

**STUDIES ON THE UTILIZATION OF EXPELLER JANGLI BADAM
(*Sterculia foetida*) CAKE AND EXPELLER COPRA (*Cocos nucifera*)
CAKE IN BROILER RATION**

**A Thesis
submitted to the
Bidhan Chandra Krishi Viswavidyalaya
in partial fulfilment of the requirements for the Degree of
Master of Veterinary Science
in
ANIMAL NUTRITION**

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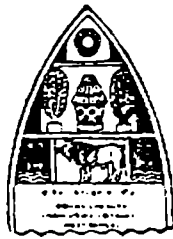
Dedicated
to my beloved parents

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C E R T I F I C A T E

This is to certify that the work recorded in the thesis entitled "STUDIES ON THE UTILIZATION OF EXPELLER JANGLI BADAM (Sterculia foetida) CAKE AND EXPELLER COPRA (Cocos nucifera) CAKE IN BROILER RATION", submitted by Santanu Bera for the award of the Degree of Master of Veterinary Science in Animal Nutrition of the Bidhan Chandra Krishi Viswavidyalaya, is the faithful and bonafide research work carried out under my personal supervision and guidance. The results of the investigation reported in the thesis have not so far been submitted for any other degree or Diploma. The assistance and help received during the course of investigation have been duly acknowledged.

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Chapter—1

INTRODUCTION

I N T R O D U C T I O N

The over increasing human population at a geometric rate in the developing countries of the world including India (Table - 1.1) in comparison to the increase of the food stuff at an arithmetic rate is the main reason which has caused a 'bottle-neck' condition for the availability of nutrients. Since few decades, due to greater intensity of natural calamities (drought, flood etc.) India is confronted with a chronic food and thus nutritional deficiency.

Table - 1.1 Population of India : 1951 - 1991

Year	Population	Decadal growth		Average annual exponential growth rate(%)
		Absolute	Percent	
1951	361,088,090	+42,420,485	+13.31	1.25
1961	439,234,771	+77,682,873	+21.51	1.96
1971	548,159,652	+108,924,881	+24.80	2.20
1981	683,329,097	+135,169,445	+24.66	2.22
1991	843,930,861	+160,601,764	+23.50	2.11

Source: Provisional population totals (1991) paper-1, page-21,
Registrar general and Census Commissioner, India.

If we look into the human health point, it is evident that for an adult the maintenance requirement is 1 gm of protein per kg of body weight per day. The minimum protein requirement of a healthy Indian has been fixed at 50 gm per day by ICMR, of which 30% i.e. 15 gm should be animal protein of high biological value. The per capita consumption of poultry meat per annum is 131 gm as against 15 kg in USA and 2.47 to 5.95 kg in European countries. From this figure, it is quite evident that we are already deficient in protein and proper attention should be given for increase in per capita consumption of particularly protein rich food materials. The production of meat, milk and eggs in India as compared to the world are presented in Table - 1.2.

The the number of livestock is highest in our country in the world but the per capita availability of animal protein is not sufficient to meet up the minimum requirement. As a result, people are becoming more interested in poultry egg and meat due to its easy availability because the rearing of birds is easier as compared to maintenance of other domesticated livestock.

Poultry industry is playing an important role in Socio-Economic Development of small farmers in India. In the global efforts to overcome malnutrition and poverty in the developing

Table - 1.2 Production of Meat, Milk and Eggs

	World			India		
	1988	1989	1990	1988	1989	1990
Beef and veal (1000 MT)	49876	50542	61152	232	234	316
Buffalo meat (1000 MT)	1435	1607	1637	290	355	325
Mutton and lamb (1000 MT)	6568	6725	6871	148	160	162
Goat meat (1000 MT)	2249	2390	2506	378	385	410
Pig meat (1000 MT)	66789	67673	69458	357	359	360
Horse meat (1000 MT)	478	490	496	-	-	-
Poultry meat (1000 MT)	37328	38283	39862	225	289	319
Total meat (1000 MT)	167882	170857	175181	1753	1907	2019
Cow milk (whole, fresh) (1000 MT)	466209	470612	475507	22000	24000	26700
Buffalo milk (1000 MT)	39006	40196	38580	25239	25955	23600
Sheep milk (1000 MT)	8624	8463	8470	-	-	-
Goat milk (1000 MT)	8510	8758	8780	1461	1545	1500
Hen eggs (MT)	35522576	35566112	35758464	1030000	1080000	1100000
Eggs exclu- ding hen	645206	644854	648795	-	-	-

Source: FAO Year Book - 1990, Vol. 44, page 199 - 226.

countries, potentiality of poultry farming has been widely accepted. It has found a special favour with the rural farmers because of its ability to provide supplementary income in the shortest possible time, simplicity of operation and with not too heavy demands on capital resources. With this silver lining in view, Government of India launched massive poultry development programmes adopting priority planning and financial investment (Table - 1.3) for uplifting poultry production appropriate to the changing needs of the growing population exclusively for the development of rural economy and alleviation of malnutrition problem.

Table - 1.3 Expenditure on poultry in the five year plans

		(Rs. Crore)
Five year plans		Expenditure (Rs. crore)
Second plan	(1956-1961)	2.8
Third plan	(1961-1966)	4.6
Fourth plan	(1969-1974)	11.5
Fifth plan	(1974-1978)	35.5
Sixth plan	(1980-1985)	42.6
Seventh plan	(1985-1990)	45.93

Source: Indian Poultry Industry year book - 1990, page-8.

This is also evidenced with an annual production of 26,000 million (Masillamony, 1991). India is the fifth largest egg producing country in the world. The production of eggs has also multiplied about five fold during the last two decades, which is evident from Table - 1.4. The production of broilers has reached from 4 million in 1971 to 75 million in 1985. It has been estimated that 200 million of broiler production in 1989 would reach 450 million by next five years (Table- 1.4). Galloping rise in the price and insufficient availability of mutton has not only increased the demand of broilers but also the broiler meat has come within the easy reach of the average Indians who have hitherto considered the meat as more a luxury than necessity.

Table - 1.4 Egg and broiler production (in million)

Year	Egg production (in million)	Broiler production (in million)
1971	5,340	4.0
1977	9,820	17.0
1980	12,500	30.0
1985	16,100	75.0
1986	17,300	100.0
1988	20,800	168.0
1989	23,000	200.0
1990	25,200	240.0

Source: Indian Poultry Industry year book - 1990, page 6-7.

It is accepted that poultry production in terms of meat or eggs could be achieved in a comparatively shorter time but the availability of feeds at economic price is the most important pre-requisite for profitable poultry production as the cost of conventional feeding alone accounts for nearly 80% of total expenses in poultry farming. The balanced feeding of poultry which has been accredited as the basic foundation for economic and viable poultry production faces crisis in view of acute shortage of protein and cereal rich feed stuffs in our country. With our over increasing human population, it will be more and more difficult to spare cereals for poultry feeding. Hence if the poultry industry is to survive and progress at the desired rate the competition between human being and poultry for the same feed must be avoided. The ever increasing trend in prices of poultry feeds presented in Table 1.5, is also causing a 'bottle-neck' in the way of the development of poultry industry.

Table 1.5 Trend in prices of poultry feeds (Rs./tonne)

year	Broiler mash	Layer mash
1976	1608	1224
1977	1855	1462
1978	1880	1461
1979	2009	1551
1980	2227	1747
1981	2453	1933
1982	2507	1973
1983	2621	2100
1984	2700	2230
1985	2730	2322
1986	2813	2279
1987	2876	2289
1988	3160	2597

Source: Indian Poultry Industry year book - 1990, page - 7

Considering the above facts, it is essential to eliminate or minimize the use of such ingredients as are costly or are largely used in human diets and the nutritionists all over the world are now engaged to explore newer feed resources. At present, extensive ventures are being made at various Research Institutes and Agricultural Universities for finding out alternative feed resources, detection of toxins or incriminating factors in non-traditional feeds and developing detoxification procedures. Realising the importance of these subsidiary feed resources, Indian Council of Agricultural Research (ICAR) have also launched National Coordinated Research project entitled "Investigations on the agricultural by-products and industrial waste materials for evolving economic rations of Livestock", which is functioning through its 10 centres located in different agroclimatic regions of this country headed by a project coordinator from 1967. These centres are engaged in devising ways and means for incorporation of various agro-industrial by-products in the rations of livestock to develop various economic combinations after identification of incriminating factors, and processing methods to make these suitable for animal feed.

The cost of protein rich feed stuffs is about 40% of the total cost of poultry ration of which oil cakes play a very crucial role. Oil cakes are the by-products of oil industries. India is one of the major oil seed producing countries in the

world. The growth in the oil seeds and oil cakes production requires immediate attention to bridge up the gap between increasing demand and supply for vegetable protein for our livestock. India is perhaps the only country in the world having largest number of commercial varieties of oil seeds such as, groundnut, mustard, rapeseed, sesame, linseed, castor copra, safflower, sunflower, niger, mahua, karanja, and quite a good number of minor oil seeds like ambadi, Indian kapok, rubber seed, watermelon seed, sunhemp seed, Kusum etc. Yet, the demand and supply gap in vegetable protein in the form of oil cakes has risen to an alarming level. A lot of research is yet to be done keeping in view the malnutrition, and scarcity of oil cakes at bay.

Next to food grains, oilseed crops contribute significantly to the agricultural economy of the country. At present, we have about 19 million hectares under oilseed production, accounting for 11 per cent of the total land under cultivation, the production of oil seed is about 12 million tonnes and the average yield is about 650 kg hectare, valued at Rs.3,500 crores.

Of the different oilseeds contributing to the oil cake basket of the country, 50 per cent comes from groundnut, rapeseed accounts for 25 per cent, sesame for 16 per cent, safflower 5 per cent and niger 4 per cent. Yet the availability

of oil cakes is not sufficient according to our requirement of poultry feeds. As such it was felt necessary to explore other unconventional oil cake. The groupwise contribution of the aforesaid oil seeds in respect of area and production may be obtained from Table - 1.6.

Table - 1.6 Contribution of individual oilseed crops

C r o p	% of total area under oilseed	% of total oilseeds production
1. Groundnut	41.4	61.4
2. Rapeseed/Mustard	20.7	18.9
3. Sesame	13.8	4.8
4. Safflower	4.1	2.7
5. Niger	3.4	1.4
6. Soyabean	2.1	2.9
7. Linseed	10.8	4.3
8. Sunflower	1.1	1.0
9. Castor	2.7	2.6
	<u>100</u>	<u>100</u>

Source: Proceeding of the seminar on oilseeds and farm Technology, 1987.

The object of the present work was, therefore, to assey the feasibility of incorporating expeller variety of Jangli badam cake (Sterculia foetida) and expeller variety of Copra (Cocos nucifera) cake in broilers' ration replacing

costly conventional feed ingredients which may add a new dimension in the arena of poultry feed industry in the day to come. Out of these two cakes no data on the utilization of Jangli badam in the ration of poultry is still available, on the other hand a huge quantity of Copra cake is available in our country particularly in the Southern parts. Considering these points, attempts were made to study the feasibility of inclusion of these oil cakes in the ration of broilers.

A few information about coconut : (Cocos nucifera)

Copra cake is the by-product of coconut oil industry. Coconut plants are generally grown in the costal areas of India. Kerala is the highest coconut producing states of India followed by Tamilnadu, Karnataka (Table - 1.7) etc. Average availability of coconut in different countries in the world are presented in Table - 1.8, while Table - 1.9 shows the estimated production of milling copra and coconut oil in India.

Table - 1.7 Area and production of coconut in the country
1989-90

State/Union territories	Area ('000 ha)		Production (million nuts)	
	1988-89	1989-90	1988-89	1989-90
Andhra Pradesh	52.0	59.0	511.2	654.7
Assam	9.3	9.8	65.9	69.4
Goa	23.4	23.5	107.2	107.5
Karnataka	220.3	225.4	1134.6	1158.7
Kerala	816.9	875.9	4215.0	4394.0
Maharashtra	7.8	7.8	103.0	108.3
Orissa	27.1	27.1	113.7	113.7
Tamilnadu	214.2	225.9	1917.3	2302.4
Tripura	7.0	7.0	4.2	4.2
West Bengal	19.8	19.8	238.5	238.5
Andaman & Nicobar Islands	23.2	23.8	81.4	83.1
Lakshadweep	2.8	2.8	25.2	25.2
Pondicherry	1.7	1.7	23.7	23.7
All India projections	1425.5	1509.5	8541.4	9283.4

Source: Directorate of Economics and Statistics, Ministry of Agriculture, Government of India.

Table - 1.8 Coconut production ('000 tonnes) of various countries

World	38,091
Indonesia	12,300
Malaysia	1,186
Philippines	8,300
India	4,739
Sri Lanka	1,968
Thailand	1,437
Mexico	1,006
Brazil	686

Source: FAO Year book, 1989, Vol. 43.

Table - 1.9 Estimated production of milling copra and coconut oil in India

Year	Production of milling copra (tonnes)	Production of coconut oil (tonnes)
1985-86	399,000	252,000
1986-87	329,000	294,000
1987-88	352,000	222,000
1988-89	438,000	276,000
1989-90	460,000	269,000

Source: Indian Horticulture, 1991. 36(3): 41.

Publication and information Division, ICAR, New Delhi

Table-1.7, Table - 1.8, Table - 1.9 are collected from this magazine.

In general, a fully matured fruit will have a composition by weight of about 35% husk, about 12% shell, about 28% meal or kernel and about 25% water. This composition may be different for nuts of different cultivars.

Some information about Jangli badam (Sterculia foetida)

Jangli badam though a widely used regional name in West Bengal for this species, is confusing and a misnomer. This name is also applied to some other plants, like S. foetida, which are in no way related to the true badam, Frunus amygdalus.

The tree is often grown for ornamental purpose and also as road side plantation (Plate - 1.1), especially in South India on the West coast from Konkan and Southward. The tree is also found in West Bengal, Bihar, Assam etc.

