Effect of Feed Protein Source on Digestion and Wool Production in Angora Rabbit

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ABSTRACT : Adult German cross (German × British × Russian) angora rabbits (one year age), 32 in number were divided randomly into four groups (T_1-T_4) with equal sex ratio and fed diets containing T_1 groundnut cake (GNC); T_3, soyaflakes (SF); T_4, sunflower cake (SFC) and T_2, a mixture of all the three cakes along with green forage as roughage for a period of 9 months. Nine per cent protein was added from each protein source. Fibre level was maintained by adjusting the level of rice phak in the diets. The diets were iso-nitrogenous and contained similar level of fibre. DMI through roughage was not affected due to source of protein in the diet, however, DMI through concentrate was higher ($p \leq 0.05$) with SFC diet, which resulted in higher total feed intake in the group (T_4). Body weights increased up to second shearing, thereafter it decreased due to summer depression. Diet containing soyaflakes sustained higher wool yield whereas, it was lowest ($p \leq 0.05$) on SFC diet. Wool attributes (staple length, medullation, fibre diameter) were not affected due to source of protein in the diet. Digestibility of fibre and its fractions (ADF, cellulose, hemicellulose) decreased ($p \leq 0.05$) with incorporation of SFC in the diets. Balance of calcium was lowest whereas, that of nitrogen was highest with SFC diet (T_4). Biological value of N and net protein utilization was better when different protein sources were mixed together (T_2). protein quality of soyaflakes proved better for wool production followed by groundnut cake and mixture of three protein sources. Sunflower cake alone or in combination decreased wool production which may be checked by supplementation of amino acids and energy. (*Asian-Aus. J. Anim. Sci. 1999. Vol. 12, No. 7 : 1075-1079*)

Key Words : Protein Source, Digestibility, Wool Growth

INTRODUCTION

Wool production in angora rabbits is about four times that of sheep on unit weight basis (Schlolaut, 1985). Since wool fibre contains 93 percent protein the dietary protein is important as it is required both for tissue synthesis and wool production. Rations containing 20% crude protein (CP) with 80 % digestibility were found to be adequate for wool production (Lall et al., 1984), whereas, diets containing 17.45% CP with 11.5% digestible CP were found to be suboptimal (Negi and Goel, 1985). Later reports indicate a level of 18% CP is required in the diet for wool production (Prasad and Malhi, 1997). Peanut, mustard, linseed and cottonseed meals can be incorporated at 60% of feed protein for wool production (Singh and Negi, 1987). A diet containing Soyaflakes gave better performance than groundnut cake and sunflower cake, however the biological value of nitrogen was better with combination of three protein sources (Bhatt et al., 1999a). Feed proteins vary widely in their ability to supply amino acids, and have been subject of extensive investigation for wool and meat production (Cheeke, 1987). Few reports, however, exist on comparative utilization of feed nitrogen from cheaper feed protein sources. In this experiment, diets having equal protein content from different protein sources were assessed for their wool production potential.

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MATERIALS AND METHODS

German × British × Russian strain adult angora rabbits, 32 in number and one year old were divided randomly into 4 groups (T_1 - T_4) of 8 with an equal sex ratio. Diets were formulated (table 1) by using either groundnut cake (GNC), soyaflakes (SF), sunflower cake (SFC) alone or in combination as a source of feed protein. About 9% CP was supplied through each cake in their respective test diet, in combination (T_2) the same amount of protein was supplied through a mixture of three sources. The level of fibre in the diets was adjusted by using rice phak. Rice phak is a combination of rice polish, rice bran and rice husk (Bhatt et al., 1999b). The animals were offered the test diets in the morning and green forage (combination of white clover, tall fescue and rye grass) in the afternoon.

Intake of dry matter through feed and grass were recorded once per fortnight. Rabbits were shorn for wool at intervals of three months. Wool yield and body weight of rabbits was recorded. Samples for analysis of wool attributes (staple length, fibre diameter, guard hair) were collected from the dorsal side of each rabbit and were analysed using Ermascope (Erma India, Chandigarh). The experiment continued for 9 months and the data from three

Table 1. Physical composition of experimental diets

Feed ingredient	T_1	T_2	T_3	T_4
Maize	21	21	22	21
Barley	20	20	22	20
Rice phak	26	26	29	18
Groundnut cake (CP 41%)	22	9	-	-
Sunflower cake (CP 30%)	-	4	-	30
Soyaflakes (CP 56%)	-	9	16	-
Fish meal	4	4	4	4
Molasses	5	5	5	5
Mineral mixture	1	1	1	1
Salt	1	1	1	1
Total	100	100	100	100
Cost of diet (Rs. per kg)	6.09	5.78	5.98	5.39

consecutive shearing was recorded. At the end of feeding trial a metabolic trial was conducted to assess the digestibility of nutrients. Feed, green forage, faeces and urine samples were analysed for proximate principles and calcium (AOAC, 1990), phosphorus (Gupta et al., 1992) and fibre fractions (Goering and Van Soest, 1984). Biological value and net protein utilization of the different test diets was calculated by method of Mc Donald et al. (1995) as:

