Replacement of Soyflakes with Cottonseed Meal in Diets of Angora Rabbits

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ABSTRACT : This experiment was conducted with 30 adult wool producing Angora rabbits of either sex, to evaluate the effect of replacing soyflakes (SF), on equal protein basis, with low gossypol containing cottonseed meal (CSM) either alone or in combination with lysine and methionine; on the biological performance, total wool yield, wool yield per shearing, wool characteristics and mortality. Three experimental mash diets were prepared by incorporating SF (6%) as standard / control protein source (T_1) and CSM (9%) as test protein source (T_2 and T_3). In T_3, amino acids-lysine and methionine (0.1% each) were added. Animals were given the experimental diets about 150 g · day^{-1}· head^{-1}, for a period of 225 d or three shearing, and *ad libitum* Kudzu-vines. No significant effect of T_2 or T_3, on the body weight gain, total wool yield, wool yield per shearing and wool characteristics, was observed compared to T_1. However, the digestibility of dry matter, crude fibers, ether extract, acid detergent fibers, neutral detergent fibers, cellulose and hemicellulose was significantly ($p<0.05$) depressed in CSM based diets. Mortality of about 20% was recorded in T_2 and T_3, but not related to the addition of CSM or gossypol toxicity. More studies are needed to standardize the safe level of CSM, duration of safe feeding of CSM, and level of amino acids supplementation in CSM based diets. ***(Asian-Aust. J. Anim. Sci. 2001. Vol 14, No. 8 : 1106-1109)***

Key Words : Cottonseed, Digestibility, Wool, Rabbit

INTRODUCTION

Soybean meal, a major plant protein supplement of high palatability and good amino acid balance is preferred world wide in rabbit feeding (Cheeke, 1987). Feeding diets containing soyflakes (SF) at 9% and 16% (protein equivalent basis) resulted in better performance in Angora rabbit (Bhatt et al., 1999a). Its high cost, non-availability, and competition for human and livestock production in developing countries, warrant its substitution. Cottonseed meal (CSM), another widely available plant by-product after extraction of oil, provides an excellent protein rich feed for livestock (McNitt, 1981). However, it contain lower amounts of amino acids like lysine, isoleucine, leucine, threonine and valine as compared to SF (Smith, 1970). In addition CSM contains a polyphenolic toxic compound i.e. gossypol, in both free and bound forms, is a major constraint in CSM utilization besides its poor palatability in rabbits (Voris et al., 1940). The bound form of gossypol, in general, is biologically inactive (Carruth, 1947) while the free form is responsible for toxicity when fed to animals (Conkerton and Frampton, 1959). Mortality rates of as high as 43.3% have been reported in weanling broiler rabbits, with typical symptoms like hemorrhages, enlarged gall bladder, edema and impaction of large intestine; when fed CSM at 20 to 40% level in experimental diets (Holley et al., 1955). So far, feeding of CSM based diets had been studied with broiler rabbits. The experiment was conducted to study the utilization of CSM in Angora rabbit diets on biological performance and wool production.

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MATERIALS AND METHODS

The present experiment was conducted with thirty adult Angora rabbits of either sex, randomly divided into three groups of ten animals each. All of the animals were sheared manually with scissors before the start of the experiment and reared individually in wire cages, under similar housing and management conditions. Three mash diets - T_1, T_2 and T_3 (table 1) were prepared by incorporating sunflower cake, mustard cake, groundnut cake, CSM and SF as protein sources; maize and barley as energy sources and rice-phak - a combination of rice husk, rice bran and rice polish, as feed ingredients (Bhatt et al., 1999b). Commercially available CSM, prepared by expeller solvent method, used and it contained low level of free gossypol (0.04%). Fishmeal, molasses, mineral mixture and salt were also added to each diet. The T_1 diet, containing SF as a standard source of protein, was fed to 1st group of animals and treated as control diet / group; whereas T_2 and T_3 diets containing CSM were fed to the 2nd and 3rd group, respectively. In T_3 diet, 200 g each of lysomix and methiomix (CDH, Pvt. Ltd. Bombay) were incorporated as sources of lysine and methionine (50% potency) per 100 kg of feed. The experiment was conducted for a period of 225 d and the experimental diets were given about 150 g · day^{-1} · head^{-1}, with a standard scoop. During evening (18:00 h) each animal was provided the fresh Kudzu-vine (*Puereria thunbergiana*) *ad libitum*. Initial body weight, body weight at different shearing, wool yield and its characteristics, plane of nutrition and mortality were recorded. Each animal

