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Effect of graded levels of Jojoba meal in the complete feed of rabbits on voluntary intake and nutrient utilization

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Abstract

The study was conducted to evaluate the supplementation of Jojoba meal (*Simmondisa Chinensis*) on feed consumption, body weight changes, feed efficiency, and digestibility of nutrients in rabbits. A total of forty New Zealand white rabbits (4 week old) were randomly allotted to four dietary treatment groups of ten rabbits in each group. The control group (T_0) was fed with complete feed with no Jojoba oil meal and test groups were fed complete feed with 5, 15 and 25% Jojoba oil meal in T_1, T_2 and T_3 groups respectively. The daily dry matter intake in test groups were significantly ($P \leq 0.05$) reduced as compared to the control group. The average weekly body weight in test diet groups found significantly ($P \leq 0.05$) reduced consistently leading to reduction of body weight. Digestibility of either proximate principles (Dry matter, Organic matter, Crude fibre, Nitrogen free extractives) or fibre fractions (Neutral detergent fibre and Acid detergent fibre) was unaffected by jojoba supplementation whereas crude protein and ether extract digestibility and intake of total digestible nutrients and digestible crude protein were significantly lower in treated groups as compared to control group of rabbits.

Key words : jojoba meal, rabbits, nutrients

Introduction

Jojoba (*Simmondsia chinensis*) is an evergreen native oil seed shrub of the Sonora deserts of Arizona, California in the United States and Mexico (Hogan, 1979). In India, it is grown in some parts of Kutch in Gujarat, Jodhpur and Jaipur in Rajasthan. Jojoba oil meal, a high protein residue (Ngoupayou *et al.* 1985), which remains after oil extraction is a potential unconventional protein feed supplement. But, the toxic and anti-nutritional substances make the meal unsuitable for livestock feeding. Boiled Jojoba meal is bitter in taste and has low acceptability in animal diets. Toxicity of the incriminating factors such as simmondsin, simmondsin-2-ferulate (Swingle *et al.*1985) and related cyanomethylene glycosides however has never been fully proved nor understood the physiological mechanisms by which these factors elicit adverse effects. Although short time consumption of Jojoba meal produced detrimental effect in animals, long time feeding had shown gradual adaptation to the meal indicating a scope for its use in animal feeding under some circumstance. Hence, additional research is needed to revalidate the dose response effect and to suggest appropriate feeding system for diets containing Jojoba meal in farm animals.

Further, possibility of partial replacement of costly protein sources with locally available protein supplements has to be explored for its nutritive value and after appropriate dose response study for safe level for sustained production. Very few animal experiments have been conducted to ascertain the feeding value as well characterization of toxic effects of Jojoba meal. Keeping this in view, the present study was conducted to evaluate the nutritive value of Jojoba meal in broiler rabbits.

Materials and Methods

Jojoba meal was procured from Association of the Rajasthan Jojoba plantation and Research project, Jaipur, Rajasthan. Forty weaned (4 weeks old) New Zealand white rabbits of comparable body weights were selected for the study. They were randomly allotted to four dietary treatment groups consisting of ten each namely, T_0 (basal diet with no Jojoba), T_1 (basal diet with 5% Jojoba), T_2 (basal diet with 15% Jojoba) and T_3 (basal diet with 25% Jojoba). Basal diet was prepared in the form of complete ration using locally available ingredients such as maize, sunflower cake, groundnut cake, wheat bran, red gram pod husk, mineral mixture, vitamin mixture and salt. Experimental diets, T_1, T_2 and T_3 were prepared by replacing 5, 15 and 25% Jojoba meal. The rabbits were kept in individual cages (15" x 18" x 11") and maintained in a well ventilated laboratory animal house.