Tree : A moderate-sized to large, handsome tree (Plate-1.2), sometimes attaining a height of about 30 metres, bark is whitish, flaking.

Leaves : Leaves digitate, crowded at the end of the branches, leaflets 5-9, sub-sessile, oblong lanceolate, 10-18 cm X 4-5 cm.



Plate 1.1 Jangli badam trees grown as road side plantation



Plate 1.2 A moderate-sized jangli badam tree



Plate 1.3 Follicles and seeds (Jangli baadam)

- Flowers : Flowers dull orange, 2.5 - 4 cm diameter, foetid smelling in panicles.
- Follicles Follicles 1-5, oblong, boat shaped, 10-12 cm long, thick, woody, bright red (Plate - 1.3).
- Seed Seeds 10-15, ovoid-oblong about 2 cm long, black.

The seeds (weight, 200-250 gm/100 seeds), sometimes called JAVA OLIVES or STINKING-BEANS are eaten raw or roasted. However, if taken in large quantities, it may cause nausea, act as violent purgative and are said to bring about abortion. They are reported to be used to adulterate cocoa. An analysis of seeds gave the following values: Moisture, 35.6%, protein 11.4%; fat, 35.5%; and mineral matter, 2.4%; and the minerals and vitamin content calcium, 33; phosphorus, 415, iron, 1.7; magnesium, 274; potassium, 517; sulphur, 122; copper, 0.82; thiamine, 0.061; riboflavin, 0.081; nicotinic acid, 1.1; vitamin C, 5 mg/100 gm (Wealth of India, X : 43-44)

The seeds yield 30-36 per cent (Kernel, 26-29; middle pulpy layer or testa, 4-7%) of a bland, light-yellow, ratty oil with feeble drying power. The pure kernel-oil is liquid, whereas the oil obtained from the pulpy layer of the testa is a soft, buttery solid. The fatty acid composition of seed oil, from the trees growing in Poona, was : Sterculic, 71.8; linoleic 1.9; oleic, 8.2; lauric, 0.1; myristic 6.6; palmitic, 10.5, and stearic acid, 0.9% (Wealth of India, X: 43-44).

Chapter—2

REVIEW OF LITERATURE

In recent years, the cost of conventional oil cakes have gone very high in the country and as such the cost of feeding farm animals, particularly poultry is increasing day by day. In the domain of poultry industry, feed cost is of paramount importance, as it exploits about 70% of the capital resources involved in this industry. Keeping in mind this burning problem, several attempts have been made by the researchers to find out appropriate, cheaper and convenient sources of different non-traditional feed ingredients in the concentrate mixture. The fruitful utilization of non-traditional feed resources through suitable research evidences will not only help in minimising the feed cost in the arena of poultry nutrition but will serve a lot in accelerating the feed resources of the country to satisfy the nutritional requirements of livestock. Therefore, with this silver lining in view, an effort has been made to review and illustrate the retrospective study so far encountered on the useful utilization of new oil cakes in the field of poultry nutrition which is likely to add a new dimension in the poultry feed industry.

In the present study, an effort has been made to evaluate the nutritive potentiality of Sterculia foetida cake and oil locally known as Jangli badam and Cocos nucifera i.e. Copra cake of expeller type in the ration of broilers. No scientific information is yet been available on the nutritive value of Jangli badam whereas information on the utilization of expeller variety of copra cake are also limited. Due to lack of sufficient information on these cakes the review has been done mostly on the allied cakes to make a comparative study regarding the merits and demerits of such unexplored feed resources, which are furnished below.

Castor meal :

Shrivastava et al. (1988) studied the pathological changes in the liver and kidneys of 675 broiler chicks fed diets containing graded levels of untreated and treated castor meal from 11 to 53 days of age. Broilers fed untreated castor meal or castor meal treated with hexane or ammonia had relatively more degenerative and necrotic changes in the liver and kidneys than those fed with water cooked or autoclaved castor meal. Diets containing low levels of water cooked or autoclaved castor meal replacing 2.5% of the groundnut meal in the reference diet did not cause any significant hepatorenal changes.

Cashew cake :

Babu and Kadirvel (1987) conducted a trial on cashew cake as a poultry feed. Cashew cake contained 27.36% CP, 4.58% EE, 1.52% CF and 5.35% T.A. on fresh matter basis. The diets were made isocaloric and isonitrogenous and the chicks receiving 10 and 20% cashew cake diets gained more than control. The weight gain on 20% cashew cake diet was significantly more ($P < 0.05$) than control. The feed efficiency was also better. The data suggest that cashew cake may be useful feed ingredient in poultry rations. However, it may not be possible to replace groundnut cake, part for part, perhaps because of poor amino acid balance of cashew protein.

Lakshmi pathi et al. (1990) made an attempt to replace 25% of maize in chick ration with cashew apple meal, most of which were going out as waste. Day old White Leghorn laying chicks (60) were divided into 2 groups of 30 chicks each and fed ad-libitum upto 8 weeks of age. The final body weight at 8th week of age between two groups did not differ significantly. The feed consumption was significantly more in the cashew apple group, probably due to more fibre in the mash. The cashew apple group was slightly less efficient in feed conversion than control group. The dry matter digestibility, protein and energy retention were slightly less in cashew apple group. The results indicated the possibility of using

cashew apple meal in chick ration at a level of less than 25% replacement of maize.

Cotton seed meal :

Atuahene et al. (1986) studied the effect of raw cotton seed meal on the performance, carcass characteristics and certain blood parameters of broiler chickens. Three hundred, 7 day-old Bosbek broiler chickens were fed diets containing 0, 2.5, 7.5 and 10% raw cotton seed meal for 9 weeks. Raw cotton seed meal at 5, 7.5 and 10% significantly reduced average weight gain and decreased feed intake in broiler chickens. Feed efficiency and mortality were not affected. There were significant differences among treatment means for dressing percentages, liver and viscera weights, haemoglobin and leucocyte counts. Both income and profit per chicken were highest in the diet containing 2.5% raw cotton seed meal.

El-Boushy and Raterink (1989) conducted a trial on cotton seed meal and peanut meal or on both replacing soyabean meal in low energy diets of broilers. Isoenergetic (ME 2850 KCal/kg) and isonitrogenous (CP 21%) diets containing 20.22% soyabean meal (SBM) or SBM partially or wholly replaced by cotton seed oil meal (CSM) or groundnut oil meal (GNM), or both were given to 936 chickens from hatching to 6 weeks old

Increasing the level of CSM from 0 to 8, 16 or 24% of diet decreased ($P < 0.05$) weight gain and increased ($P < 0.05$) feed gain ratio in chickens at 3 weeks old. Weight gains and feed intakes were improved when diets with 24% CSM (free gossypol 310 mg/kg) were supplemented with iron (600 mg/kg) which had a chelating effect on free gossypol.

Aguilera et al. (1989) found that replacement of soya-bean meal by cotton seed meal - meatmeal or Sunflower meal meatmeal decreased growth rate and efficiency of utilization of protein in Cornish white rock chicken when fed from 0 to 4 weeks of age. Except for the diet based on Sunflower seed meal, supplemented with 0.25% L-lysine, the incorporation of lysine or methionine and lysine tended to give better performance, increasing intake of metabolizable energy and energy retention, with increased protein excretion relative to fat deposition and improved efficiency of utilization of metabolizable energy.

Filter cake :

Abrigo and Gerpacio (1986) reported proximate and mineral composition of filter cake (FC), a by-product of the sugar industry as 92.17% DM, 6.62% crude protein, 46.59% nitrogen free extract, 2.69% calcium and 1.36% phosphorus. In trial 1, filter cake was added to broiler diets to replace

maize at 0, 5.0, 7.5, 10.0 or 15%, all with 22% CP, and in trial 2, FC was added at 0, 7.5, 10.0 and 12.5% of the diet. Results suggest that filter cake can be used in broiler diets at a maximum inclusion rate of 10% without any adverse effect on performance.

Guar meal :

Verma and Singh (1985) showed that Guar meal (GM), a high protein by-product of the guar gum extraction industry when inoculated with spore of Aspergillus sp. and fermented for 60 hours at 30°C in a semisolid system can be included in the ration of poultry. On drying, crude protein content of GM increased from 37 to 42% after fungal fermentation. In a bio-assay with chickens, utilization of Guar meal protein was 36% higher after fermentation.

Nagra and Virk (1986) found that incorporation of guar meal at 10% and mustard cake at 15% in the diet of 1 week old broiler chicks significantly decreased the rate of growth and feed efficiency. Growth rate was slightly improved when guar meal and mustard cake both were given but feed efficiency was not improved.

Khatta et al. (1988) studied the chemical composition and amino acid profile of four varieties of guar seeds (H3-182,

HG-75, HFG-119 and FS-277). The seeds of varieties of HG-75 and HG-182 contained significantly higher amount of CP as compared to other two varieties. HG-75 had highest amount of threonine, Serine and alanine. Valine was highest in variety FS-277. Cystine and methionine were in trace in all the varieties.

Akhtar et al. (1990) studied the feasibility of autoclaved guar meal in chick ration. A total of 120 chickens were given isonitrogenous and isoenergetic starter rations containing 0, 10, 15 or 20% autoclaved guar meal for 4 weeks and finisher ration containing 0, 5, 10 or 15% autoclaved guar meal for 2 weeks. Weight gain, feed intake and feed efficiency were similar between groups indicating no deleterious effect of autoclaved guar meal.

Mango seed Kernel :

Das et al. (1988) carried an experiment to find out the suitability of inclusion of mango seed kernel in chick ration. Diets containing 0, 5, 10 and 20% mango seed kernel (MSK) and 10 and 20% washed MSK (WMSK) replacing maize were fed for 8 weeks to 240 day old male. White Leghorn chicks. MSK contained crude protein 5.33%, ether extract 11.12%, crude fibre 2.46%, calcium 0.37%, phosphorus 0.25% and tannin 8.9% on DM basis. WMSK had 51% of the tannin content removed. Increasing

level of MSK in the diet decreased growth rate, blood glucose and plasma protein concentrations, caused hypercholesterolaemia and pathological changes in the tissues. Chicks having diets with 0 and 5% MSK and 10% WMSK had normal organ histology, but those with 10% MSK and 20% WMSK had changes only in the liver.

Niger cake :

Samanta and Biswas (1987) studied the effect of replacement of GNC with deoiled niger cake in broiler ration. The results indicated that the chicks fed with 0, 25, 50 and 100% deoiled niger cake replacing GNC have no significant difference in weight gain, feed consumption and feed efficiency upto 8 weeks of age. Though at 100% replacement of deoiled niger cake, the weight gain and feed consumption were statistically insignificant. Feed efficiency was also poor at 100% replacement. They concluded that deoiled niger cake could safely replace deoiled GNC in broiler ration upto 50% level i.e. 12.5% parts of deoiled niger cake could be incorporated without any toxic effect.

Sarkar et al. (1987) studied the utilization of deoiled niger cake by starting chicks. Deoiled niger cake (NCD) which contained 37.15% crude protein was included in the diet of unsexed WL chicks at different levels replacing deoiled

groundnut cake nitrogen (i.e. isonitrogenously) in proportions of 0, 20, 30 and 40% in experiment 1 and 0, 40, 60, 80 and 100% in experiment 2. The performance of chicks indicated that NCD could safely be included in diet upto a maximum level of 18.65% replacing 60% groundnut cake nitrogen of reference diet. The N-corrected ME values of NCD by practical diet method was found to be 2.054 KCal/gm.

Maiti and Biswas (1991) reported that deoiled niger cake (DNC) contained CP, 37.71; EE, 1.90; CF, 18.07; total ash, 12.24; NFE, 30.28; Ca, 0.93; and P, 1.21 on percent drymatter basis. DNC was quite rich in protein like other conventional oil cakes but was high in CF (18.07%). This DNC was included in the ration by replacing groundnut cake protein at 0, 25, 50, 75 and 100% levels on isonitrogenous and isocaloric basis. The experimental birds were fed the reference and test diets from 127 days of age, the data were collected from 181 to 280 days of old. The data indicated that the inclusion of DNC substituting DGNC protein upto 75% level had no adverse effect on egg production, egg weight, feed consumption per dozen of eggs and feed consumption per kg egg weight. Egg quality traits studied also did not reveal any adverse effect with inclusion of DNC substituting DGNC upto 100% level. However, at 100% level of replacement, significantly lower egg weight was observed.

Oak seed :

Upreti et al. (1988) reported that Oak seed contained 89.92% dry matter; 3696 KCal/kg of GE, 8.25% of crude protein, 1.59% crude fibre, 2.56% ether extract, 84.73% NFE and 2.87% total ash on DM basis. They have reported the tannin content of Oak seed as 6.00% and incorporated ground oak seed in starter diets at 5, 10 and 15% levels in place of maize of the control ration. The results indicate that the weight gain of chicks in control diet were significantly higher than that of others. Feed consumption was significantly reduced with the increase in the level of oak seed in the diet from 5 to 10% and above. However, 5% level of inclusion of oak seed did not have any adverse effect on feed consumption, and feed/gain ratio was found to be similar in all the diets. These response might be due to the presence of tannin or some other undetermined deleterious factors in oak seed.

Polanga (Calophyllum inophyllum) oil cake :

Dash et al. (1990) conducted an experiment with Polanga oil cake as feed stuff for broilers. Day-old Red Cornish chicks were fed with diets containing 0, 10, and 15% defatted polanga oil cake (DPOC); 10, 15 and 20% Polanga oil cake (POC) and 1.65% polanga oil (PO) which is equivalent to 20% of POC for 8 weeks of age. Inclusion of DPOC, POC and PO in the diets depressed growth but the depression was not significant upto 15%

inclusion level of DPOC or POC in the ration. The depression was found to be more with POC than DPOC. The results showed that along with calaustralin there might be some other substance(s) which is/are also responsible for growth depression. It was concluded that DPOC may profitably be used upto 15% in the broiler ration despite of slight growth depressing effect.