Table 1. Physical composition of experimental diets (kg/ 100 kg)

Feed ingredients	T_1	T_2	T_3
Sunflower cake	6	6	6
Mustard cake	6	6	6
Groundnut cake	6	6	6
Soyflakes (CP-54%)	6	-	-
Cottonseed meal (CP-36%)	-	9	9
Maize	20	20	20
Barley	20	20	20
Rice-phak	25	22	22
Fishmeal	4	4	4
Molasses	5	5	5
Mineral mixture	1	1	1
Salt	1	1	1
Lysomix	-	-	0.2
Methiomix	-	-	0.2

Table 2. Chemical composition of experimental diets (% on DM basis)

Nutrients	T_1	T_2	T_3	Kudzu-vine
CP	15.26	16.42	16.73	14.22
CF	14.25	13.86	13.77	22.55
EE	0.72	0.70	0.67	2.29
NFE	58.92	59.12	58.33	48.45
Total ash	10.85	9.90	10.5	12.49
NDF	48.20	50.28	50.40	55.79
ADF	29.10	28.40	26.80	38.32
Hemicellulose	19.10	21.88	23.60	17.47
Cellulose	12.40	13.45	13.35	29.13
Calcium	0.98	0.89	0.84	2.64
Phosphorus	0.40	0.54	0.56	0.41
Lysine (Calculated)	0.71	0.69	0.79	-
Sulfur containing amino acids (calculated)	0.56	0.59	0.69	-

was sheared manually with scissors by the same person, at 75 d interval for three consecutive shearing and pooled wool samples collected from the dorsal region of each rabbit were analysed using Ermascope (Erma India, Chandigarh) for their staple length, fiber diameter and guard hairs. After 2nd shearing, the metabolic trial was conducted with 4 animals from each group, to measure the digestibility of nutrients. The total intake of concentrate and roughage during the metabolic trial was recorded. Feces voided and urine excreted were collected and representative samples were taken for proximate analysis and calcium (AOAC, 1990), cell wall fractions (Goering and Van Soest, 1984), and phosphorus (Gupta et al., 1992). Statistically, the data were analyzed by analysis of variance (ANOVA) as the method of Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

The experimental diets (T_1, T_2 and T_3) were formulated on CP basis, and equal amount of protein (3.2%) was added in each diet by incorporating 6% of SF (CP-54%) in T_1 and 9% of CSM (CP-36%) in T_2 and T_3 diets (table 1). The chemical composition of the diets (table 2) revealed slightly higher CP (16.42 and 16.73%) and lower CF (13.86 and 13.77%) in the CSM based diets as compared to the control diet (15.26% CP and 14.25% CF). This difference might be related to the higher amount of rice-phak added in the control diet which contains less CP but more CF (Bhatt, 1993). All other nutrients in the diets were within the permissible limits (NRC, 1977). The Kudzu-vine fed to the rabbits contains CP-14.22%, CF-22.55%, Calcium-2.64% and Phosphorus-0.41%.