Samples of feed collected during the experiment were pooled every week for further analysis. The samples were analyzed for proximate principles as per the method described in A.O.A.C. (1990). Calcium and phosphorus were estimated according to Talapatra *et al.* (1940). The forage fiber fractions were estimated according to the method described by Goering and Vansoest (1970) and toxic content of feed were estimated according to method described by Van Boven *et al*. (1993). Feeding cum growth trial was conducted for a period of 13 weeks. Individual experimental rabbits were weighed before the start of experiment and subsequently at weekly interval till the end of experiment. Average daily gain of body weight was calculated. A digestion trial was conducted for a period of five days after the completion of three weeks of feeding trial to study the nutrient utilization in experimental animals.

Statical analysis

The data generated in the present study with regards to dry matter (DM) intake, digestibility of nutrients and growth rate were subjected to analysis of variation according to Snedecor and Cochran (1985) and results were interpreted accordingly.

Results

Chemical composition of Jojoba oil meal and experimental diets

The Jojoba oil meal used in the preparation of complete ration of experimental rabbits in the present study comprised 27.49% crude protein (CP), 11.59% ether extract (EE), 7.37% crude fiber (CF) and total ash (TA) 3.05% (Table 1). The hexane extract of the oil meal (10.75%) when re-extracted with acetone, the waxy material obtained which is said to be containing mixed toxicants was about 5.83%.

Table 1: Chemical composition of Jojoba meal (% DM)

Parameters	Per cent
Organic matter	96.95
Crude protein	27.49
Crude fat	11.59
Crude fiber	7.37
Total ash	3.05
Neutral detergent fiber	28.34
Acid detergent fiber	26.21
Mixed toxicant	5.83
Hexane extract	10.75

The CP content in four experimental diets (T_o, T_1, T_2 and T_3) were 17.24, 17.78, 18.37, 18.57% respectively. The mixed toxicant level contributed from different levels of Jojoba oil meal included in the complete ration was 1, 3.79 and 5.78 % in T_1, T_2 and T_3 rations respectively.

Effect of Jojoba oil meal on voluntary feed intake

The average dry matter (DM) intake (g/day) at the end of the first week was 21.2, 10.99, 11.52 and 13.16 in T_o, T_1, T_2 and T_3 respectively (Table 2). There was a significant ($P \leq 0.05$) reduction in DM intake irrespective of the level of Jojoba in the test diets. The same trend continued till the end of 4th week and the control group animals consumed 26.28 g/day while the test groups consumed 11.81 to 15.81 g/day.

Table 2: Mean dry matter intake (DMI g/day) in experimental rabbits

Weeks	Control	Treatment groups		
	T_0	T_1	T_2	T_3
1	21.20^a	10.99^b	11.52^b	13.16^b
2	25.42^a	18.79^b	17.48^b	13.96^b
3	26.33^a	17.32^b	16.68^b	20.23^b
4	26.28^a	11.81^b	15.58^c	15.81^c
5	44.65^a	17.05^b	23.75	-
6	44.22^a	23.03^b	-	-
7	43.92^a	29.00^b	-	-
8	41.32^a	28.12^b	-	-
9	51.21^a	19.97^b	-	-
10	60.24^a	27.97^b	-	-
11	46.35^a	17.75^b	-	-
12	58.46^a	12.40^b	-	-
13	55.60	-	-	-
Mean±SE	41.94±1.20	19.51±0.72	17.00±0.82	15.79±1.3

Mean value with different *superscripts* in a row differ significantly ($P \leq 0.01$)

Table 3: Mean weekly body weights (g) in experimental rabbits

Weeks	Control	Treatment groups		
	T_0	T_1	T_2	T_3
0	293.50	298.00	293.50	293.80
1	360.50	314.00	319.00	303.50
2	418.00	345.00	338.75	294.17
3	469.00^a	333.33^b	307.50^b	285.00^b
4	496.00^a	335.00^b	326.67^b	275.00^b
5	524.00^a	312.50^b	250.00^b	-
6	552.00	350.00	-	-
7	575.00	365.00	-	-
8	607.00	355.00	-	-
9	640.00^a	350.00^b	-	-
10	672.00	320.00	-	-
11	700.00^a	305.00^b	-	-
12	788.75^a	300.00^b	-	-
13	816.25	-	-	-
Mean±SE	608.61±51.65	356.90±35.14	305.90±11.78	290.29±4.31

