Growth Performance, Humoral Immune Response and Carcass Characteristics of Broiler Chickens Fed Alkali Processed Karanj Cake Incorporated Diet Supplemented with Methionine

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ABSTRACT : A study was conducted to see the effect of dietary incorporation of alkali (1.5% NaOH, w/w) processed solvent extracted karanj cake (SKC) supplemented with methionine on growth performance, humoral immune response and carcass characteristics of broiler chickens from 0 to 8 weeks of age. One hundred and twenty, day- old broiler chicks were wing banded, vaccinated against Marek's disease and distributed in a completely randomized design (CRD) into 3 groups of 40 chicks each, which was further replicated to 4 and fed on diet containing soybean meal and those of test groups were fed diets containing alkali (1.5% NaOH) treated SKC partially replacing soybean meal nitrogen of reference diet (12.5%) without or with supplementation of methionine (0.2%). Individual body weight of chicks and replicate-wise feed intakes were recorded at weekly intervals throughout the experimental period. Feed consumption from 1 to 14, 28, 42 and 56 d of age was recorded for each replicate and feed conversion efficiency (weight gain/feed intake) for the respective period was calculated. Mortality was monitored on daily basis. On 28th day of experimental feeding, two birds of each replicate in each dietary group (8 birds/diet) were inoculated with 0.1 ml of a 1.0% suspension of sheep red blood cells (SRBC) and the antibody titre (log 2) was measured after 5 days by the microtitre haemmagglutination procedure. After 42 days of experimental feeding, a retention study of 4 days (43-47 d) duration was conducted on all birds to determine the retention of various nutrients such as DM, N, Ca, P and GE. On 43rd day of experimental feeding, one representative bird from each replicate of a dietary treatment (4/dietary group) was sacrificed, after fasting for two hours with free access to water, through cervical dislocation to observe the weight of dressed carcass, primal cuts (breast, thigh, drumstick, back, neck and wing), giblet (liver, heart and gizzard), abdominal fat and digestive organs. The body weight gain of chicks fed reference diet and those fed diet incorporated with NaOH treated SKC (12.5% replacement) with or without methionine supplementation was comparable during 0 to 4 weeks of age. However, dietary incorporation of alkali processed SKC replacing 12.5% nitrogen moiety of soybean meal resulted in growth retardation, subsequently as evidenced by significantly ($p<0.05$) lowered body weight gain during 0 to 6 weeks of age in birds fed diet incorporated with alkali processed SKC at 6.43% without methionine as compared to those supplemented with methionine or reference diet. Dietary incorporation of alkali (1.5% NaOH) processed SKC replacing 12.5% of soybean meal nitrogen in the diet of broiler chickens had no adverse effect on feed conversion ratio during all the weeks of experimental feeding. The humoral immune response (HIR) as measured by the antibody titre in response to SRBC inoculation was comparable among all the dietary groups. No significant difference in the intake and retention of DM, N, Ca, P or GE was noted among the chicks fed reference and alkali processed SKC incorporated diets with or without methionine supplementation. None of the carcass traits varied significantly due to dietary variations, except the percent weight of liver and giblet. The percent liver weight was significantly ($p<0.05$) higher in the birds fed diet incorporated with alkali processed SKC as compared to that in other two groups. Thus solvent extracted karanj cake could be incorporated after alkali (1.5% NaOH, w/w) processing at an enhanced level of 6.43%, replacing 12.5% of soybean meal nitrogen, in the broiler diets up to 4 weeks of age, beyond which the observed growth depression on this diet could be alleviated by 0.2% methionine supplementation. ***(Asian-Aust. J. Anim. Sci. 2005. Vol 18, No. 5 : 677-681)***

Key Words : Alkali Processed Karanj Cake, Broiler Chickens, Growth Performance, Humoral Immune Response, Carcass Characteristics

INTRODUCTION

Agro-forest based industrial byproducts are gaining momentum as alternate feed resources for the poultry industry (Haque et al., 1996) due to chronic shortage of protein and energy rich animal feeds in India and other South East Asian countries. One such byproduct is karanj cake, the residue left after oil extraction. Deoiled karanj cake (0.5 -1% EE) though rich in protein, it was advocated for its incorporation in various types of poultry rations as such without processing, that too at very lower levels (Mandal, 1977).