Rapeseed oil meal :

Gampbell (1988) studied the effect of rapeseed oil meal replacing cotton seed oil meal in wheat based starter and finisher diets. Fourteen hundred day old broilers were fed for 45 days a control diet, or a diet with 15% cotton seed oil meal supplemented with lysine at 0, 3.75 or 4.25 mg/KCal ME (3.13 or 3.55 in finisher diet) or a diet with 15% rapeseed oil meal and similar lysine supplementation, body weight and feed conversion efficiency data showed that 15% rapeseed oil meal was an effective replacement for cottonseed oil meal. Both rapeseed oil meal and cotton seed oil meal when adequately supplemented with lysine gave similar broiler performance as a maize based soyabean meal diet. Poor growth performance of broilers were noted particularly with unsupplemented cotton seed oil meal diet. In a further trial, 1650 broilers were given control, cotton seed oil meal or rapeseed oil meal diets with lysine 0, 3.65, 4.05 or 4.45 mg/KCal ME

(2.82, 3.06 or 3.30 in finisher diets). Optimum growth was with lysine 4.05 and 3.06 mg/KCal ME in starter and finisher diets; respectively.

Arena and Penz (1988) studied the metabolizable energy of rapeseed meal at 21 and 42 days of age using Hubbard broilers giving diets with 0, 20 or 40% rapeseed meal and found decreased metabolizable energy of rapeseed meal with the increase level of inclusion in the diet. Differences were greater at 21 than at 42 days of age. In another experiment, 1 to 56 days old male and female Hubbard chickens were used in 5 groups of 14 with 4 replications and were given diets based on maize without or with 7.5, 15.0, 22.5 or 30% rapeseed meal in part replacement of soyabean meal. Gain in body weight was significantly lower and feed conversion efficiency were greater in 28 days old chickens with diets having 22.5, or 30% rapeseed meal. From 1 to 56 days old, gain and feed efficiency were significantly lower in chickens with 30% meal than that of other groups.

Prabhakari et al. (1992) studied the effect of ghani pressed mustard cake detoxified by the process developed at CFTRI at 10% (Group-B) and 20% (Group C) levels in the diets of broilers from 0-9 weeks of age. The performance and meat quality was compared with control (Group A) without mustard/rapeseed meal and experimental with 10% solvent extracted

rapeseed meal (group D) in respective, isocaloric and isonitrogenous diet. Body weights at 8 weeks of age of A, B, C and D groups were 1.58, 1.61, 1.58 and 1.30 kg and feed efficiency ratio were 2.17, 2.11, 2.17 and 2.34 respectively. They concluded that Ghani pressed mustard cake (CFTRI process) can be included in broiler diets upto a level of 20%.

Rubber seed and Kernels :

Narahari and Kothandaraman (1987) conducted a feeding trial in which White Leghorn pullets were fed diets containing either rubber seeds or kernels, replacing 50% or 100% of dietary yellow maize from 9 to 43 weeks of age. The growth rate during growing period and the age at sexual maturity remained unaffected by the dietary treatments, but the feed efficiency in the rubber kernel groups were better than that of rubber seed group. During laying period, the groups fed with rubber kernel meal showed better body weight gain, feed efficiency and egg production. The group with 30% rubber seed meal recorded the poorest values for the above trial. Feeding rubber kernels to layers had slightly lowered the albumen and yolk quantities but not the shell thickness. Total replacement of maize either with rubber seeds or kernels had resulted in very pale, 'platinum' coloured yolk. However, they were found to be non-toxic to pullets and efficient substitute for yellow maize in grower and layer diets.

Nahar seed meal :

Konwar et al. (1986) conducted an experiment with broiler chicks of either sex incorporating nahar seed meal (NSM) at 8.3, 16.6 and 25.0% levels in starter diets and 8.85, 17.70 and 26.55% levels in finisher diets respectively replacing 15, 30 and 45% of dietary maize of the reference diet. Diets were almost isonitrogenous and isocaloric. The results suggested that NSM can be included upto a level of 26.5% replacing dietary maize in broiler ration without any significant difference ($P > 0.05$) in feed intake, weight gain, feed : gain ratio and dressing percentage.

Safflower meal :

Rehman and Malik (1986) carried out an experiment to find out the suitability of inclusion of safflower meal in broiler rations. A total of 162, day-old chickens were freely fed with diets having soyabean oil meal replaced by 0, 11.3, 23, 35 or 48% safflower meal (diets 1 to 5) or with added lysine @ 0.1, 0.3, 0.4 or 0.5% (diets 6 to 9) respectively. Average weight gain and feed intake were significantly reduced in chickens with diets 3, 4 and 5. Feed conversion efficiency was reduced in chickens with diets 4 and 5. Lysine supplementation increased weight gain, feed intake and feed conversion efficiency suggesting that safflower may be deficient in lysine.

Chaudhary et al. (1989) conducted an experiment with deoiled cakes of Kod-thumba (Citrullus colocynthis), ambadi (Hibiscus cannabinus) and safflower (Carthamus tinctorius) using 12 day-old male commercial hybrid chickens for 6 weeks replacing deoiled groundnut cake and malt sprouts in the control diets. It was observed that diets having upto 15% safflower or ambadi, improved growth as compared to control. 10% Kod-thumba and 20 or 25% safflower reduced ($P < 0.01$) growth, 21 or 23% of the three cakes combined or of safflower and ambadi 1:1 improved ($P < 0.01$) growth whereas 22.5% of Kod-thumba and safflower combined reduced growth.

Sunflower oil cake :

Thyagarajan et al. (1988) studied the performance of broilers fed with ration where groundnut oil cake was completely replaced by Sunflower oil cake (SFoc). The body weight of broilers at 8th week of age was found to be better in ration containing Sunflower oil cake, whereas the feed efficiency was found to be favourable in ration having groundnut oil cake.

Salih and Taha (1989) performed a feeding trial, in which 7 to 42 days old 240 hypro-broiler chickens were fed on diets containing sunflower seed meal @ 0, 100, 200 or 400 gm/kg. Feed intake, live weight gain, feed conversion

efficiency, dressing percentage and mortality were the same in all the groups.

Musharaf (1991) conducted an experiment with day-old, 1152 broiler chickens by providing with isonitrogenous and isoenergetic mash or pelleted diets containing partially decorticated sunflower seed meal at 0, 50, 100, 150, 200 or 250 gm/kg supplemented with lysine and methionine. Sunflower seed meal upto 250 gm/kg gave equal or better body weight gain than the control, soyabean meal diet ($P < 0.01$), but there was a significant lower feed conversion ratio at diet having 250 gm/kg. He concluded sunflower seed meal having high fibre content may also be included @ 250 gm/kg in broiler diets, provided lysine and methionine are supplemented.

Ologhobo (1991) carried out two experiments to find out the effect of substitution of sunflower seed meal for soyabean meal and groundnut meal in practical type broiler diets. Growth and feed efficiency were tested with 0, 25, 50, 75 and 100% soyabean meal (SSM) or groundnut oil meal (GNM) replaced by sunflower oil meal (SM) and fed to broilers for 8 weeks. Substituting SM for SBM at 50, 75 and 100% decreased ($P < 0.05$) weight gain and feed conversion efficiency. Metabolizable energy and nitrogen retention were not affected.

When SM was substituted for GNM, weight gain and feed efficiency did not differ upto 50% substitution. Beyond this level performances of broilers were found to be decreased ($P < 0.05$).

Tamarind seed :

Panigrahi et al. (1999) determined the nutritive value of tamarind seed for broiler chicks and found that whole tamarind seeds (Tamarindus indica) contained crude protein 131.3, crude fibre 67.1, crude fat 48.2, tannins 56.2 gm/kg and trypsin inhibitor activity (TIA) of 10.8, with most of the tannins being located in the testa. They observed that tamarind seeds were poorly utilized by day-old broiler chickens. Processing did not improve their nutritive value and infra-red micronisation produced physical adverse effects in chickens. They also found that chickens fed on diets having tamarind seed had higher water intake than control and pancreas weights, intestinal and caecal length were also increased. They suggested that the primary factor responsible for the poor utilization of tamarind seed might be the indigestible nature of its polysaccharide rather than its tannin content, or the possible presence of other toxins.

Copra cake :

Panigrahi et al. (1987) showed that broiler chicks fed on a diet containing expeller copra cake upto 500 gm/kg of high residual oil content not only retained less DM and gained less weight than those fed on a control diet with no copra, but also experienced difficulty in achieving similar food intake. Chicks given the diet with copra 500 gm/kg initially displayed an excited behaviour pattern, which may have developed out of frustrating as they could neither derived adequate nourishment from their feed nor increase feed intake sufficiently to allow them to achieve their genetic potential for growth. Chicks however, showed considerable adaptation in efficiency of feed-utilization and intake were increased gradually. There were no significant differences in 7 week body weight of chickens fed on the control diets and diets containing copra @ 125 and 250 gm/kg. Although weight gain at the group having 500 gm/kg of copra cake were lower, the carcass of these chicks had less abdominal fat and were consequently leaner.

Sarkar and Banerjee (1987) reported that deoiled coconut oil cake (CNCD) contain 26.23% protein, 10.61% CF, 1.85% EE, 7.32% ash, 53.99% NFE. CNCD was included in the diet for unsexed WL chicks at different levels isonitrogenously replacing deoiled groundnut cake (GNCD) nitrogen. The performance

of the chicks indicated that CNCD could safely be included in diet upto a maximum level of 8.58% replacing 20% GNCD nitrogen of reference diet, inclusion at higher level resulted poor feed efficiency. N-corrected ME values by practical diet method was found to be 1.605 KCal/gm.

Iennerts (1988) estimated the nutrient contents of different copra cake. Crude protein was found to be 20 to 21% for expeller cakes with 4 to 8% fat and oil meal contained lysine 2.4 to 2.4, methionine plus cystine 2.9 to 3.8, tryptophan 0.8 to 1.6, threonine 3.3 to 3.4, arginine > 10 and leucine > 6%. Cellulose was relatively high and lignin content was low. Minerals exceeded 6%, values for K and P were from 1.8 to > 2 and from 0.53 to 0.58, for Mg atleast 0.3 and for Ca only 0.15%. Main trace elements were Fe and Mn with > 450 and 64.9 to 73.5 mg/kg, followed by Zn, Cu and Co. The nicotinic and pantothenic acid contents of cake were found to be 26 and 6 mg/kg respectively.

Teves et al. (1988) found that copra meal when hydrolysed by mannanase from Streptomyces sp. no.17, contained a significant lower crude fibre and increase in the apparent digestibility of dry matter, crude protein, crude fat and increase apparent metabolizable energy. Although there was no marked difference in feed consumption by broilers, improved ed

weight gain and efficiency of feed utilization were observed with mannanase treated meal.

Querubin et al. (1989) performed a feeding trial in which 10 day-old, Pilch broiler chickens were fed on a booster broiler diet containing 22% CP; from 11 to 28 days old the chickens received a starter diet containing 20% crude protein based on maize, soyabean and rice bran or on maize, soyabean and copra meal without or with supplementary lysine, methionine, threonine and tryptophane. The finisher diet given from 29 to 46 days old contained 18 or 16% CP. The added amino acids significantly increased weight gain and protein efficiency ratio. Amino acids given with the diet containing 18 and 16% CP gave a better growth performance than that of the diet having maize, soyabean and rice bran supplemented without or with amino acid containing 20 or 18% CP. They concluded that the diet containing 20 or 30% copra meal and supplemented with the amino acids gave similar results to the diet of maize, soyabean and rice bran with no added amino acids. Supplementary amino acids slightly increased average dressing percentage, with little or no effect on the liver, gizzard or heart weights.

Panigrahi (1992) obtained copra meals with residual lipid contents of 75 and 220 gm/kg by double (low and high

pressure) screw press expelling and by single press (moderate pressure) respectively. In his experiments 1 and 2, 24 Ross-I broilers were given experimental diets from 1-3 week old. In experiment I, diets contained low and high lipid copra meals supplemented with lysine 12.4 plus methionine + cystine 8.3 gm/kg or lysine 13.5 plus methionine + cystine 9.0 gm/kg. Weight gain was significantly affected by lipid content of copra meals and by level of amino acid supplementation and gain were 441 and 386 gm for the low lipid copra meals and 486 and 441 gm for the high lipid copra meal with low and high amino-acid supplementation, respectively. In experiment 2, the low lipid copra meal and low amino acid diet was supplemented with methionine @ 1.25 and/or lysine 1.66 gm/kg. He reported that supplementary amino acids did not affect weight gain of birds.

Chapter—3

MATERIALS AND METHODS

PART - I

STUDIES ON JANGLI BADAM (Sterculia foetida)

Experiment - 1

Evaluation of expeller Jangli badam cake in broilers

I) Chemical composition of Jangli badam (Sterculia foetida)

cake :

Object : To ascertain the feasibility of Jangli badam cake in broiler ration, chemical analysis of Jangli badam cake was done.

Methods Jangli badam cake as used in the present experiment was procured from Kalyani, West Bengal. The cake was the pure one after extraction of the oil by expeller method. The representative samples of oil cake was grounded thoroughly and preserved in screw capped bottle for subsequent analysis. For chemical analysis, four samples were taken randomly and the values recorded here are the averages of the four samples.

Dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF), nitrogen free extract (NFE) and total ash (TA)

content of the cake were estimated by the methods as suggested by AOAC (1975) whereas calcium (Ca) and phosphorus (P) contents of the samples were done by the modified methods of Talapatra et al. (1940).

II) Assessment of feeding value of Jangli badam cake in broiler ration :

Object : An attempt was made to find out the effects of feeding Jangli badam cake at different levels of inclusion by replacing basal portion of the concentrate mixture for determining its feeding value on the basis of growth and feed efficiency of broilers.