Table 3 presented the biological performance, wool yield, wool characteristics and mortality of Angora rabbits. Between groups comparison revealed no difference in initial body weight and at 1st, 2nd and 3rd shearing. These findings indicate that CSM incorporation in the diet at 9% alone or along with lysine and methionine supplementation did not have any significant positive or negative effect on the body weight gain of rabbits. Casady et al. (1962) and Tor-Agbidye et al. (1992) also recorded non-significant effect on body weight gain of broiler rabbits receiving 9% and 10% low gossypol containing CSM diets. Positive effect of lysine and methionine supplementation to CSM based diets on the body weight gain had been reported (Cheeke and Amberg, 1972), however, the lysine and methionine levels added were comparatively higher. The total value of lysine (calculated) in T_3 diet (0.79%) was slightly more and that of methionine (0.69%) meet the recommended levels for wool producing Angora rabbit (Shemin et al., 1991). More amino acids may be needed in CSM based diets. The lysine added to the experimental diet T_3 was to overcome deficiency, if binding to gossypol in CSM occurs, and not for body weight gain. No positive effects of lysine and methionine (0.1% each) supplementation on body weight gain have been reported in Angora rabbits, maintained on sunflower and mustard cake based diets (Bhatt, 2000).

Dry matter intake was similar between groups for concentrate and roughage. The addition of CSM at 9% level alone, or in combination with lysine and methionine, did not affect palatability. Likewise, non-significant effect of CSM incorporation in diet, up to 17% (McNitt et al., 1982) and up to 9.4% (Reddy et al., 1979), on feed intake had been reported, however, reduced intake have been reported giving CSM containing diets at 15% level (Aganga et al., 1991). Interestingly, feed intake of rabbits given a 20% level of CSM diet was significantly ($p<0.05$) higher than 15% level in the same experiment.

Table 3. Biological performance and wool attributes of Angora rabbit fed experimental diets

Parameters	T_1	T_2	T_3
Number of animals	10	10	10
Body weight (kg)			
Initial	2.96 ± 0.04	3.15 ± 0.03	3.06 ± 0.04
1st shearing	3.04 ± 0.03	3.19 ± 0.03	3.02 ± 0.04
2nd shearing	3.12 ± 0.03	3.29 ± 0.04	3.22 ± 0.02
3rd shearing	3.19 ± 0.03	3.19 ± 0.04	3.21 ± 0.03
Dry matter intake ($g \cdot d^{-1} \cdot head^{-1}$)			
Concentrate	112.7±9.1	112.9±2.9	101.2±5.0
Roughage	52.8±6.4	56.8±2.0	56.6±0.6
Total	165.5±7.7	169.7±2.4	157.8±2.8
Plane of nutrition ($g \cdot d^{-1} \cdot head^{-1}$)			
DCPI	17.28	17.78	17.32
TDNI	105[a]	100.5[b]	99.7[b]
Wool yield / shearing (g)			
1st shearing	137.0 ± 1.87	149.5 ± 3.04	152.5 ± 3.17
2nd shearing	134.5 ± 3.00	125.5 ± 1.42	125.5 ± 2.77
3rd shearing	128.5 ± 2.27	130.6 ± 2.04	142.5 ± 0.76
Total wool yield (g)	400 ± 6.28	380 ± 8.77	392 ± 10.72
Wool characteristics			
Staple length (cm)	5.01± 0.03	5.20 ± 0.06	4.96 ± 0.04
Fiber diameter (μm)	12.45 ± 0.04	12.49 ± 0.03	12.81 ± 0.07
Guard hair (%)	2.73 ± 0.13	2.43 ± 0.05	2.51 ± 0.01
Mortality (%)	-	20	20

Figures bearing different superscripts in a row differ significantly ($p<0.05$).

Difference of digestible crude protein (DCP) intake per day per animal in all three groups was not found. However, the total digestible nutrients (TDN) intake per day per animal was lower ($p<0.05$) given the CSM alone (T_2) and the lysine and methionine supplemented (T_3) diets. The digestibilities of DM, CF and EE in CSM based diets contribute significantly to energy supply of rabbits. Poor digestibilities of nutrients in CSM based calf starter (Fiems et al., 1986) and diet with 30% CSM in finishing pigs (Sastry and Agrawal, 1998) has been reported.