Mean value bearing different superscripts in a row differ significantly ($P \leq 0.05$)

Effect on body weight

The initial body weights (g) of the experimental animals were 293.50, 298.00, 293.50 and 293.80 in T_0, T_1, T_2 and T_3 respectively (Table 3). The weekly mean body weight gradually increased in control group while in the test diet group, body weight reduced significantly ($P \leq 0.05$).

Feed conversion efficiency

The efficiency of feed conversion in control group was initially low (0.77) and subsequently the efficiency was increased to 2.73 at the end of the experiment. Since the test diet groups were showing negative growth as well as feed intake, the feed conversion efficiency values were not calculated.

Digestibility of dietary nutrients

The average digestibility of dietary nutrients such as dry matter, organic matter (OM), crude fibre, nitrogen free extractives (NFE), neutral detergent fibre (NDF) and acid detergent fibre (ADF) did not differ significantly between the groups except CP and EE (Table 4). The animals in groups T_1, T_2 and T_3 were shown to have significantly ($P \leq 0.05$) lower digestibility for CP and EE.

Table 4:Percent digestibility of nutrients (Mean±SE) in experimental animals

	Control	Treatment groups		
Parameters	**T_0**	**T_1**	**T_2**	**T_3**
Dry matter	79.12±0.54	81.14±0.76	80.03±0.78	80.90±0.58
Organic matter	79.08±0.54	80.42±0.41	79.97±0.78	78.59±1.05
Crude protein	77.34^{a}±0.59	72.01^{b}±1.12	71.85^{b}±1.43	70.80^{b}±1.09
Ether extract	89.50^{a}±0.33	79.17^{b}±0.68	80.72^{b}±2.69	78.17^{b}±0.78
Crude fiber	56.69±1.14	51.85±3.76	50.10±4.17	47.89±2.39
Nitrogen free extract	84.93±0.39	85.05±0.45	84.43±2.22	77.92±3.51
Neutral detergent fiber	61.17±1.05	57.05±1.25	56.60±3.72	54.61±5.70
Acid detergent fiber	61.39±0.60	59.65±1.98	55.78±1.63	57.52±1.24

Mean value with different superscript in a row differ significantly ($P \leq 0.05$)

The digestible crude protein (DCP) intake in control group (T_0) was significantly ($P \leq 0.05$) higher (3.75 g/day) as compared to T_1 (2.83), T_2 (2.87) and T_3 (1.77). Similarly, total digestible nutrients (TDN) intake was 22.06 g/day in T_0 which was significantly ($P \leq 0.05$) high as compared to T_1 (16.78), T_2 (18.56) and T_3 (10.29). However neither DCP nor TDN content of the experimental diets differs significantly.

Discussion

Chemical composition of Jojoba oil meal and experimental diets

The Jojoba oil meal was having the crude protein content of 27.49% (Table 1) which is comparable to the traditional oil such as sunflower cake. Hence, complete diet in the present study were prepared by partial replacement of high protein groundnut cake with a Jojoba oil meal at 0, 5, 15 and 25% with sunflower cake to make the complete diets iso-nitrogenous. The diets used in the present study were adequate in providing required nutrients as per the standard recommendation (NRC, 1977).

The mixed toxicants mainly comprising simmondsin and simmondsin 2' ferulate, in Jojoba oil meal was also comparable to the values reported by Ngoupayou *et al*. (1985) and Swingle *et al.* (1985). The ether extract content of Jojoba oil meal used in the present study was comparatively at higher range i.e. 11.59% as the Jojoba oil meal procured for the present study might be screw pressed, contrary to solvent extraction. The crude fibre content of the test ingredient (Jojoba) was also comparable to the value obtained by Swingle *et al.* (1985).