Experimental design

Day-old 'VENCOB' broiler chicks one hundred in number were collected from Midnapore Hatcheries, Calcutta for the purpose of this study. The birds were individually weighed, wing banded and randomly distributed in five groups of 20 chicks having two replicates (i.e. 10 chicks in each replicate). The composition of reference ration is presented in Table 2.1. Experimental rations were prepared by replacement of basal portion of the reference ration by Jangli badam cake at different levels as shown hereunder.

Table - 2.1 Composition of reference ration for broilers
(on per cent)

Ingredients	Starters	Finishers
<u>Basal :</u>		
Maize	60.00	63.00
Soyabean meal (yellow)	14.50	13.50
Fish meal	12.00	12.00
Til cake (Black)	10.00	8.00
	<u>96.50</u>	<u>96.50</u>
<u>Additives :</u>		
Dicalcium phosphate	1.500	1.500
Mineral mixture ⁽¹⁾	1.705	1.705
Trace mineral mixture ⁽²⁾	0.045	0.045
Rovimix (A ₂ B ₂ D ₃) ⁽³⁾	0.025	0.025
Rovibe ⁽⁴⁾	0.025	0.025
Choline chloride (50%)	0.200	0.200
	<u>3.500</u>	<u>3.500</u>
Crude protein % (DM basis)	21.43	20.58
Calculated ME/KCal/kg	2833.75	2858.45

- (1) Composition of Mineral Mixture (in percentage): Ca - 28.00%, P - 5.00%, Mg - 0.025%, Fe - 0.6%, Cu = 0.01%, Mn = 0.25% Zn - 0.21%, Co - 0.005%, NaCl - 10%, I = 0.001%
- (2) Composition of trace mineral mixtures: MnSO₄, H₂O = 22.0gms, Fe₂SO₄, 7H₂O = 15.0 gms, CuSO₄, 5H₂O = 2.0 gms, ZnCO₃ = 6.0 gms.
- (3) Composition of Rovimix (A₂B₂D₃) : Each gm of the product contained Vit.-A - 40,000 I.U., Vit.-B₂ - 25 mg; Vit.-D₃ - 5,000 I.U.
- (4) Composition of Rovibe : Each gm of the product contained Vit.B₁ - 4 mg, Vit.-B₆ - 8 mg, Vit. B₁₂ - 40 µg, Niacin - 60 mg, Ca-Pantothenate - 40 mg, Vit.C - 40 mg.

- Group- 1 (T_1) : Control diet (without any Jangli badam cake)
- Group- 2 (T_2) : 10% of the basal portion of the control ration was replaced by Jangli badam cake.
- Group- 3 (T_3) : 20% of the basal portion of the control ration was replaced by Jangli badam cake.
- Group- 4 (T_4) : 30% of the basal portion of the control ration was replaced by Jangli badam cake.
- Group- 5 (T_5) : 40% of the basal portion of the control ration was replaced by Jangli badam cake.

Housing and Management :

All the birds were housed in electrically heated battery brooders having thermostatic control with raised screen floors. Each replicate of 10 birds were placed in separate battery having equal floor space. The battery brooders which were previously disinfected and cleaned were kept side by side in a clean ventilated room. Provision for light was made with electric bulbs. At 28th day of age, the birds were shifted to Californian cages.

Feeding and Watering :

The broiler chicks were offered accurately weighed quantity of reference and test diets meant for respective groups twice daily to ensure ad libitum feeding. Left over

residue in the feeding troughs was quantitatively collected every day and duly subtracted from the total feed offered during the previous 24 hours, to get the net feed consumption of each replicate.

The water pots were cleaned every day and kept filled with clean and wholesome water to ensure ad libitum intake.

Duration of the experiment :

This growth study in broiler chicks were carried out upto 8 weeks age of the birds.

Parameters studied :

The following parameters were recorded during the experimental period.

- a) Initial body weight of all the experimental birds individually at the beginning of experiment followed by weekly intervals during the whole experimental period.
- b) Mortality number of the birds.
- c) Average total body weight gain per bird in T₁ group (control) and T₂ group (10% replacement) during the whole experimental period as well as weekly weight gain per bird. (all the birds of the other groups died during the experimental period).

- d) Weekly feed consumption in T₁ and T₂ groups.
- e) Total feed consumption in T₁ and T₂ groups for the entire experimental period.
- f) Feed efficiency ratio (FER)

III) Pathological study of vital organs on feeding Janqli badam cake to broilers :

Objective : To find out the toxic effect of feeding Janqli badam cake at different levels of inclusions in the ration on the vital organs of broiler chicks.

Methods : The dead birds of groups T₂, T₃, T₄ and T₅ were necropsied and gross pathological lesions were recorded.

Internal organs like liver, kidney and heart from the dead birds of all the groups were preserved in 10% neutral formalin saline, processed through ascending grades of alcohol, cleared in cedarwood oil, embedded in paraffin, and sectioned at 4 - 5 μ thick and stained with haematoxylin and eosin (Lillie, 1954) for further observations.

Experiment - 2

Studies on Jangli badam (Sterculia foetida) oil in broilersI) Chemical composition of Jangli badam oil :

Object : To ascertain the feasibility of Jangli badam oil in broiler ration, chemical analysis was done.

Methods : Jangli badam oil used in this experiment was pure one and procured from Kalyahi, West Bengal. Physical and chemical analysis of oil was done from Italab Pvt. Ltd., Calcutta whereas fatty acids composition analysis was done from Department of Soil Science and Agricultural Chemistry, BCKV by the method of gas liquid chromatography technique as described in the grazzetta ufficiale (1981).

II) Feeding value of Jangli badam (Sterculia foetida) oil in broiler finisher diet :

Objective : As the Jangli badam cake was of expeller variety and cause partial mortality of the chicks at 10% replacement and 100% mortality in 20, 30 and 40% levels of inclusion replacing basal portion of the reference ration (Experiment - 1), the present experiment was designed to find out whether the toxin/deleterious factor is present in the oil portion of the cake or elsewhere. For this purpose, pure jangli badam oil was mixed with the broiler finisher ration.

The dose of mixing was the same as was likely to be present in the rations of experiment - 1 containing 10, 20, 30 and 40% expeller variety of jangli badam cake.

Experimental design : Forty, day-old "VENCOB" broiler chicks were collected from Midnapore hatcheries, Calcutta along with the previous lots of chicks (experiment-1). The birds were reared upto 4 weeks of age on control ration. They were then individually weighed, wing banded and randomly distributed having 10 chicks in each of the four experimental group. The control group was common as in Experiment - I.

The broiler chicks were fed with finisher diet (Table - 2.1) and the experimental diets were prepared by mixing calculated amount of pure jangli badam oil as discussed earlier.

Group-1 (T_1) : Control diet (without any jangli badam oil).
The birds of experiment-I was used here also.

Group-6 (T_6) : 5.6 gms of jangli badam oil was mixed (as jangli badam cake contain 5.6% EE) with each kg of broiler finisher ration.

Group-7 (T_7) : 11.2 gms of jangli badam oil was mixed with each kg of broiler finisher ration.

Group-8 (T₈) : 16.8 gms of jangli badam oil was mixed with each kg of broiler finisher ration.

Group-9 (T₉) : 22.4 gms of jangli badam oil was mixed with each kg of broiler finisher ration.

Experimental period : The experiment was conducted from 4 to 8 weeks age of the birds.

Parameters studied :

The following parameters were recorded during the experimental period.

- a) Initial body weight of all experimental birds individually at the beginning of experiment followed by weekly intervals during the entire experimental period.
- b) Mortality number of birds on feeding with different levels of jangli badam oil.
- c) Average total body weight gain per bird as well as weekly weight gain per bird.
- d) Weekly feed consumption as well as total feed consumption per bird for the entire experimental period.
- e) Feed efficiency ratio (FER).

III) Pathological study of vital organs after feeding janqli badam oil with broiler finisher ration :

Objective : To find out the toxic effect of feeding janqli badam oil at different quantities in the finisher ration on the vital organs of broiler chicks.

Methods : All the dead and slaughtered birds of groups T₁, T₆, T₇, T₈ and T₉ were necropsied and gross pathological lesions were recorded.

Internal organs like liver, kidney and heart of all groups of birds were preserved in 10% neutral formalin saline and then histopathological examination was performed by the method as suggested by Lillie (1954).

Statistical methodology : All the data developed in this experiment were subjected to statistical analysis as per Snedecor and Cochran (1967).

Part - II

STUDIES ON EXPELLER VARIETY OF COPRA (Cocos nucifera)
CAKE IN BROILERS

Experiment - 1

Feeding value of expeller copra cake in broilers

I) Studies on the chemical composition of expeller variety
copra (Cocos nucifera) cake

Objective : Chemical composition of expeller variety of copra cake will represent its nutritive value as a feed ingredient. To ascertain the possibility of utilization of expeller copra cake as a protein source, in replacement of other conventional oil cake like til cake (red) at different levels in the ration of broilers, it was subjected to chemical analysis.

Methods : Expeller copra cake as used in this experiment, was supplied by Shalimar coconut oil mill, Calcutta. For chemical analysis, the representative samples of oil cake was grounded thoroughly, four samples were taken randomly and preserved in screw capped bottle for further analysis.

The estimation of DM, CP, EE, CF, NFE, TA & acid insoluble ash were carried out by the usual chemical methods as

suggested by AOAC (1975), whereas calcium and phosphorus contents of these material were estimated by the modified methods of Talapatra et al. (1940).

II) Effect of feeding expeller copra cake as a protein source in broiler ration on isonitrogenous replacement of Til cake (red) at different levels on growth and feed efficiency :

Objective : An attempt was made to study the effect of feeding expeller variety of copra cake as a protein source on isonitrogenous replacement of red til cake at different levels on the growth and feed efficiency of broilers.

Experimental design :

Eighty, day-old 'HUBBARD' broiler chicks were collected from Arambag Hatcheries, Calcutta. The birds were individually weighed, wing banded and distributed in four groups of twenty chicks each. Each group was further sub-divided into two replicates having 10 chicks in each replicate. One group was fed with control diet, whereas other groups were fed with experimental diets as mentioned below :

Group-1 (T_1) : Control diet containing 10% red til cake

Group-2 (T_2) : 20% protein of red til cake present in the control ration was replaced by expeller copra cake.

Group-3 (T_3) : 40% protein of red til cake present in the control ration was replaced by expeller copra cake.

Group-4 (T_4) : 60% protein of red til cake present in the control ration was replaced by expeller copra cake.

The addition of extra amount of copra cake in the experimental diets due to its low protein content in comparison to red til cake was adjusted by lowering the amount of tapioca milk residue (TMR) in respective diets.

The composition of broiler starter and finisher rations were furnishes in Table 2.2 and 2.3 respectively.

Experimental period :

Duration of this experiment was upto 6 weeks of age of broilers, of which first 4 weeks were fed with broiler starter diets and the last 2 weeks were fed with the broiler finisher diets.

Parameters studied :

The following parameters were recorded during the experimental period.

Table - 2.2 Composition of broiler starter ration with different levels of expeller copra cake (percentage)

Ingredients	Control ration (T ₁)	20% replace- ment (T ₂)	40% replace- ment (T ₃)	60% replace- ment (T ₄)
<u>Basal :</u>				
Maize	57.00	57.00	57.00	57.00
Tapioca milk residue (TMR)	3.00	2.20	1.40	0.60
Soyabean meal (yellow)	14.50	14.50	14.50	14.50
Til cake (red)	10.00	8.00	6.00	4.00
Copra cake (expeller)	0.00	2.80	5.60	8.40
Fish meal	12.00	12.00	12.00	12.00
<u>Additives:</u>				
Dicalcium phosphate (DCP)	1.500	1.500	1.500	1.500
Mineral mixture ⁽¹⁾	1.705	1.705	1.705	1.705
Trace mineral mixture ⁽²⁾	0.045	0.045	0.045	0.045
Choline chloride (50%)	0.200	0.200	0.200	0.200
Rovimix AB ₂ D ₃ ⁽³⁾	0.025	0.025	0.025	0.025
Rovibe ⁽⁴⁾	0.025	0.025	0.025	0.025
Crude protein %(on DM basis)	22.26	22.24	22.22	22.20
Calculate ME (KCal/kg)	2728.25	2728.54	2728.83	2729.12

(1) Composition mineral mixture (in percentage); Ca - 28.00%, P - 5.00%, Mg - 0.025%, Fe - 0.6%, Zn - 0.21%, Cu - 0.01%, Co - 0.005%, NaCl - 10%, Mn - 0.25%, I - 0.001%.

(2) Composition of trace mineral mixture : MnSO₄·H₂O - 22.00 gms, Fe₂SO₄·7H₂O - 15.00 gms, ZnCO₃ - 6.00 gms, CuSO₄·5H₂O - 2.00gms

(3) Composition of Rovimix AB₂D₃ : Each gm of the product contained: Vit.A - 40,000, I.U., Vit. B₂ - 25 mg, Vit.D₃ - 5,000 I.U.

(4) Composition of Rovibe - Each gm of the product contained : Vit B₁ - 4 mg, Vit B₆ - 8 mg, Vit B₁₂ - 40 µg, Niacin - 60 mg, Ca - Pantothenate - 40 mg and Vit.C - 40 mg.

