

(MILLER *et al.*, 1954), energy, protein and fibre density, rate of passage and caecal retention (AGUILERA *et al.*, 1970) in addition to the age of the animals and climatic conditions. Dietary inclusion of NSKC at graded levels did not significantly influence the digestibility of dry matter which ranged from 56.69 to 58.90 % (Table 2). The observed DMD on different diets was nearer and within the reported range of 56 to 72 % (FEKETE *et al.*, 1990; GROBNER *et al.*, 1985). Similarly, the rabbits on all the diets digested crude protein without any significant difference. Protein digestibility is closely related to the source of protein (DE BLAS *et al, 19*84) and the type of raw material incorporated in the diet than to the chemical composition (FRAGA *et al*, 1984). Caecal fermentation with subsequent caecotrophy plays an important role in protein utilization of rabbits (SANTOMA *et al*, 1989). The comparable protein digestibility among rabbits on all the diets, thus clearly indicates that dietary inclusion of NSKC even up to 20% did not affect the CP digestibility as compared to PNM inclusion in broiler rabbits. Similar comparable protein utilization was also noticed by incorporating alkali treated neem seed kernel meal (ATNSKM) (BHOSALE, 1994), water washed neem seed kernel meal (KHAN 1994) full fat neem seed meal (SALAWU *et al*, 1994) and raw neem seed meal (FUZINIMI *et al*, 1990) in the diets of rabbits. In general, rabbits are not efficient utilizers of fibre in comparison to other herbivores because of rapid passage rate of digesta and lack of protozoal population in the gut unlike ruminants and horses. This may be the reason for comparatively lower values of crude fibre (27.4-28,0 %) or ADF (17.6-20.6 %) digestibility as compared to other nutrients in rabbits. However, the nutritive value of structural fractions of plant cell (ADF) is limited as they contribute less than 5 % of the total DE in rabbits on conventional diets (DE BLAS *et al*, 1986). The rabbits on all the diets digested the rest of the nutrients similarly for DM and protein.

After considering losses through faeces and urine from intake, the daily retention of nitrogen as well as energy was, however, depressed with increase in level of NSKC beyond 10 % (Table 2). Nitrogen retention in rabbits were found to be better on diets containing 23,42 % kcal DE/g of DCP (DE BLAS *et al*, 1981 ; SWAROOPARANI, 1993), The energy-protein ratio in the diet having 5 % NSKC was 23.22 (Table 3) which was nearer to the ratio suggested by the above workers, This might be the reason for better nitrogen and energy retentions by rabbits on this diet than on other NSKC containing diets (Table 2) as energy-protein ratio in those diets were either wider or narrower than the suggested ratio.

Table 2 : Nutrient digestibility and retention in broiler rabbits.

Attribute	Diet				SEM
	D1	D2	D3	D4	
Digestibility (%)					
Dry matter	57.81	57.35	58.90	56.69	2.34
Crude protein	67.82	69.35	70.29	66.68	2.15
Ether extract	83.20	83.76	83.14	81.17	0.91
Crude fibre	27.57	27.59	28.00	27.46	0.47
NFE	68.67	67.93	70.43	63.79	1.97
NDF	42.82	40.07	45.18	41.32	3.18
ADF*	20.59^{a}	19.52^{a}	19.92^{a}	17.68^{b}	0.64
Energy	60.18	59.39	59.10	59.25	2.82
Nutrient retention					
Nitrogen** (% Dig. N)	63.08^{b}	68.69^{a}	60.25b	53.07^{c}	1.58
Energy** (% DE)	89.73^{a}	85.89^{bc}	85.63^{bc}	80.73^{c}	1.17

Means with different superscripts in a row differ significantly, *P<0,05, **P<0,01.

Table 3 : Nutritive value and plane of nutrition

Attribute	Diet				SEM
	D1	D2	D3	D4	
Nutritive value (% in DM or Mcal/kg DM)					
Digestible crude protein	11.20	11.17	11.55	10.85	0.36
Total digestible nutrients	63.31	63.50	64.05	62.23	1.65
Digestible energy	2.69	2.60	2.53	2.63	0.10
Metabolizable energy* *	2.57^{a}	2.20^{b}	2.21^{b}	2.17^{b}	0.05
Energy (DE) : Protein (DCP) ratio*	24.04^{a}	23.22^{ab}	21.86^{b}	24.28^{a}	0.57
Nutrient intake (g or Kcal/kgw$^{0.75}$.)					
Dry-matter	42.29	49.74	50.39	49.91	3.42
Crude protein	6.98	8.03	8.30	8.06	0.56
Digestible crude protein	4.70	5.55	5.88	5.32	0.38
Total digestible nutrients	26.80	31.57	32.68	30.95	2.19
Digestible energy	113.38	129.65	128.82	130.05	3.46

Means with different superscripts in a row differ significantly. *P<0.05 ; **P<0.01

Table 4 : Growth rate and efficiency of nutrient utilization.