Biological Value (BV) =

$$\frac{\left[\text{Nitrogen Intake} - (\text{Faecal Nitrogen} - \text{Metabolic Faecal Nitrogen}) - (\text{Urinary Nitrogen} - \text{Endogenous Urinary Nitrogen})\right]}{\left[\text{Nitrogen Intake} - (\text{Faecal Nitrogen} - \text{Metabolic Faecal Nitrogen})\right]}$$

Net Protein Utilization (NPU) =

$$\text{Biological Value (BV)} \times \text{Digestibility (\%)}$$

The amino acids and starch values of different feed ingredients were calculated from reference values given in the literature (Church, 1986). The cost of the diets was calculated on the basis of prevailing market rates of feed ingredients. The data was analysed by randomized block design using one way classification (Snedecor and Cochran, 1967).

RESULTS AND DISCUSSION

The crude protein and crude fibre level in all the test diets was almost similar (table 2). Content of acid detergent fibre (ADF), neutral detergent fibre (NDF), and lignin was high in sunflower containing diet (T_4). This was due to higher content of fibre components in sunflower cake (Bhatt and Sawal, 1999). The nutrients in the test diets were within the permissible limits (NRC, 1977). The amount of calculated amino acid

Table 2. Chemical composition of experimental diets and green forage (% on dry matter basis)

Nutrient	T_1	T_2	T_3	T_4	Green forage
DM	89.5	89.6	88.8	89.83	27.96
CP	15.83	15.73	15.54	14.78	17.06
CF	15.11	13.64	13.68	14.68	25.06
EE	1.96	1.6	1.45	1.46	2.59
NFE	58.42	60.42	61.2	60.75	44.57
Total ash	8.95	8.61	8.27	8.33	10.72
Acid insoluble ash	3.83	3.74	3.96	2.91	3.2
Calcium	1.24	1.2	0.9	0.82	2.82
Phosphorus	0.62	0.45	0.51	0.4	1.34
Acid detergent fibre	24.69	25.01	24.36	29.16	37.87
Neutral detergent fibre	50.88	53.84	47.21	56.57	52.62
Hemicellulose	28.19	28.86	19.85	27.41	15.73
Cellulose	15.8	15.94	18.29	16.64	30.73
Lignin	8.97	9.07	8.71	12.52	15.2
Calculated analysis:					
Lysine	0.89	0.95	1.1	1	-
Methionine+cysteine	0.42+0.15	0.59+0.22	0.47+0.25	0.64+0.35	-
Arginine	1.9	1.5	1.4	1.9	-
Starch	32.39	31.84	36.35	31.09	-
Other soluble sugars	8.52	8.21	8.1	7.16	-
Total soluble sugars	40.91	40.05	44.45	38.25	-

showed that lysine level was higher in T_3 and T_4, whereas methionine + cysteine level was higher in T_2 and T_4 diet. Arginine level was high in groundnut cake (T_1) and sunflower cake (T_4) consisting diet but was lower in the diet containing soyaflakes (T_2 and T_3). Starch level and total soluble carbohydrates level were high in T_3 diet consisting of soyaflakes and was low in sunflower cake consisting diet (T_4).

Body weight of rabbits in three consecutive shearing (table 3) indicates that weights increased in all the treatments up to 2nd shearing and decreased thereafter in 3rd shearing. This depression in body weight was attributed due to summer stress as the experiment was conducted from Nov. 97 - July 98. Stephen et al. (1979) also reported summer depression in broiler rabbit. Significant ($p \leq 0.05$) differences were recorded for total wool yield in different groups. Wool yield in T_1, T_2 and T_3 groups was statistically similar although T_3 group gave highest wool yield (302.5±6.8 gm) as compared to other groups. Wool yield in T_4 (SFC) group was significantly ($p \leq 0.05$) lower than other treatment groups. Wool production compares favourably with values reported earlier from this station for this strain of rabbit (Anonymous, 1998). High lysine, low arginine, high nitrogen free extract, high soluble carbohydrates and low lignin content of diet might be the factors responsible for better wool yield in the diet containing soyaflakes (T_3), whereas significantly ($p \leq 0.05$) lower wool yield with sunflower cake diet (T_4) might be due to lower content of soluble sugars coupled with higher cell wall and lignin contents of diet. The rate of wool growth is sensitive to changes in energy intake provided mainly by carbohydrates (Ryder and Stephenson, 1968). In our studies the wool yield was directly related to the total soluble sugar content of diet. This might be due to protein sparing effect of soluble carbohydrates for tissue protein synthesis and wool production. In addition to it soluble carbohydrates also synthesize ribose to form part of the nucleic acids molecules involved in protein synthesis.