Table - 2.3 Composition of broiler finisher ration with different levels of expeller copra cake (percentage)

Ingredients	Control ration (T ₁)	20% replacement (T ₂)	40% replacement (T ₃)	60% replacement (T ₄)
<u>Basal :</u>				
Maize	59.00	59.00	59.00	59.00
Tapioca milk residue (TMR)	3.00	2.20	1.40	0.60
Soyabean meal (yellow)	12.50	12.50	12.50	12.50
Til cake (red)	10.00	8.00	6.00	4.00
Copra cake (expeller)	0.00	2.80	5.60	8.40
Fish meal	12.00	12.00	12.00	12.00
<u>Additives :</u>				
Dicalcium phosphate (DCP)	1.500	1.500	1.500	1.500
Mineral mixture ⁽¹⁾	1.705	1.705	1.705	1.705
Trace mineral mixture ⁽²⁾	0.045	0.045	0.045	0.045
Choline chloride (50%)	0.200	0.200	0.200	0.200
Rovimix AB ₂ D ₃ ⁽³⁾	0.025	0.025	0.025	0.025
Rovibe ⁽⁴⁾	0.025	0.025	0.025	0.025
Crude protein %(on LM basis)	21.46	21.44	21.42	21.40
Calculated ME (KCal/kg)	2743.25	2743.54	2743.83	2744.12

(1) Composition mineral mixture (in percentage): Ca - 28.00%, P - 5.00%, Mg - 0.025%, Fe - 0.6%, Zn - 0.21%, Cu - 0.01%, Co - 0.005%, NaCl - 10%, Mn - 0.25%, I - 0.001%.

(2) Composition of trace mineral mixture : MnSO₄.H₂O - 22.00 gms, Fe₂SO₄.7H₂O - 15.00 gms, ZnCO₃ - 6.00 gms, CuSO₄.5H₂O - 2.00gms

(3) Composition of Rovimix AB₂D₃: Each gm of the product contained: Vit.A - 40,000 I.U. Vit B₂ - 25 mg, Vit.D₃ - 5,000 I.U.

(4) Composition of Rovibe - Each gm of the product contained : Vit B₁ - 4 mg, Vit B₆ - 8 mg, Vit B₁₂ - 40 µg, Niacin - 60 mg Ca - Pantothanate - 40 mg and Vit.C - 40 mg.

- a. Initial body weight of all the experimental birds individually at the beginning of the experiment followed by weekly intervals during the entire experimental period of 6-weeks.
- b. Average total body weight gain per bird per group as well as weekly weight gain per bird.
- c. Weekly feed consumption per bird.
- d. Total feed consumption per bird for the entire experimental period.
- e. Feed efficiency ratio (FER).

III. Effect of feeding copra cake on cut-up parts, slaughter characteristics and organs of broilers :

Objective : To study the effect of feeding copra cake on carcass quality and cut-up parts of broilers.

Slaughtering method :

Four birds of each group at the end of experiment (at the age of 44 days), were starved over night to empty their crops and sacrificed for cut-up parts and haematological studies. During starvation, water was supplied ad libitum. Before slaughtering body weight of the birds were taken

carefully to obtain eviscerated percentage. Weight of different cut-up parts, including organs were taken to obtain percentage of cut-up parts as compared to eviscerated weight, and organ weight as compared to percentage of live weight.

The birds were slaughtered by stunning method (i.e. by detaching atlanto-occipital joints) and allowed to bleed till death. Blood samples were collected in the test tube for haematological studies. Subsequently, the birds were dressed by removing the feathers, skin and wings partly. The feet were removed at the hock joint and wings at the Carpo-metacarpal joint. A cut was made below the keel bone to separate the viscera. Inedible offals like intestine, spleen, lungs, trachea, esophagus, genital tract, etc. were removed. Giblets consisting of heart, liver and gizzard were also cleaned and weighed to obtain giblet percentage as well as eviscerated percentage.

The eviscerated carcasses were used for the measurement of percentage of cut-up parts like breast, neck, wing, trunk, thigh and drum-stick. The thigh were removed at the junction of ileum, the wings were separated at the junction of humerus and scapula whereas, the neck was dissected at the junction of last cervical and first thoracic vertebra.

IV) Effect of feeding expeller copra cake on haematology of broilers

Object : To observe the haematological changes of broilers, if any on feeding with different levels of expeller copra cake.

Methods : For haematological studies, blood samples were collected from four birds in each group in the test tube containing anticoagulant, ethylenediaminetetracetic acid (EDTA) while slaughtering at the end of 44 days growth trial and were used for determining the following parameters.

- a) Erythrocyte sedimentation rate (ESR mm/1st hour)
- b) Packed cell volume (PCV in percentage)
- c) Haemoglobin (Hb in gm/100 ml)

Experiment - 2

Determination of metabolizable energy (ME) value of expeller copra cake

Object : Much importance has been laid on the ME value of different feed-stuffs as this measure of energy has been found to be of practical significance in poultry nutrition. The object of this study was, therefore, to determine the ME value of expeller copra cake.

Procedure : Day-old 'HUBBARD' broiler chicks fifty in number obtained from Arambag Hatcheries, Calcutta, were used in this study. The birds were weighed, wing banded and randomly distributed in duplicate groups of 8 chicks each and put in electrically heated, thermostatically controlled battery brooder with raised screen floors, having suitable provisions for supplying of feed and water. The chicks were fed the reference and test rations from 0 to 28 days of age. Feed and water were supplied ad-libitum.

The ME value of expeller copra cake was determined by the practical type method as described by Sibbald and Slinger (1963). The composition of the reference ration used was the same as reference broiler starter ration (diet-T₁) presented in Table - 2.2.

While preparing the reference diet every efforts were made to meet the requirements of protein, energy, minerals and vitamins. The test rations were formulated from the reference ration by substituting the expeller copra cake, for part of the basal portion of the reference ration on weight by weight basis. The additives portion was kept constant for all the diets. The levels of substitutions of expeller copra cake were 20% and 30%.

Diet - A : Practical type reference ration.

Diet - B ; Copra cake (expeller) replaced 20% of the basal portion of the practical type reference ration.

Diet - C ; Copra cake (expeller) replaced 30% of the basal portion of the practical type reference ration.

Proper grinding and thorough mixing of various ingredients of basal fractions were ensured in order to prevent pick and choose of a particular ingredient by the birds. The additive portion was directly grounded as required and mixed with the ration thoroughly to ensure complete and uniform mixing while preparing the diets.

The metabolic trials were conducted for three days on 26th, 27th and 28th day of age of the birds during a four week experimental period employing total collection technique. Excreta samples were collected at 24 hours intervals and three 24 hours collections from each replicate were pooled and maintained in the frozen state until processed for analysis.

Processing of excreta :

The pooled excreta samples were thoroughly mixed with the addition of a solution of 2% HCl containing CuSO_4 . The samples were then dried in an electrical oven at $75-80^\circ\text{C}$ for 72 to 80 hours. The dried materials were then exposed to the atmosphere overnight and weighed. It was subsequently ground

for further analysis. The procedure adopted for proximate analysis of feed and excreta were the same as recommended by AOAC (1975). The gross energy value of feed and excreta were determined by chemical composition multiplying by Atwater's Physiological fuel values.

The method for calculation of classical ME values for experimental diets was that of Sibbald et al. (1960); the nitrogen corrected ME values were that of Hill et al. (1960); while the ME values of test ingredient was found out by the method as applied by Sibbald and Slinger (1963) for practical type diets.

Statistical Methodology :

All the data developed here were subjected to statistical analysis by one way analysis of variance as per Snedecor and Cochran (1967).

Chapter—4

RESULTS AND DISCUSSION

PART - I

Studies on Jangli badam (Sterculia foetida)

Experiment - 1

Evaluation of Expeller variety of Jangli badam cake in broilersI) Chemical composition of Jangli badam cake (Expeller)

The chemical composition of expeller variety of Jangli badam cake was done to assay its nutritive value as well as feasibility of its use in broiler ration. The chemical composition is presented in Table - 4.1

Table 4.1 Chemical composition of expeller jangli badam cake
(on percent dry matter basis)

Nutrients	Percentage
Dry matter (DM)	93.10
Crude protein (CP)	8.51
Ether extract (EE)	6.01
Crude fibre (CF)	19.92
Total ash (TA)	4.59
Nitrogen free extract (NFE)	60.97
Calcium (Ca)	0.28
Phosphorus (P)	0.54

From the Table 4.1, it was evident that the crude protein, ether extract, crude fibre, total ash, nitrogen free extract, calcium and phosphorus contents of Jangli badam cake (expeller) was 8.51%, 6.01%, 19.92%, 4.59%, 60.97%, 0.28% and 0.54% respectively. From the chemical composition, it is evident that Jangli badam cake is rich in NFE contents and thereby may be used as an energy rich feed ingredient, though its CF content is also somewhat higher.

II) Assessment of feeding value of Jangli badam cake (expeller) in broiler ration :

This experiment was conducted to find out the effect of expeller Jangli badam cake at different levels of inclusion by replacing basal portion of the ration for determining its feeding value on the basis of growth and feed efficiency of broilers. This growth study in broiler chicks were carried out upto 8 weeks of age and the data are presented in Table - 4.2, Fig. 4.1, while Appendix Table - 4.1 shows the weekly growth pattern of experimental birds.

(a) Change in body weight :

The average body weights of day-old broiler chicks of the experimental birds are 35.50 ± 0.62 , 37.15 ± 0.74 , 36.45 ± 0.87 , 38.20 ± 0.64 and 35.77 ± 0.72 gm in groups

Table - 4.2 Effect of feeding Jangli badam cake (expeller) at different levels on growth, fed efficiency and mortality of broilers

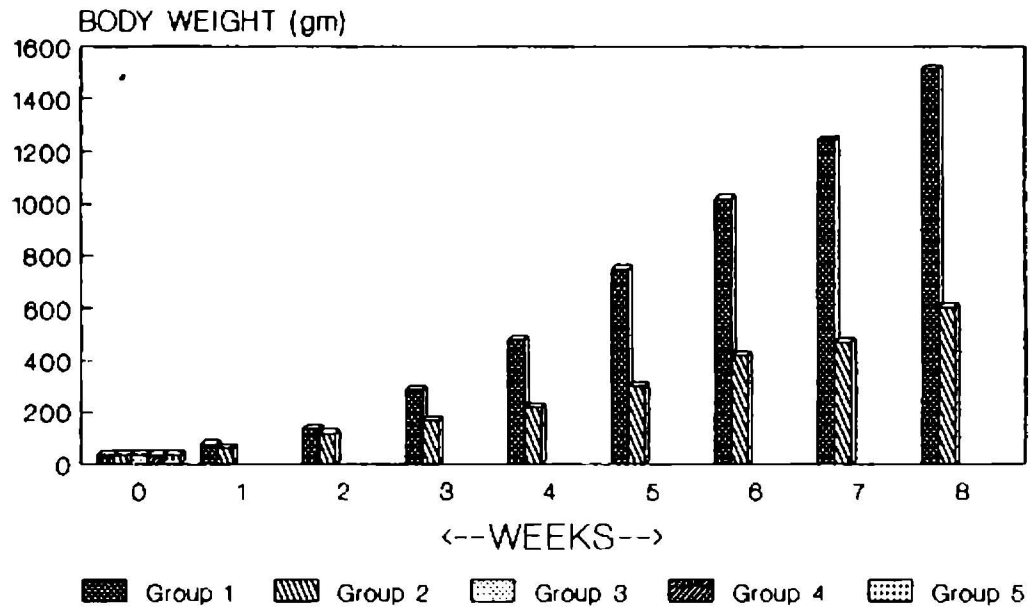
Group	Rep-licas	Av. initial b.wt.	Av. of the repli- cates	Av. final b.wt.	Av. of the two re- plica- tes	Av. of the body wt. gain	Av. of the two re- plica- tes	Av. total feed consu- med	Av. of the two re- plica- tes	Av. feed effi- ciency ratio	Av. of the two re- plica- tes	Mortality (%)
T ₁	A	35.90	35.50	1475.00	1517.50	1439.10	1482.00 ^a	3877.70	3938.23	2.6945	2.66	Nil
	B	35.10	±0.62	1560.00	± 33.69	1524.90	± 42.90	3998.75	± 60.52	2.6223	±0.04	
T ₂	A	37.50	37.15	515.00	609.16	477.50	572.01 ^b		1796.60		3.14	75%
	B	36.80	±0.74	703.33	±77.13	666.53	± 83.57					
T ₃	A	37.30	36.45									100%
	B	35.60	±0.87									
T ₄	A	38.50	38.20									100%
	B	37.90	±0.64									
T ₅	A	35.20	35.77									
	B	36.33	±0.72									

Values bearing different superscript in a column differ significantly (P < 0.01)

* 75% birds were died within 56 days of experimental period, so data of replicates are not available.

** All the birds were died within 6-9 days after starting the experiment, so data are not available.

Fig.4] Average weekly body weight of broilers feeding at different levels of jangli badam cake (expeller)



T₁ (Control), T₂ (10% replacement), T₃ (20% replacement), T₄ (30% replacement) and T₅ (40% replacement) respectively.

All the birds of group T₃ (20% replacement), T₄ (30% replacement) and T₅ (40% replacement) showed the sign like loss of appetite, weakness of the legs, disincline to move, lower their head and drops wing and feathers (Plate - 4.1) and ultimately died within 6-9 days after starting the experiment so that no data is available for final body weight whereas 75% of the birds of group - T₂ died within 56 days of experimental period.

The weekly body weight of T₁ (Control) and T₂ (10% replacement) groups have been presented in Fig. 4.1 and Appendix Table 4.1. The diagram showed that the body weight of T₂ group (with 10% expeller Jangli badam cake) was less than the control throughout the experimental period which might be either due to some growth depressing factor or due to the low protein content of the cake.

The average final body weights after 8 weeks of experimental period were 1517.50 ± 33.69 and 609.16 ± 77.13 gm in groups T₁ (control) and T₂ (20% replacement) respectively.

The data (Table - 4.2) on statistical analysis revealed highly significant ($P < 0.01$) differences between T₁ and T₂ groups.