Comparison of wool data revealed that the total wool yield of control and test groups was not different ($p>0.05$). The relatively lower total wool yield observed in the T_2 and T_3 groups was due to death of 2 animals each in these groups at 3rd shearing. Further, within and between groups, comparison of wool yields at 1st, 2nd and 3rd shearing, significant difference was not found. This indicates that continuous feeding of CSM at 9% level alone or in combination with lysine and methionine had no adverse effect on the total wool yield or wool yield per shearing up to three consecutive shearing. Similarly, comparison of wool characteristics revealed no significant difference

Table 4. Digestibility coefficient (%) of nutrients in rabbits fed experimental diets

Nutrients	T_1	T_2	T_3
DM	66.34±0.68[a]	61.45±2.74[b]	59.38±1.07[b]
CP	69.93±2.36	66.78±1.95	68.80±1.28
CF	39.78±2.40[a]	13.23±1.58[b]	17.60±4.22[b]
EE	58.82±2.95[a]	34.22±6.56[b]	37.60±8.2[b]
NFE	74.99±1.13	75.03±2.41	71.82±1.21
ADF	51.04±1.42[a]	39.59±4.53[b]	35.05±3.36[b]
NDF	55.58±1.67[a]	47.62±4.7[b]	49.63±6.66[b]
Cellulose	85.41±0.71[a]	77.19±4.71[b]	66.28±5.37[c]
Hemicellulose	72.22±2.72[a]	65.4±4.24[b]	64.07±2.56[b]
DCP	10.44	10.48	10.97
TDN	63.93	59.22	56.82

Figures bearing different superscripts in a row differ significantly ($p<0.05$).

($p>0.05$) between pooled staple length, fiber diameter and guard hair (%) of control and test groups, indicating that different diets did not influence the genetically controlled parameters. There is no report to substantiate the findings pertaining to the effect of CSM on wool yield and wool attributes. However, on the basis of body weight of rabbits, which is almost proportional to the wool yield, it supports the effect in this experiment.

A 20% mortality was recorded in T_2 and T_3 whereas in T_1 there was no mortality. Post-mortem findings indicated that deaths in T_2 were due to pneumo-nephritis and hairball while in T_3 due to hepatitis and pneumo–hepatitis. The earliest mortality recorded in this experiment was at 172 d (in the group T_3). None of the symptoms on sickness and lesions recorded on post-mortem examination were characteristics of CSM or gossypol toxicity as reported earlier (McNitt, 1981). High mortality in broiler rabbits fed higher levels of CSM had been encountered (Holly et al., 1955; Tor-Agbidye et al., 1992), however, feeding of CSM (up to 15%) with low gossypol levels (0.04% or less) has been considered safe for the rabbit (McNitt, 1981). Severity of toxicity and development of symptoms depends upon daily dose and accumulation of gossypol in the body. In this experiment, the total gossypol intake in T_2 and T_3 was 914.5 mg and 819.7 mg over 225 d (on basis of 0.04% free gossypol in the CSM used). This level of gossypol should not be toxic to the rabbit as none of the test groups reflected any depression in body weight throughout the experiment. Similarly, in a experiment conducted for 270 d in which a total dose of 810 mg of gossypol was administered, no depression in body weight was found (Reddy et al., 1979). Thus, the mortality observed in T_2 and T_3 may not possibly be because of gossypol.

Results of metabolic trial (table 4) revealed significant ($p<0.05$) differences between SF and CSM supplemented diets for the digestibilities of DM, CF, EE, ADF, NDF,

cellulose and hemicellulose. The digestibility was lower in CSM supplemented diets (T_2 and T_3), however, difference in digestibility between T_2 and T_3 diets was not observed, indicating that the decreased digestibility of nutrients was directly related to CSM (the only different constituent in test diets from the control diet). The chemical composition clearly indicated that there was no excess of any analyzed principles in test diets, which might have affected its utilization adversely.

It could be concluded that replacement of SF with low free gossypol containing CSM (up to 9% on equal protein basis) in feeding of wool producing Angora rabbits, for a period of 225 d or three shearing, is feasible. The supplementation of lysine and methionine up to 0.1% each, may need further studies as significant effect on body weight gain, wool yield, wool characteristics and mortality was not found.

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