Concentrate intake was significantly ($p \leq 0.05$) higher in SFC diet (T_4) which might be to regulate energy intake whereas, the lowest value of the same was observed in T_1 and T_3. Incorporation of different oilseed cakes as source of feed protein had no significant ($p \leq 0.05$) effect on intake of feed dry matter through roughage. This resulted in highest ($p \leq 0.05$) total DMI with sunflower cake diet (T_4). Higher

Table 3. Biological performance and wool attributes of rabbits fed different experimental diets

Parameters	T_1	T_2	T_3	T_4
Body weight (kg)				
Initial	2.47±0.08	2.42±0.03	2.46±0.10	2.45±0.09
1st shearing	2.53±0.09	2.47±0.06	2.58±0.1	2.51±0.1
2nd shearing	2.57±0.10	2.59±0.06	2.53±0.09	2.56±0.11
3rd shearing	2.53±0.10	2.52±0.09	2.52±0.09	2.47±0.06
Gain	0.06	0.1	0.06	0.02
Wool yield (g)				
1st shearing	97.1 ±6.1	92.1 ±5.6	105.0 ±4.4	92.1 ±7.6
2nd shearing	104.3 ±7.9	105.0 ±4.1	105.0 ±7.4	80.0 ±2.2
3rd shearing	89.2 ±9.9	89.2 ±10.3	92.5 ±8.5	66.4 ±7.1
Total	290.6 ±7.9^a	286.3 ±6.6^a	302.5 ±6.8^a	238.5 ±5.6^b
Dry matter intake (g/d)				
Concentrate	67.8 ±7.6^b	90.1 ±9.8^a	76.3 ±6.9^b	101.4 ±6.8^a
Roughage	62.7 ±5.1	51.9 ±8.8	57.2 ±8.7	62.0 ±7.5
Total	130.5 ±6.3^b	142.0 ±9.3^b	133.5 ±7.8^b	163.4 ±7.1^a
DMI/kg $W^{0.75}$	65.6	71.4	66.7	82.2
Plane of nutrition (g)				
DCPI/h/d	14.04	15.3	14.23	17.41
TDNI/h/d	75.53	78.08	74.84	91.85
DE kcal/h/d	338.8	345.1	330.8	405.9
Wool quality				
Staple length (cm)	5.02±0.16	5.04±0.12	5.03±0.2	5.07±0.22
Fibre diameter (μ)	13.42±0.37	13.45±0.33	13.29±0.38	13.42±0.32
Guard hair (%)	2.08±0.35	2.42±0.35	2.43±0.49	2.30±0.53

Figures (in row) with same superscripts are not significantly different while with different superscripts are significantly ($p \leq 0.05$) different from each other.

concentrate intake in SFC diet (T_4) was attributed to its low energy value coupled with higher amount of indigestible fibre including lignin in sunflower cake as compared to groundnut cake and soyaflakes (Cheeke, 1987; Balogun and Etukude, 1991). Dry matter intake($W^{0.75}$ kg BW) was also higher in the same diets (T_2 and T_4) indicating higher energy needs, expressing poor energy level of these diets. Higher cell wall and hemicellulose contents of T_2 and T_4 diets as compared to other diets lowered the energy value of these diets which led to higher feed intake. Feed intake increased with increasing level of dietary crude fibre to maintain a constant energy intake (Spreadbury and Davidson, 1978; Lang, 1981).

Plane of nutrition of rabbits in different groups (table 3) indicates higher digestible crude protein (DCP), total digestible nutrients (TDN) and digestible energy (DE) intake in T_4 group which was due to higher DMI of rabbits of this group. Digestibility and balance of nutrients among rabbits in different groups indicate (table 4) Significant ($p \leq 0.05$) differences for the digestibility of crude fibre, acid detergent fibre, cellulose and hemicellulose. Digestibility of crude fibre was lower in SFC diets (T_2 and T_4) and was due to high amount of lignin in these diets. Bhatt and Sawal (1999) also reported decrease in digestibility of fibre with increase in level of SFC in the diet. The digestibility of ADF and cellulose followed the same trend as was followed for crude fibre digestibility. Randall (1976) observed that differences in fibre digestibility appear to be related to lignin content of fibre but not to the fibre content of the diet. Slightly lower digestibility of dry matter, crude fibre and fibre fractions in SF diet (T_3) as compared to GNC diet (T_1) was due to higher level of rice phak in SF diet (T_3) as compared to GNC diet. The balance of calcium was highest in SF diet (T_3) and lowest in SFC diet (T_4).