Feeding of karanj cake at higher levels adversely affected the performance due to the presence of toxic factors such as karanjin and pongamol in the oil or oil fraction of the cake (Natanam et al., 1989a, Dhara et al., 1997). The expeller and solvent extracted cakes also contain tannins to the extent of 3.16 and 3.41%, respectively.

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Table 1. Ingredient and nutrient composition of starter diets (Percent on as fed basis)

Ingredient	Diet		
	D1	D2	D3
Maize	60.5	58.92	58.92
Soybean	35	30.5	30.5
Karanj	0	6.43	6.43
Deoiled rice bran	0.72	-	-
Vegetable oil		0.5	0.5
Limestone	1.6	1.5	1.5
DCP	1.3	1.3	1.3
Lysine	0	0.07	0.07
Methonine	0.16	0.16	0.36
Salt	0.4	0.3	0.3
Mineral Mix.[a]	0.1	0.1	0.1
Vitamin Mix. [b]	0.22	0.22	0.22
Calculated (nutrient composition)			
ME (kcal/kg)	2,894	2,889	2,889
CP (%)	22.04	21.77	21.71
Ca (%)	1.01	1.01	1.01
NPP (%)	0.40	0.40	0.40
Lysine (%)	1.20	1.19	1.19
Methionine (%)	0.51	0.52	0.72

[a] Trace minerals premix supplied per kg of diet: Cu 7.25 mg, Fe 80 mg, I 1.2 mg, Mn 65 mg and Zn 68 mg.

[b] Vitamins premix supplied per kg diet: Calcium pentothenate 8 mg, chlonie chloride 1,000 mg, niacin 12 mg, pyrodoxine hydrochloride 1.6 mg, vitamin A 8,250 IU, vitamin D_3 1,200 ICU, vitamin E 8 mg, vitamin K 10 mg vitamin B_1 0.8 mg, vitamin B_2 5 mg, vitamin B_{12} 8 mcg.

Supplementation of methionine partially alleviated growth depression due to karanj cake feeding in broiler chicken (Natnam et al., 1989a). No detailed studies have, however, been made for its proper utilization in poultry feeding after processing, except for a few physical treatments (Mandal and Banerjee, 1974; Natanam et al., 1989b). Recently Panda et al. (2003) detoxified karanj cake by various physico-chemical methods like dry heat, water washing, pressure cooking, alkali and acid treatments and microbiological treatment with *Sacchraromyces cerevisiae* (strain S-49). Based on the residual toxin left back in the processed cake these authors concluded that alkali treatment is the best method of detoxification. The present study was, therefore, conducted to study the effect of dietary incorporation of alkali (1.5% NaOH, w/w) processed solvent extracted karanj cake (SKC) supplemented with methionine on growth performance, humoral immune response and carcass characteristics of broiler chickens.

MATERIALS AND METHODS

Processing of karanj cake

Solvent extracted karanj cake was procured from local market and was detoxified by various physico-chemical methods such as dry heat, water washing, pressure cooking, alkali and acid treatments and microbiologically treated with *Saccharomyces cerevisiae* (strain-49) (Prabhu, 2002).

Table 2. Ingredient and nutrient composition of finisher diets (Percent on as fed basis)

Ingredient	Diet		
	D1	D2	D3
Maize	63	64	64
Soybean	30	26.5	26.5
Karanj	0	5.5	5.5
Deoiled rice bran	3.1	0.45	0.45
Limestone	1.75	1.5	1.5
DCP	1.3	1.3	1.3
Lysine	0	0	0
Methonine	0.13	0.13	0.33
Salt	0.4	0.3	0.3
Mineral Mix.[a]	0.1	0.1	0.1
Vitamin Mix. [b]	0.22	0.22	0.22
Calculated (nutrient composition)			
ME (kcal/kg)	2,905	2,910	2,910
CP (%)	20.28	20.11	20.11
Ca (%)	1.02	1.00	1.00
NPP (%)	0.40	0.39	0.39
Lysine (%)	1.04	1.01	1.01
Methionine (%)	0.45	0.45	0.65

[a] Trace minerals premix supplied per kg of diet: Cu 7.25 mg, Fe 80 mg, I 1.2 mg, Mn 65 mg and Zn 68 mg.