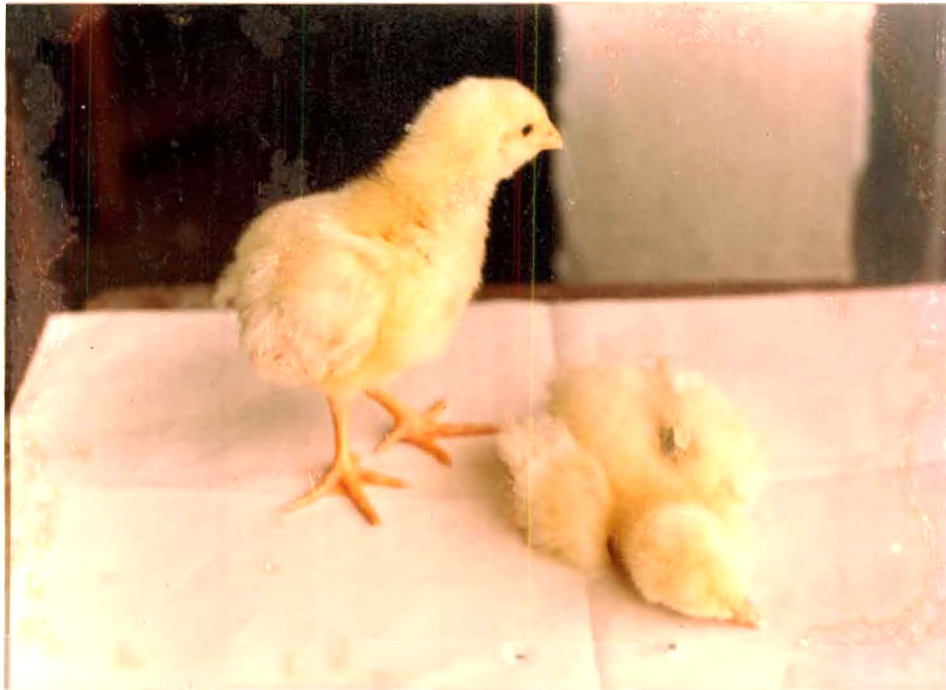


Plate 4.1 Control and treated (T_4) birds after
3 days of experiment

(b) Mortality percentage of the birds :

It has already been stated earlier that in groups T₃, T₄ and T₅ all the experimental birds died within 6-9 days of starting the experiment whereas 75% birds of T₂ died within 56 days of the experiment. The mortality percentage of birds are presented in Table - 4.3 while Fig. 4.2 shows the graphical representation of the same.

Remaining live birds of T₂ showed the symptoms like loss of appetite, poor growth and emaciation, ruffled feathers, incoordination of gait, paleness of comb and wattles. These symptoms might be due to presence of toxin/deleterious substances in the expeller Jangli badam cake. At higher level of inclusion causing 100% mortality of the birds within short time as in case of group - T₃, T₄ and T₅. Subsequently at lower level as in case of group T₂ (10% inclusion) causing 75% mortality and live birds showed the symptom of toxicity.

(c) Effect on feed consumption

The data on feed consumption of T₁ and T₂ groups along with their statistical analysis have been presented in Table- 4.2, Appendix Table - 4.2 and Fig. 4.3.

It was observed from the Table 4.2 that total feed consumed (in gm) per bird were 3938.23 ± 60.52 and 1796.60

Table 4.3 Mortality percentage of broilers feeding at different levels of expeller Jangli badam (Sterculia foetida) cake

Days	T ₂ group		T ₃ group		T ₄ group		T ₅ group	
	No. of birds died	Total mortality % of that day	No. of birds died	Total mortality % of that day	No. of birds died	Total mortality % of that day	No. of birds died	Total mortality % of that day
0								
3			2	10	6	30	10	50
6	5	25	13	65	11	55	10	50
9	3	15	5	25	3	15		
12	2	10						
15								
.								
21	1	5						
24	1	5						
27	1	5						
.								
48	1	5						
.								
56	1	5						

Fig.4.2 Mortality percentage of broilers feeding at different levels of jangli badam cake (expeller)

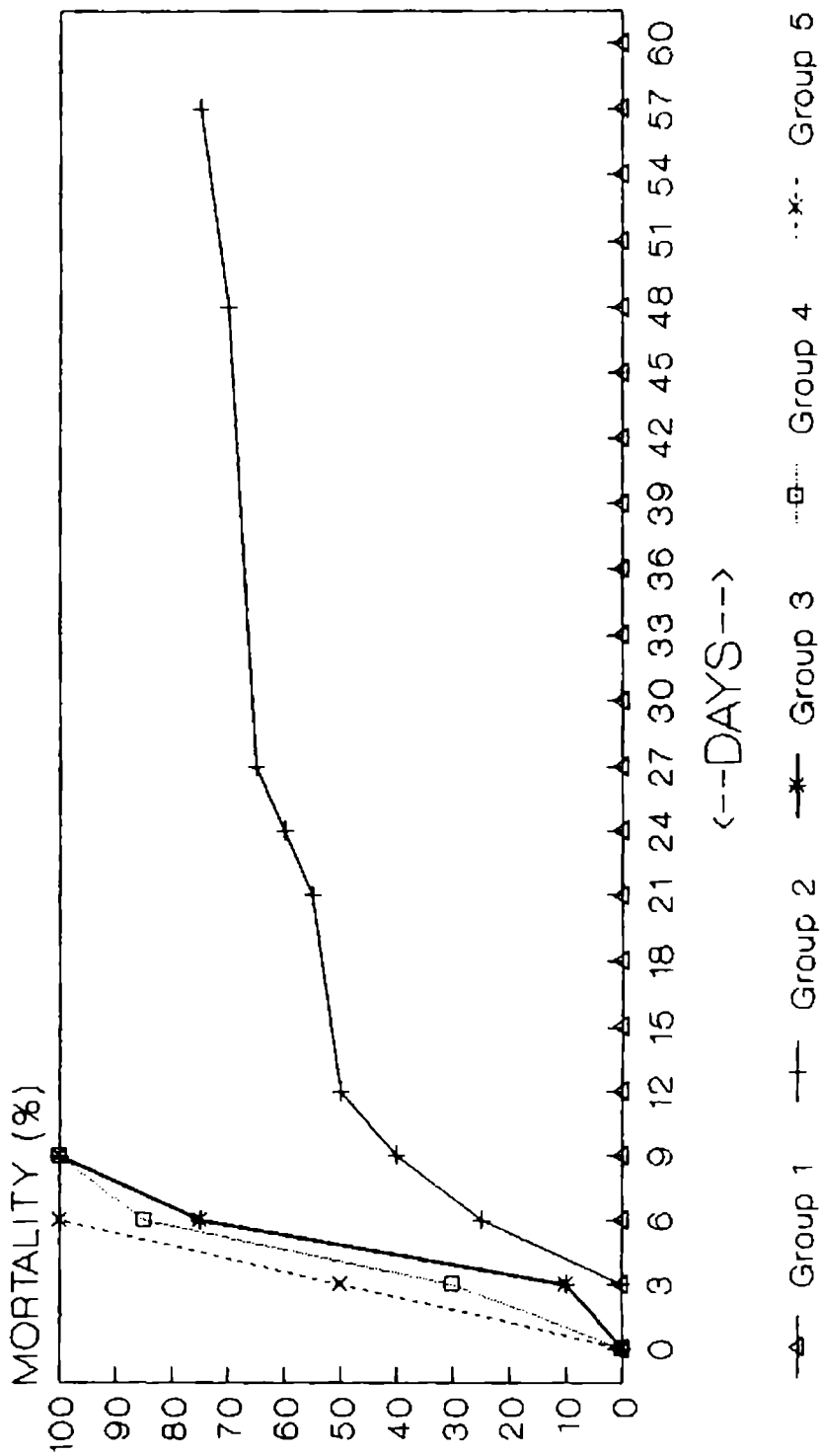
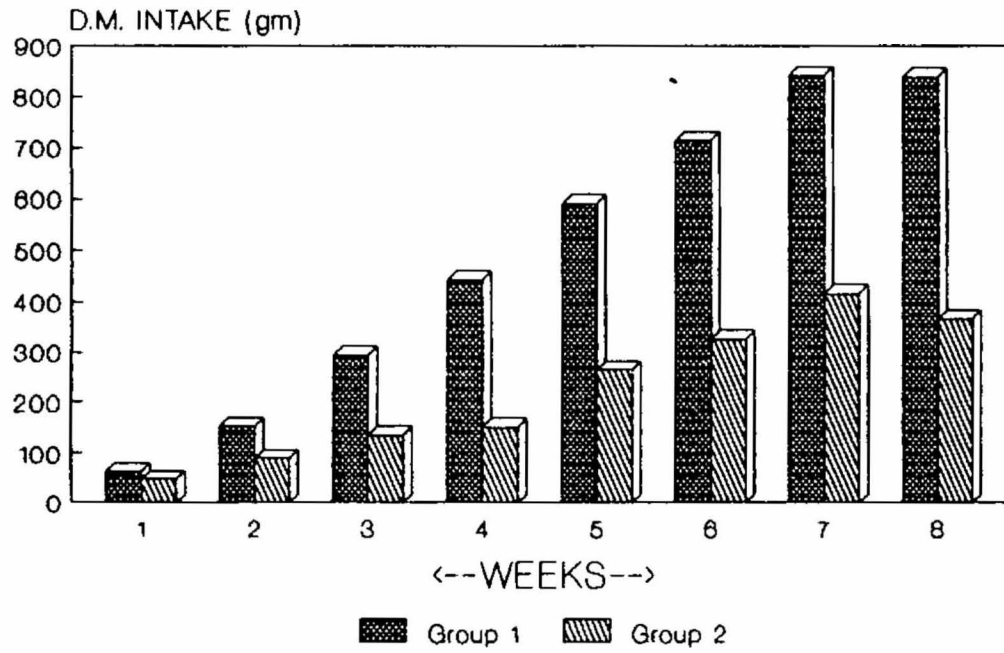


Fig.4.3 Average weekly D.M. intake of broilers feeding at different levels of jangli badam cake (expeller)



in group T₁ and T₂ respectively during the entire experimental period of 8 weeks. The higher feed consumption control group (T₁). It might be due to lower palatability unacceptability of the expeller Janqli badam cake.

The feed efficiency ratio of T₁ and T₂ groups were found to be 2.66 and 3.14.

The poorer feed efficiency of T₂ group might be due to the factors already mentioned earlier while discussing total feed consumption.

Experiment - 2

I) Chemical composition of Janqli badam oil

To ascertain the feasibility of Janqli badam oil in broiler ration, chemical and physical analysis of the pure oil were carried out to determine the quality in respect of edibility. Physically the colour and flavour was just like mustard oil but specific gravity of the oil was somewhat lower than that of mustard oil.

Number of standard assays which were helpful in characterizing the oil has been presented in Table - 4.4.

It is evident from the Table 4.4 that the saponification value of the oil which is inversely correlated with the average chain length of the constituent fatty acids was 187. Saponification value of other oils like groundnut oil, olive oil, rapeseed oil, coconut oil were 186-196, 185-196, 168-179 246-268 respectively.

Table - 4.4 Physico-chemical constants of pure jangli badam oil

Standard assays	Results
Refractive index at 40.0°C	1.4670
Butyro-refractometer reading at 40.0°C	61.7
Iodine value (wijs)	142.5
Saponification value	187.0
Unsaponifiable matter	0.58 percent
Free fatty acid as oleic acid	1.75 "
Moisture and volatile matter	0.05 "
Bellier test (Turbidity temperature Acetic acid method)	16.0°C
Flash point	270.0°C
Test for rancidity	Negative
Test for castor oil	Negative
Test for mineral oil	Negative
Test for sesame oil	Positive
Polybromide test	Negative

Iodine value (an estimate of the relative amounts of unsaturated fatty acids in the triglyceride molecules of the fat) of the Jangli badam oil was 142.5. Iodine value of other oils like groundnut oil, olive oil, rapeseed oil, coconut oil were 83 - 105, 77 - 95, 94 - 105, 8 - 9.5 respectively.

Fatty acids composition of the Jangli badam oil are presented in Table - 4.5

Table - 4.5 Fatty acids composition of Jangli badam oil
(in percentage)

Name of fatty acids	Percentage
Palmitic (RT - 1.77)	12.470
Stearic (RT - 2.68)	3.747
Oleic (RT - 2.87)	4.444
Linolenic (RT - 3.07)	8.514
Linoleic (RT - 3.38)	16.925
11 Eicosenoic acid (RT - 4.76)	9.701
Erucic acid (RT - 8.14)	1.660
Behenic acid (RT - 6.15)	6.089
Arachidic (RT - 4.76)	9.700
Unidentified fatty acid (RT - 7.24)	1.707

It is evident from Table - 4.5 that the Jangli badam oil contains 12.47% palmitic acid, 4.444% oleic acid and 8.514% linolenic which are not desirable characteristics of an edible oil as most of the edible oils contain 4-5% palmitic acid, about 10% oleic acid and 16-17% linolenic acid. Behenic acid is most undesirable fatty acid of an edible oil but Jangli badam oil contain about 6.089% behenic acid. This might be the another cause of non-edibility of this oil. This oil also contains 1.707% of an unidentified fatty acid which may also play some role for non-edibility of the oil.

II) Assessment of feeding value of Jangli badam oil in broiler finisher diet :

As expeller variety of Jangli badam cake cause partial mortality at 10% inclusion and 100% mortality at 20, 30 and 40% levels of inclusion replacing basal portion of the reference ration (Experiment-1), the present experiment was conducted to find out whether the toxin/deleterious factor(s) is/are present in the oil portion of the cake or elsewhere. The effect of feeding pure jangli badam oil by mixing with feed at specific levels on growth, feed efficiency and mortality of broilers were also studied. This experiment was carried from 4 to 8 weeks age of the birds.