Effect of Jojoba oil meal on voluntary feed intake

Rabbits in Jojoba oil meal supplemented groups had shown severe inhibition of dry matter intake (Table 2) as compared to the control group. The voluntary intake was uniformly reduced in all the Jojoba supplemented groups. The results indicate that Jojoba oil meal has severely reduced the voluntary feed intake in rabbits. Similarly dry matter intake reduction has been reported by Ngouypayou *et al.* (1982) in chicks; Ngouypayou *et al.* (1985) in rabbits; Cokelaere *et al.* (1993a) in rats; Vermaut *et al.* (1997) in chicken ; Flo *et al*.(1999) in rats and Trei *et al.* (1979) in sheep and cattle. The reduction in dry matter intake in the present study could be attributed to bitter flavors of Jojoba beans (Booth *et al.* 1974) and anorexic effect of simmondsin due to its effect on satiety center (Flo *et al.*1998).

Effect on body weight

The body weight of rabbits in test groups were significantly ($P \leq 0.05$) reduced as compared to control group (Table 3). Like voluntary intake, the body weight was also uniformly reduced in all the Jojoba supplemented groups, indicating that the Jojoba oil meal has got a profound adverse impact on normal growth. This is evident from the Table 3 which shows significantly negative body weight that is affecting the cumulative average weekly gain of rabbits in test diet groups. Similar findings were also reported by Ngoupayou *et al.* (1982) in chicks; Ngoupayou *et al.* (1985) in New Zealand white rabbits; Arnouts *et al.* (1993) in broiler breeder pullets; Vermaut *et al.* (1997) in chicken; Booth *et al.* (1974); Cokelaere *et al.* (1993a,b) and Flo *et al.* (1999) in rats; and Roeline *et al.* (2000) in dogs. Severe voluntary feed intake reduction appears to be the direct cause for the reduced body weight gain in the present study. The results are in agreement with Arnouts *et al*. (1993) and Cokelaere *et al.* (1995) who have attributed the body weight reduction to inhibition of appetite linked with simmondsin content of Jojoba oil meal.

Feed conversion efficiency

It is evident from the previous section that voluntary feed intake was reduced and concomitant reduction of daily gain in weight. Moreover, mortality in the experimental animals was recorded in test diet groups from second week onwards. Therefore feed conversion efficiency of control diet could not be compared with the test groups.

Digestibility of dietary nutrients

The digestibility of dry matter, organic matter and fibre content was not altered by the inclusion of Jojoba oil meal in the present study (Table 4). However, digestibility of crude protein and ether extract fractions were significantly ($P \leq 0.05$)

reduced in Jojoba fed group as compared to control group. The reason for no effect on digestibility on the above parameters may be due to compensatory effect of experimental animals to overcome from the availability of less feed, at digestion level, due to depressed voluntary feed intake to fulfill the critical need of nutrients. However, the reason for the decreased CP intake may be attributed to the presence of additional toxicant such as trypsin inhibitor present in Jojoba meal as reported by Swingle *et al.* (1985). The digestible CP intake and also TDN intake were reduced in the experimental rabbits in the present study. Decrease in digestible nitrogen values was also observed in rats (Ngoupayou *et al.* 1985) sheep (Swingle *et al.* 1985) and dog (Roeline *et al.* 2000).

Conclusion

From the foregoing, it is concluded that the supplementation of Jojoba oil meal as low as 5% in diet may severely reduce dry matter intake with concomitant loss of body weight leading to high mortality in broiler rabbits. Nutrient utilization was also affected in terms of reduced DCP and TDN intake. Jojoba oil meal, a new unconventional protein supplement found to be of limited nutritional value in rabbit production particularly beyond 5% inclusion levels.

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