[b] Vitamins premix supplied per kg diet: Calcium pentothenate 8 mg, chlonie chloride 1,000 mg, niacin 12 mg, pyrodoxine hydrochloride 1.6 mg, vitamin A 8,250 IU, vitamin D_3 1,200 ICU, vitamin E 8 mg, vitamin K 10 mg vitamin B_1 0.8 mg, vitamin B_2 5 mg, vitamin B_{12} 8 mcg.

Based on the residual toxins left back in the processed cake, the NaOH (1.5%, w/w) treatment was selected for bulk preparation and animal experimentation. The NaOH treated SKC was, thus, prepared by soaking the cake for 24 h in water (W/V, 1:1) having sodium hydroxide at 1.5% (W/W). The processed cake was sun dried, ground and stored in gunny bags for incorporation into the diet to substitute soybean meal nitrogen partially (12.5%) for broiler feeding with or without methionine supplementation.

Stocks and husbandry

One hundred and twenty, day- old broiler chicks from a hatch of around 150 chicks were wing banded, vaccinated against Marek's disease and distributed in a completely randomized design (CRD) into 3 groups of 40 chicks each, which was further replicated to 4. The chicks of each replicate were housed at random in the pens of wire floored battery brooders having provision of feeders, waterers and faecal trays from 1 to 56 days of age. The brooder temperature was maintained at 34±1°C up to 7 days of age and gradually reduced to 26±1°C by 21 days of age after which, chicks were maintained at room temperature. All the chicks were kept under uniform managemental conditions throughout the experimental period.

Feeds and feeding

The chicks of the reference group were fed on diet (Tables 1 and 2) containing soybean meal (D-1) and those

Table 3. Live weight gain and feed conversion ratio of broiler chickens during 0 to 8 weeks period

	D-1	D-2	D-3	SEM
Body wt. gain (g)				
0-2 wk	315.67	306.57	309.52	2.56
0-4 wk	877.27	847.72	846.20	7.98
0-6 wk	1,577.48 [a]	1,490.45 [b]	1,561.75 [a]	11.03
0-8 wk	2,202.68 [a]	2,115.58 [b]	2,177.66 [a]	14.03
Feed conversion ratio				
0-2 wk	1.66	1.67	1.78	0.03
0-4 wk	1.77	1.82	1.84	0.03
0-6 wk	2.12	2.18	2.14	0.04
0-8 wk	2.50	2.57	2.56	0.05

[a, b] Means with different superscripts in a row differ significantly ($p<0.05$).

of test groups were fed diets containing alkali (1.5% NaOH) treated SKC partially (12.5%) replacing soybean meal nitrogen of reference diet with out (D-2) or with supplementation of methionine (0.2%) (D-3). Water and feed was made available *ad libitum* with a provision for measurement.

Experimental procedures

Individual body weight of chicks and replicate-wise feed intakes were recorded at weekly intervals throughout the experimental period. Feed consumption from 1 to14, 28, 42 and 56 d of age was recorded for each replicate and feed conversion efficiency (weight gain/feed intake) for the respective period was calculated. Mortality was monitored on daily basis.

On 28th day of experimental feeding, two birds of each replicate in each dietary group (8 birds/diet) were inoculated with 0.1 ml of a 1.0% suspension of sheep red blood cells (SRBC). After 5 days of post inoculation, the SRBC inoculated birds were bled through the brachial vein to measure the antibody titre (log 2) by the microtitre haemmagglutination procedure of Wegmann and Smithies (1966).

After 42 days of experimental feeding, a retention study of 4 days (43-47 d) duration was conducted on all birds to determine the retention of dry matter (DM), nitrogen (N), calcium (Ca), phosphorus (P) and gross energy (GE). The birds in a replicate were treated as a single unit. Daily feed offered and faeces voided during this period was recorded. The DM, N, Ca, P and GE in feed and faeces were analyzed as per the AOAC (1990). Based on feed intake and excreta voided, the net retention of DM, N, Ca, P and GE was calculated as retention of nutrients on percent basis.

On 43rd day of experimental feeding, one representative bird from each replicate of a dietary treatment (4/dietary group) was sacrificed, after fasting for two hours with free access to water, through cervical dislocation to observe the weight of dressed carcass, primal cuts (breast, thigh, drumstick, back, neck and wing), giblet (liver, heart and gizzard), abdominal fat and digestive organs. All the carcass characteristics were expressed on percent live weight basis.