Attribute	Diets				SEM
	Dl	D2	D3	D4	
Initial body weight (g)	937.27	906.36	904.54	901.00	67.66
Final body weight(g)	1357.27	1380.00	1386.36	1226.36	87.80
Average daily gain (g)	10.00	11.27	11.47	8.07	8.19
Nutrient efficiency intake (g or Kcal/g gain)					
Dry matter	6.11	5.72	5.64	7.21	0.69
Digestible crude protein	0.68	0.64	0.65	0.78	0.24
Digestible energy	16.42	14.94	14.30	19.04	4.36
Feed cost/kg gain (Rs)	28.67	26.08	24.87	29.56	2.42

*Based on prevailing market price (Rs)/kg of various ingredients (Maize hay, 0.84; yellow maize, 4.37; deoiled GNC, 5.30; NSKC, 1.50; Meat meal, 4.00;
Wheat bran, 3.34; molasses, 0.40; tallow, 8.00, 1ineral 1ixture, 4.99; Sea salt, 1.20 and feed additive (Duocoxin, Tetracycline HCl and Vitablend @ Rs. 131.00 per 100 kg diet).

Nutritive value and plane of nutrition

The DCP, TDN and DE contents of composite diets offered to rabbits were comparable and ranged from 10.85 to 11.55 %, 62.23 to 64.05 % and 2.53 to 2.69 Mcal/kg DM, respectively (Table 3). The ME content was significantly ($P<0.01$) lower in the NSKC containing diets (2.17-2.21 Mcal/kg DM) as compared to that in PNM incorporated (control) diet. However, the plane of nutrition in terms of daily intake of DM, protein (CP and DCP) and energy (TDN and DE) per unit metabolic body size among rabbits between 6-12 weeks of age did not vary due to replacement of PNM by NSKC at graded levels (Table 3). Similarly, SALAWU *et al* (1994) could not notice any significant difference in feed intake between rabbits on diets containing cottonseed meal (18.3 %) and full fat neem seed meal when incorporated up to 20 %. Likewise, BHOSALE (1994) reported a comparable intake of feed among SC fryer rabbits fed PNM (11 %), ATNSKM (15 %) or water soaked NSKM (15%) between 6 and 12 weeks of age. Thus, incorporation of NSKC had no adverse effect on palatability and voluntary feed intake in rabbits.

Body weights, nutrient efficiency and economics

The weekly body weight changes, total weight gain and average daily gain (ADG) of broiler rabbits between 6 and 12 weeks of age on different diets did not vary significantly (Table 4). The ADG was 10.00, 11.27, 11.47 and 8.07 g on diets D_1, D_2, D_3 and D_4 respectively. The observed daily gains were, however, lower than the range (16.49-20.44 g/d) reported by BHOSALE (1994) in SC and WG rabbits between 6-12 weeks of age fed water soaked NSKM or ATNSKM but comparable with the ADG (8.48-12.04 g/d) as reported by KHAN (1994). Similarly, the dietary inclusion of neem seed kernel cake at graded levels did not significantly influence the efficiency of utilization of DM as well as various nutrients (CP, DCP, TDN and DE) between 6 and 12 weeks of age which varied from 5.72 to 7.21 for DM, 0.93 to 1,17 for CP, 14.30 to 19.04 for DE (Table 4). In addition to the availability of nutrients above maintenance for productive functions, other factors such as nutrient density, intake, digestibility and utilization decides the efficiency of nutrient utilization in the body. Although not significant, the rabbits fed diets containing 5 and 10 % NSKC (D_2 and D_3) were 6.4 and 7.7 % more efficient in utilizing DM and grew faster by 12.7 and 14.7 %, respectively as compared to the rabbits on PNM containing control diet. The rabbits on 20 % NSKC were less efficient by 18% than control. PARILLO and VASENINA (1981) and BHOSALE (1994) also reported similar findings.

The poor growth rate and feed efficiency in general might be due to the poor genetic potentiality of the rabbits along with tropical environmental conditions of the present study. LUKEFAHR and CHEEKE (1991) observed 10-20 g ADG in tropics as against 35-40 g under temperate climates. Moreover, lowered performance could be expected while using mash from of diet instead of pelletted form with similar composition (CHEEKE, 1987).

The feed cost per Kg gain varied from Rs. 24.87 to Rs. 29.56 ($ 1.0 = Rs. 42) on different diets. The feed cost per kg gain though did not differ significantly due to dietary variations, but numerically it was lower by 9.03 and 7.75 % on diets containing 5 and 10 % NSKC respectively as compared to that on PNM containing diet. Overall, intake, digestibility, growth rate and efficiency of nutrient utilization of rabbits on diets containing graded levels of NSKC were comparable up to 10 % dietary incorporation. Performance of rabbits on PNM diet and feed cost per kg gain was lower in the former than on the later diets. It can be concluded that NSKC can be a wholesome vegetable protein substitute in fryer rabbit diets up to 10 % to mitigate chronic shortage of scarce and costly conventional vegetable oil cakes in the developing countries.

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