The data on growth study are presented in Table - 4.6 Appendix Table - 4.1 and also in Fig. 4.4

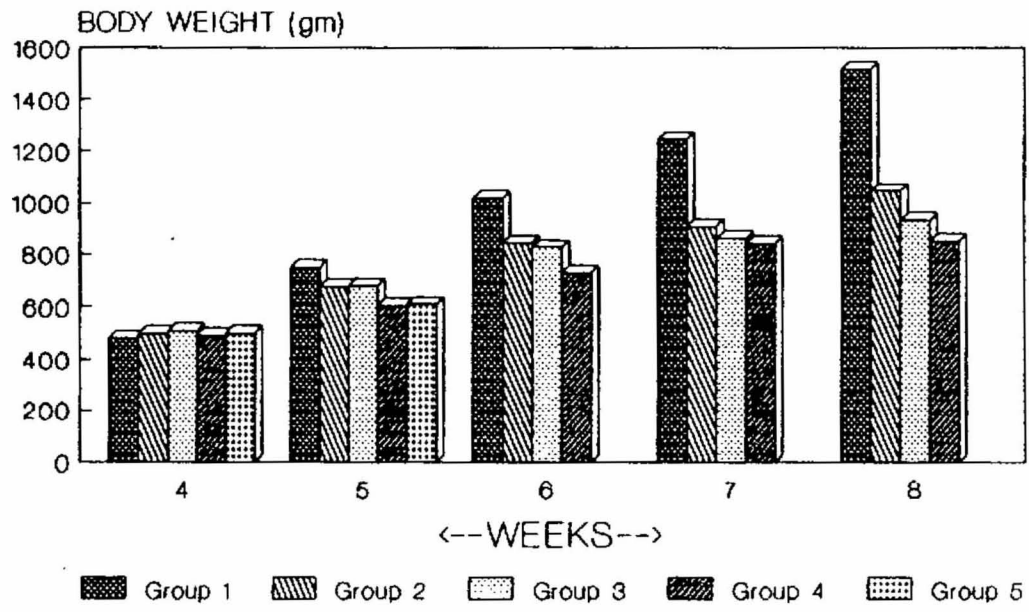
Table - 4.6 Effect of feeding Jangli badam oil at different levels on growth and feed efficiency of broilers

Group	Average initial body weight	Average final body weight	Average body weight gain	Total feed consumed	Feed efficiency ratio	Mortality %
T ₁	482.47 ±19.35	1517.50 ±33.69	1035.03 ^e ±45.66	2985.22	2.88	0.0%
T ₆	498.21 ±12.84	1046.30 ±24.30	548.09 ^b ±19.61	2138.50	3.90	10%
T ₇	508.33 ±17.05	935.00 ±27.73	426.67 ^b ±18.53	1947.90	4.57	20%
T ₈	493.20 ±13.26	852.50 ±27.42	359.30 ^b ±28.58	1746.93	4.86	700%
T ₉ [*]	502.00 ±10.60					100%

Values bearing different superscript in a column differ significantly (F < 0.01)

* All the birds were died within 14 days after starting the experiment

Fig.44 Average weekly body weight of broilers feeding at different levels of pure jangli badam oil



a) Change in body weight :

The average initial body weight of broiler at 4th week of age were 482.47 ± 19.35 , 498.21 ± 12.84 , 508.33 ± 17.05 , 493.20 ± 13.26 and 502.00 ± 10.60 gm in T_1 (Control), T_6 (contain 5.6 gm oil/kg ration), T_7 (contain 11.2 gm oil/kg ration), T_8 (contain 16.8 gm oil/kg ration) and T_9 (contain 22.4 gm oil/kg ration) respectively.

The average final body weight after 8 weeks were 1517.50 ± 33.69 , 1046.30 ± 24.30 , 935.00 ± 27.73 and 852.50 ± 27.42 in Groups T_1 , T_6 , T_7 and T_8 respectively. All the birds of T_9 group were died within 14 days after starting the experiment. The average weight gain from 4-8 weeks of age of the birds were 1035.03 ± 45.66 , 548.09 ± 19.61 , 426.67 ± 18.53 and 359.30 ± 28.58 in T_1 , T_6 , T_7 and T_8 respectively.

On statistical analysis of the data it may revealed that the final body weight/gain in weight of T_1 (control) was significantly higher ($P < 0.01$) than that of T_6 , T_7 and T_8 . This type of growth depression effect of the jangli badam oil might be due to presence of some unidentified toxin/deleterious factor(s) within the oil.

b) Mortality number of birds :

It has been observed from Table 4.7 as well as from Fig. 4.5 that the inclusion of 22.4 gms of oil/kg ration (T_9) cause 100% mortality of the birds within 2 weeks after starting the experiment, whereas inclusion of 5.6 gm (T_6), 11.2 gm (T_7) and 16.8 gm (T_8) of Jangli badam oil per kg of broiler finisher ration caused 10, 20 and 70% mortality in respective groups probably due to presence of some toxin/deleterious substance(s) within the oil.

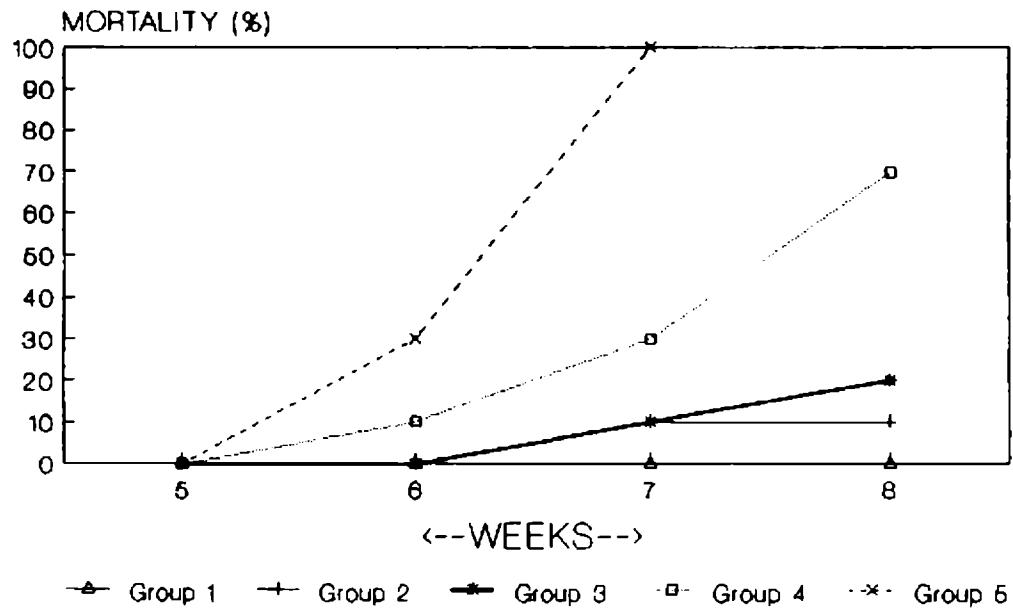
Table 4.7 Mortality percentage of broilers feeding at different levels of pure jangli badam oil

Group	Age in weeks				Total % of mortality
	5th week	6th week	7th week	8th week	
1 (T_1)	0.0%	0.0%	0.0%	0.0%	0.0%
6 (T_6)	0.0%	0.0%	10.0%	0.0%	10.0%
7 (T_7)	0.0%	0.0%	10.0%	10.0%	20.0%
8 (T_8)	0.0%	10.0%	20.0%	40.0%	70.0%
9 (T_9)	0.0%	30.0%	70.0%	-	100.0%

c) Effect on feed consumption and feed efficiency in different treatments :

The data on feed consumption and feed efficiency are also presented in Table 4.6. whereas average weekly feed

Fig.4.5 Mortality percentage of broilers feeding at different levels of pure jangli badam oil



consumption have been presented in Appendix Table - 4.2 and Fig. 4.6.

It is observed from Table 4.6 that total feed consumed (gms) per bird of T₁, T₆, T₇ and T₈ were 2985.22, 2138.50, 1947.90 and 1746.93 gms respectively during the entire experimental period from 4-8 weeks.

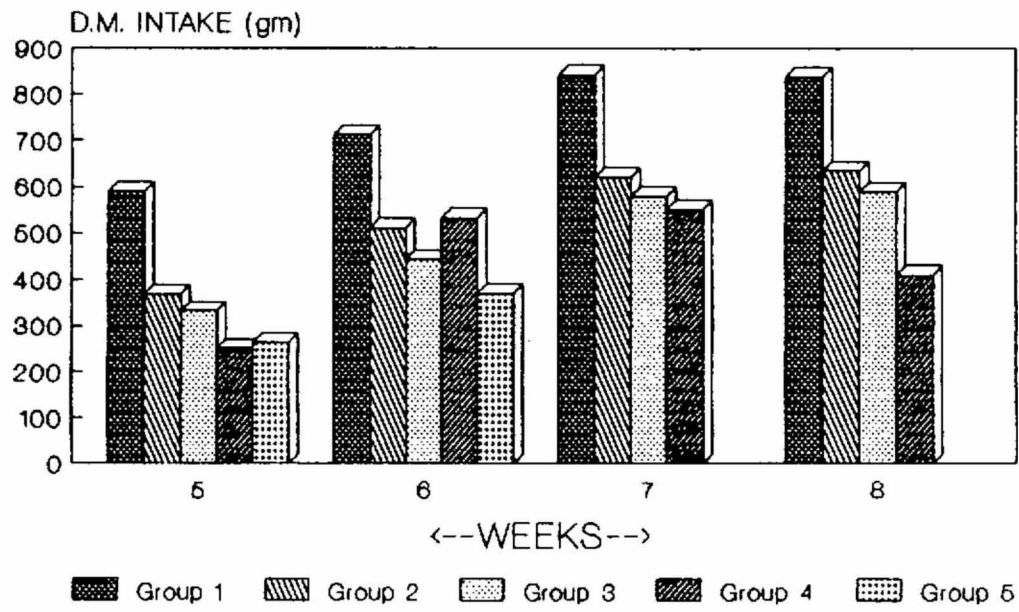
It was observed that the birds of control group (T₁) consumed more amount of feed than that of groups T₆, T₇ and T₈ and the birds of T₈ (containing 16.8 gm oil/kg of ration) consumed lowest amount of feed than the other treated groups.

It is also evident from the same Table 4.6 that there is a decreasing trend of feed intake with the increasing level of oil in the ration.

Feed efficiency ratio in T₁, T₆, T₇ and T₈ were 2.88, 3.90, 4.57, 4.86 respectively which apparently shows that the FER is lower in T₁ and T₆ groups as compared to T₇ and T₈. The data could not be compared statistically as there was no replications in these groups.

This type of effect on growth and feed efficiency of broilers might be due to the presence of some unidentified toxic/deleterious substance(s) in the oil.

Fig.4.6 Average weekly D.M. intake of broilers feeding at different levels of pure jangli badam oil



III) Pathological study on vital organs of broilers after feeding expeller jangli badam cake and pure oil

Pathological study was carried out to observe the effect of feeding expeller jangli badam cake and pure oil at different levels on vital organs (liver, kidney and heart) of broilers.

In the present investigation remarkable gross changes were observed in vital organs. All the dead birds of groups T₃, T₄, T₅ showed petechial hemorrhage in sub-cutis and in different serosal coverings. Gall bladder was highly enlarged 2-3 times than normal in group T₈ and T₉ groups. All the live birds of groups T₂, T₆, T₇, T₈ showed pale colourization of liver (Plate - 4.2) and heart and kidney was hyperemic. These changes were observed in isolated places at lower level of inclusion whereas the whole organs are found to be affected at higher level of inclusions.

The section of the liver showed coagulative necrosis of the parenchyma in limited places. The necrosis was seen mostly towards the central vein (Plate - 4.3) in case of lower levels of inclusions of cake or oil. But at higher level of inclusions, the section of the liver showed massive coagulative necrosis. The necrosis was observed towards the central vein as well as the peri-portal areas.



Plate 4.2 20% jangli badam cake fed broiler showing internal organs. The liver was pale in colour

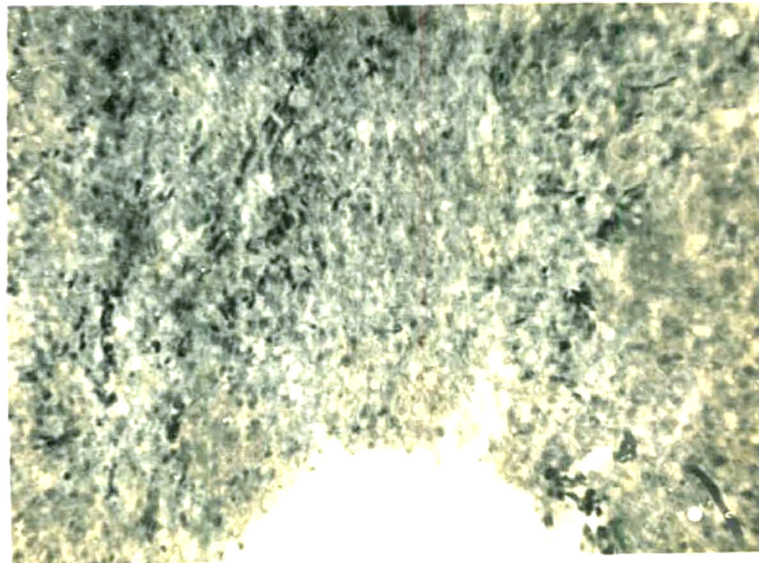


Plate 4.3 Section of broiler liver showing coagulative necrosis fed at 20% jangli badam cake, 450 X H & E.

The section of the kidney showed congestion and coagulative necrosis in tubule and glomeruli (Fig. 4.4) in different places at lower levels of inclusion of cake or oil. But at higher level of inclusion, the section of the kidney showed massive coagulative necrosis both in tubule and glomeruli (Plate - 4.5 and Plate - 4.6) at higher level of inclusions of cake or oil.

The section of the heart showed coagulative necrosis in isolated places at lower level of inclusions but at higher levels of inclusion, the section of the heart showed massive coagulative necrosis.