The data pertaining to various parameters were subjected to one way analysis of variance as per the methods of Snedecor and Cochran (1989). The means in different treatments were tested for statistical significance using Duncan's multiple range test (Duncan, 1955) with significance of $p\leq0.05$.

RESULTS AND DISCUSSION

Body weight and feed conversion ratio

The body weight gain of chicks fed reference diet and those fed diet incorporated with NaOH treated SKC (12.5% replacement) with or without methionine supplementation was comparable during 0 to 4 weeks of age (Table 3). However, dietary incorporation of alkali processed SKC replacing 12.5% nitrogen moiety of soybean meal resulted in growth retardation subsequently as evidenced by significantly ($p<0.05$) lowered body weight gain during 0 to 6 weeks of age in birds fed diet incorporated with alkali processed SKC at 6.43% as compared to those fed same diet supplemented with methionine or reference diet which did not differ significantly among birds of later two diets. It clearly indicates that supplementation of methionine to the diet incorporated with alkali processed SKC at 6.43% would be beneficial in alleviating the growth depression. The same trend was noticed during 0 to 8 weeks of age.

Dietary incorporation of alkali (1.5% NaOH) processed SKC replacing 12.5% of soybean meal nitrogen in the diet of broiler chickens had no adverse effect on feed conversion ratio during all the weeks of experimental feeding (Table 3). Supplementation of methionine to alkali (1.5% NaOH) processed SKC containing diet had no influence in improving the feed conversion ratio. No information is available on the feeding of alkali processed karanj cake in chickens. However, dietary incorporation of solvent extracted karanj cake replacing nitrogen moiety of soybean meal at either 25% or 50% in the concentrate mixture of small ruminants like lambs had no influence on either growth or feed intake (Prabhu, 2002).

Though early growth is genetically regulated, growth in later stages is influenced by factors like plane of nutrition, hormonal status, environment and heredity (Widdowson, 1980). Optimum nutritional regime is one of the essential factors to exploit full genetic potential of an individual. In the present study, a linear increase in the body weight was observed in the birds on all the diets. The comparable feed conversion ratio of all the dietary groups clearly indicated that dietary inclusion of alkali (1.5% NaOH) processed SKC containing diet replacing 12.5% of soybean meal nitrogen had no adverse influence on feed conversion. In spite of the similar feed conversion, there was growth depression beyond 4 wk of age on alkali processed SKC

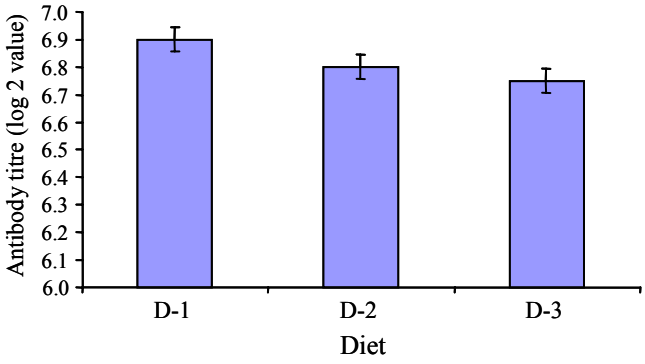

Figure 1. Humoral immune response of broiler chickens.

Table 4. Intake (g/bird/d) and retention (%) of nutrients during 43 to 46 days of age

Intake (I) /retention (R)	D-1	D-2	D-3	SEM
DMI	122.56	121.01	121.90	1.39
DMR	72.22	69.91	69.92	0.57
NI	24.53	24.32	24.44	0.27
NR	58.83	55.94	55.61	0.87
CaI	1.336	1.312	1.326	0.02
CaR	41.21	35.96	36.21	1.23
PI	0.882	0.872	0.876	0.01
PR	74.81	72.49	72.28	0.65
GEI	501.29	496.35	499.10	5.62
GER	75.93	74.79	73.96	0.54

DMI: dry matter intake; DMR: dry matter retention; NI: nitrogen intake; NR: nitrogen retention; CaI: calcium intake; CaR: calcium retention; PI: phosphorus intake; GEI: gross energy intake; GER: gross energy retention.

diet when methionine was not supplemented. This might be attributed to the presence of residual incriminating factors still left back in the processed cake.