Significant ($p \leq 0.05$) group differences were noted in nitrogen intake being 3.16, 2.71, 2.64 and 2.43 g/d for group T_4 ,T_1 ,T_3 and T_2 respectively and were due to differences in feed DMI through concentrate feed although the trend was not uniform in different groups. Non significant differences were observed in nitrogen outgo through faeces in different groups. However, nitrogen excretion through urine was significantly ($p \leq 0.05$) higher in SFC diet (T_4), indicating that the digestibility of feed nitrogen was similar among the diets but the quality of feed nitrogen was not same in all the test diets indicating imbalance in the amino acid profile of feed protein due to which more loss was observed after absorption. Nitrogen balance as per cent of intake was significantly ($p \leq 0.05$) higher in SFC diets (T_2 and T_4) whereas the biological value of nitrogen and net protein utilization was highest in T_2 diet consisting of a mixture of three oil seed meals as protein source. Blending of different protein sources together increased the biological value of nitrogen as it provides balanced amino acids (McDonald et al., 1995). Fibre and

Table 4. Digestibility (%) and balance of nutrients

Nutrients	T_1	T_2	T_3	T_4
DM	61.31 ± 2.77	57.06 ± 3.86	58.01 ± 2.99	58.78 ± 1.96
CP	66.07 ± 2.26	66.55 ± 1.04	66.23 ± 2.97	68.18 ± 2.82
CF	41.83 ± 3.77^a	31.09 ± 2.13^b	36.69 ± 2.55^a	32.88 ± 0.69^b
EE	60.32 ± 4.67	61.03 ± 6.50	62.30 ± 5.66	62.57 ± 4.65
NFE	69.44 ± 2.69	64.86 ± 2.45	66.36 ± 4.28	67.45 ± 4.22
NDF	55.97 ± 3.20	52.55 ± 5.66	49.02 ± 4.94	57.37 ± 5.06
ADF	44.29 ± 2.76^a	32.65 ± 10.8^b	42.71 ± 3.52^a	33.10 ± 1.58^b
Cellulose	70.50 ± 4.32^a	38.87 ± 2.26^c	50.57 ± 3.77^b	37.07 ± 0.75^c
Hemicellulose	74.32 ± 1.64^a	75.91 ± 2.17^a	60.50 ± 2.04^b	64.95 ± 3.79^b
DCP (%)	10.76	10.78	10.66	10.66
TDN (%)	57.88	54.99	56.06	56.21
Balance (%) of intake				
Nitrogen	33.23 ± 0.06^b	36.27 ± 0.38^a	32.96 ± 0.85^b	36.08 ± 0.1^a
Calcium	26.74 ± 5.22^b	26.53 ± 0.19^b	34.78 ± 8.57^a	13.45 ± 1.17^c
Nitrogen balance (g/d)				
Nitrogen intake	2.71 ± 0.15^b	2.43 ± 0.26^c	2.64 ± 0.20^b	3.16 ± 0.10^a
Outgo through faeces	0.92 ± 0.11	0.81 ± 0.09	0.87 ± 0.05	1.00 ± 0.09
Outgo thorugh urine	0.89 ± 0.14^b	0.74 ± 0.14^c	0.90 ± 0.13^b	1.02 ± 0.02^a
Balance (g/d)	0.90 ± 0.01^b	0.88 ± 0.02^b	0.87 ± 0.02^b	1.14 ± 0.03^a
Biological value of nitrogen	0.66	0.72	0.66	0.67
Net protein utilization	43.77	48.11	43.85	45.83

Figures bearing different superscripts (in rows) differ significantly ($p \leq 0.05$).

protein content in the diet and their interaction have a major influence on energy and protein utilization. Higher consumption has been associated with lower protein quality (Spreadbury, 1978). Inspite of higher nitrogen balance and almost similar DCP and TDN contents in SFC diet (T_4), wool yield was significantly ($p \leq 0.05$) lower as compared to other groups. It might be due to higher level of SFC in rabbit diet. Adverse effect of SFC in broiler rabbit growth were observed at 24% level (Bhatt and Sawal, 1999). Ryder and Stephenson (1968) demonstrated that wool growth is sensitive to changes in energy intake mainly through carbohydrates.

Results of the experiment reveal that the protein quality of soyaflakes is better for wool production followed by groundnut cake. Sunflower cake alone or in combination decreased wool production, which may be checked by supplementing energy and amino acids.

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