Humoral immune response

The humoral immune response (HIR) as measured by the antibody titre in response to SRBC inoculation was comparable among all the dietary groups (Figure 1). The response to a foreign antigen in an individual depends on several factors such as genetic background (Gross and Siegel, 1988), dosage of antigen (Dunnington et al., 1994), type of antigen (Dunnington et al., 1993), route of administration (Van der Zijjp, 1983), sensitivity of an individual (Gross and Siegel, 1993; Kim et al., 2004) and levels of intake of nutrients (Cao et al., 2004). The comparable immune response that was observed across the dietary groups in the present study clearly indicated that dietary incorporation of alkali processed SKC replacing 12.5% nitrogen moiety of soybean meal had no adverse effect on humoral immune response.

Intake and retention of nutrients

The daily intake and percent retention of DM, N, Ca, P and GE in chicks fed different diets during 43 to 46 (7^{th} week) days of age have been presented in Table 4. No significant difference in the intake and retention of DM, N, Ca, P or GE was noted among the chicks fed reference and alkali processed SKC incorporated diets with or without methionine supplementation during 43 to 46 days of age. The nutrient retention depends on the amount of nutrients available above the maintenance requirements for production purposes. This in turn is dictated by feed intake (Tarazi and Alshawabkeh, 2003), digestibility, energy density, energy to protein ratio and efficiency of their utilization (Mandal et al., 2004). The comparable intake and retention of DM, N, Ca, P or GE among the chicks of all the dietary groups indicated that dietary incorporation of alkali (1.5% NaOH) processed SKC replacing 12.5% of soybean meal nitrogen had no adverse effect on nutrient retention. Similarly, Prabhu (2002) reported that dietary incorporation of 16.5% alkali treated SKC had no adverse effect on utilization of either DM or N.

Table 5. Carcass characteristics (% live weight) of broiler chickens at 6^{th} week of age

Characteristic	D-1	D-2	D-3	SEM
Dressed weight wt.	72.48	72.32	73.04	0.330
Liver	2.19^{c}	2.73^{a}	2.53^{b}	0.062
Heart	0.52	0.51	0.53	0.008
Gizzard	1.90	1.91	1.98	0.031
Giblet	4.61^{b}	5.15^{a}	5.04^{a}	0.067
Abd. fat	1.36	1.32	1.43	0.049
Small intestine	3.64	3.60	3.65	0.037
Large intestine	0.29	0.29	0.29	0.009
Primal cuts				
Breast	16.31	16.55	16.72	0.200
Thigh	10.86	10.65	10.41	0.206
Drumstick	10.71	10.92	10.75	0.115
Back	15.44	15.67	15.69	0.166
Wing	8.68	8.65	8.66	0.034
Neck	4.47	4.36	4.38	0.082

[a, b, c] Means with different superscripts in a row differ significantly ($p<0.05$).

Carcass characteristics at 6^{th} week of age

The data on carcass traits viz. dressing percentage, percent live weight of liver, heart, gizzard, giblet, abdominal fat, SI and LI and commercial cuts viz. percent weight of breast, thigh, drumstick, back, wing and neck have been set out in Table 5. None of the carcass traits varied significantly ($p>0.05$) due to dietary variations, except the percent weight of liver and giblet. The percent liver weight was significantly ($p<0.05$) higher in the birds fed diet incorporated with alkali processed SKC as compared to that on other two groups. Supplementation of methionine to alkali processed SKC incorporated diet alleviated the adverse effect as there was a significant ($p< 0.05$) reduction in hypertrophy of liver as compared to relative weight of liver from those fed alkali processed SKC as such. The comparable percent weight of giblet in the

birds fed alkali processed SKC containing diet with or without methionine supplementation was significantly ($p< 0.05$) higher than that in birds fed reference diet. None of the slaughtered and dressing characteristics differed significantly due to incorporation of SKC to replace 25 and 50% nitrogen moiety of soybean meal of control diet of lambs as observed by Prabhu (2002).

CONCLUSION

Solvent extracted karanj cake could be incorporated after alkali (1.5% NaOH, w/w) processing at an enhanced level of 6.43%, replacing 12.5% of soybean meal nitrogen, in the broiler diets up to 4 weeks of age, beyond which the observed growth depression on this diet could be alleviated by 0.2% methionine supplementation. Such diet, by partially sparing costly and scarce conventional oil cake, supported optimum nutritional performance and immunocompetence in broiler chickens.

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