From the above experiment, it may be concluded that the inclusion of jangli bedam cake or oil in broiler ration cause pathological changes of liver, kidney and heart. These changes might be due to toxic/celerterious substance(s) present in the oil portion of the cake.

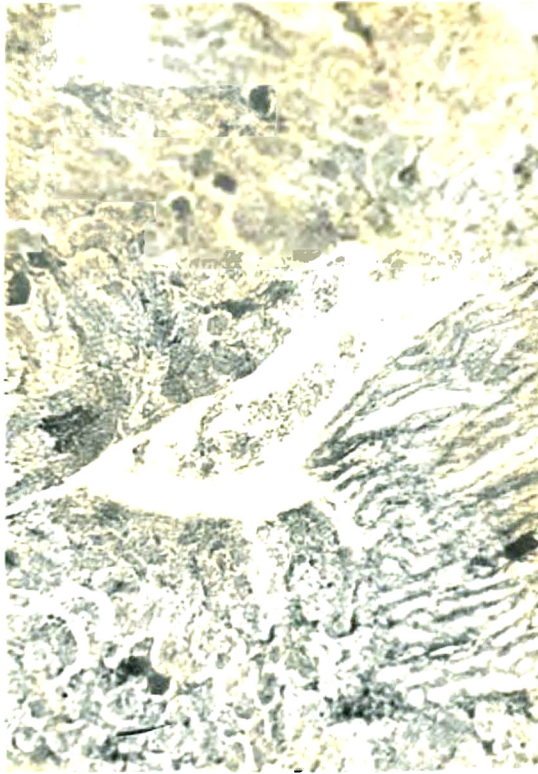


Plate 4.4 Section of broiler kidney showing congestion and coagulative necrosis in tubule and glomeruli fed at 20% jangli badam cake, 100 X H & E

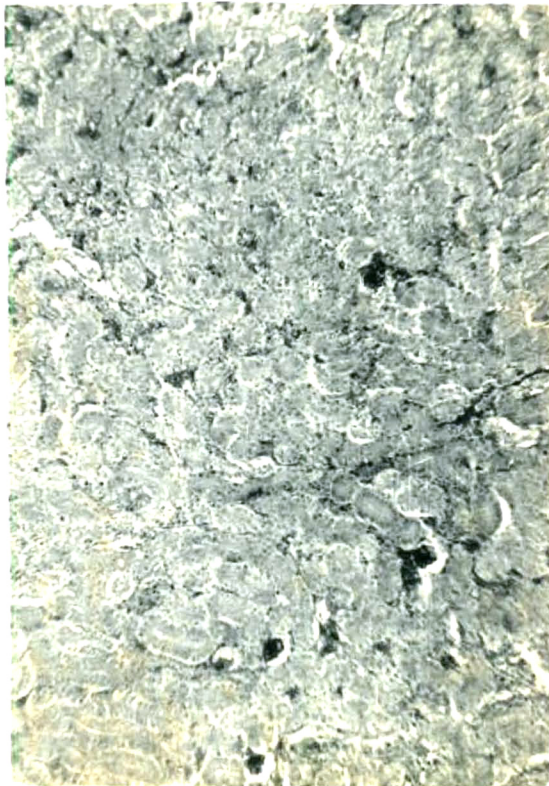


Plate 4.5 Section of broiler kidney showing massive coagulative necrosis fed at 22.4 gm of pure jangli badam oil/kg diet, 100 X H & E

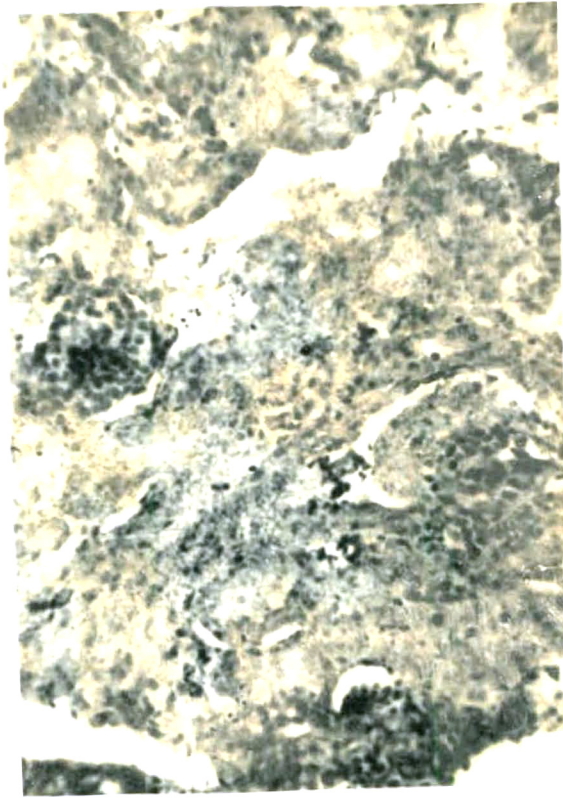


Plate 4.6 Section of broiler kidney showing massive coagulative necrosis fed at 22.4 gm of pure jangli badam oil/kg diet, 450 X H & E.

PART - II

STUDIES ON EXPELLER VARIETY OF COPRA (Cocos nucifera)
CAKE IN BROILERS

Experiment - 1

Feeding value of expeller Copra cake in broilersI) Studies on the chemical composition of expeller variety of
copra (Cocos nucifera) cake

The chemical composition of expeller variety of copra cake was compared with that of red til cake as well as to assess its nutritive value as a vegetable protein source. The chemical composition is presented in Table - 4.8.

Table - 4.8 Chemical composition of expeller copra cake and red til cake (on per cent dry matter basis)

Nutrients	Expeller copra cake	Red til cake
Dry matter (DM)	91.73	91.07
Crude protein (CP)	23.05	32.53
Ether extract (EE)	12.75	9.28
Crude fibre (CF)	9.39	17.21
Total ash (TA)	5.76	14.11
Acid insoluble ash (AIA)	1.20	6.23
Nitrogen free extract (NFE)	49.05	26.87
Calcium (Ca)	0.23	1.93
Phosphorus (P)	0.62	1.63

It is evident from Table - 4.8 that the crude protein (CP) of expeller copra (23.05%) is less than that of red til cake (32.53%) whereas the ether extract (EE) content (12.75%) is slightly higher than that of red til cake (9.28%). Crude fibre content of expeller copra cake (9.39%) was about half than that of red til cake (17.21%), Nitrogen free extract (NFE) content of expeller copra cake (49.05%) was about 2 times more than that of red til cake (26.87%).

Further, the higher total ash content of red til cake indicates its richness in mineral contents which is clear from its higher calcium and phosphorus levels.

II) Effect of feeding expeller copra cake as a protein source in broiler ration on isonitrogenous replacement of til cake (red) at different levels on growth and feed efficiency

This experiment was conducted to find out the effect of partial replacement of copra cake (expeller) protein as a substitute of red til cake protein at different levels of inclusion in broiler's ration. The experiment was carried out for a period of six weeks.

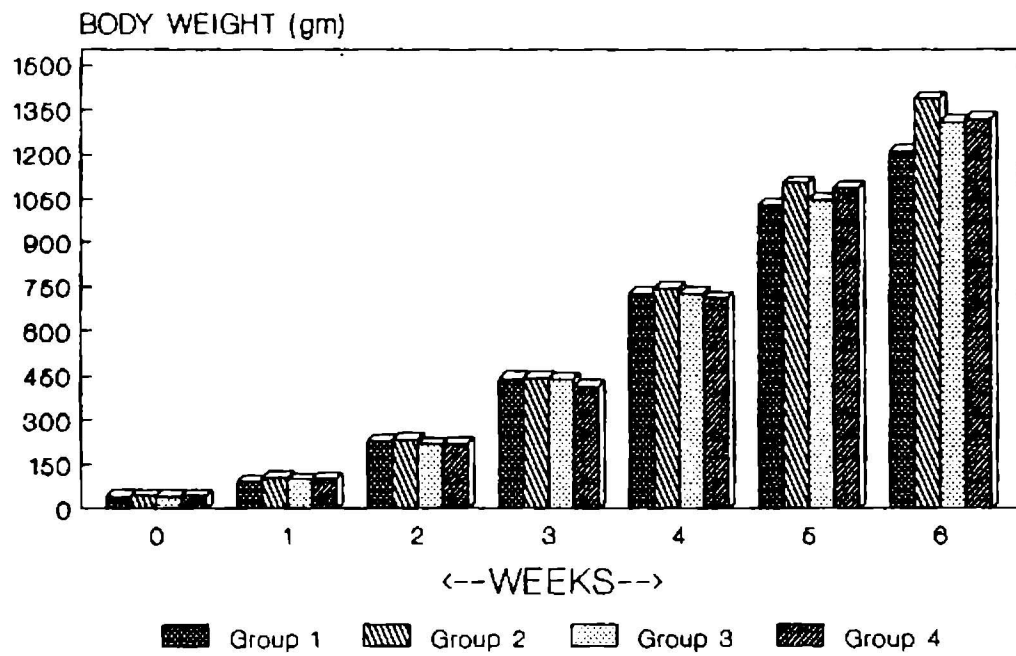
The data on growth are presented in Table - 4.9 Appendix Table 4.3 and Fig. 4.7.

Table - 4.9 Effect of feeding copra cake (expeller) at different levels on growth and feed efficiency of broilers

Gr- oup	Rep- licate	Ave. initial b.wt. (gm)	Gr. Ave. (gm)	Ave. final b.wt. (gm)	Group Ave. (gm)	Ave. b.wt. gain (gm)	Group Ave. (gm)	Total feed con- sumed (gm)	Group Ave. (gm)	Feed effi- ciency ratio	Group Ave. (gm)	Morta- lity %
T ₁	A	43.92	43.36	1219.33	1209.39	1175.41	1166.03 ^{bc}	2564.84	2596.27	2.182	2.227 ^a	Nil
	B	42.80	±0.68	1199.44	±35.89	1156.64	±35.81	2627.70	±22.22	2.272	±0.045	
T ₂	A	44.58	44.27	1368.13	1387.50	1323.55	1343.24 ^a	2778.02	2729.99	2.099	2.033 ^b	Nil
	B	43.95	±1.10	1406.88	±33.85	1362.93	±33.66	2681.96	±33.96	1.968	±0.066	
T ₃	A	43.00	42.38	1271.42	1306.42	1228.42	1264.05 ^{ab}	2579.94	2616.02	2.100	2.070 ^b	Nil
	B	41.75	±0.77	1341.42	±41.94	1299.67	±42.23	2652.09	±25.51	2.040	±0.030	
T ₄	A	43.40	42.55	1275.00	1318.93	1231.60	1276.38 ^{ab}	2553.27	2698.87	2.073	2.113 ^{ab}	Nil
	B	41.70	±0.74	1362.85	±45.82	1321.15	±45.97	2844.48	±102.96	2.153	±0.040	

Average values bearing the same superscript within the same column do not differ significantly (P < 0.05).

Fig.4.7 Average weekly body weight of broilers feeding at different levels of copra cake (expeller)



a) Change in body weight

The average body weight of day-old broiler chicks of the experiment were 43.36 ± 0.68 , 44.27 ± 1.10 , 42.38 ± 0.77 , 42.55 ± 0.74 gm in T_1 (control), T_2 (20% replacement), T_3 (40% replacement) and T_4 (60% replacement) respectively.

The average final body weight of experimental birds after six weeks were 1209.39 ± 35.89 , 1387.50 ± 33.85 , 1306.42 ± 41.94 , 1318.93 ± 45.82 gm in respective groups.

The average weight gain in 6 weeks were 1166.03 ± 35.81 , 1343.24 ± 33.66 , 1264.05 ± 42.23 , 1276.38 ± 45.97 gm in T_1 , T_2 , T_3 and T_4 respectively.

The data (Table-4.9) on statistical analysis revealed that the effect of various treatments exhibited highly significant ($P < 0.05$) differences among different groups.

The final body weight as well as gain in weight of T_2 (20% replacement) was significantly higher ($P < 0.05$) than that of T_1 (control). The T_3 and T_4 groups attained better body weight/weight gain as compared to control (T_1). This increased body weight gain might be due to lower crude fibre, higher lipid content as well as lower acid insoluble ash content of copra cake leading to better utilization of nutrients

with particular reference to energetic efficiency. This has been amply reflected in better ME value of copra cake (1.914 KCal/gm) as noted in this investigation which is higher than red til cake (1.505 KCal/gm) as reported by Banerjee et al. (1974).

Panigrahi (1992) has also reported that body weight gain is significantly affected by lipid contents of copra meal. High lipid content of copra meal might be the cause of better growth performance of treated groups than that of control. Til cake has also been reported to contain considerable amount of phytate which adversely affects the nutrient utilization through G.I. tract whereas Momongan et al. (1964) suggested that copra meal does not contain any toxic or growth depressing factor. It might be the another cause of better growth performance of treatment groups.

Scott et al. (1969) reported that copra meal is deficient in lysine and methionine. Devendra have also (1976) reported that coconut cake is deficient in lysine and histidine.

The interesting characteristic of the present investigation showed that as the level of inclusion of copra cake increased, the growth response decreased. The decreased growth response although numerically better than the control might be

due to lower amino-acid content in terms of lysine and methionine in particular.

b) Results on feed consumption and feed efficiency in different treatments

The results on feed consumption and feed efficiency of feeding different levels of copra cake (expeller) are presented in Table-4.9 and Fig. 4.8 whereas average weekly feed intake have been presented in Appendix Table 4.4 and Fig. 4.9.

It is observed from Table 4.9 that total feed consumed per bird of T₁, T₂, T₃ and T₄ were 2596.27 ± 22.22, 2729.99 ± 33.96, 2616.02 ± 25.51 and 2698.87 ± 102.96 gms respectively during the entire experimental period of 6 weeks.

On critical observation it may be noted that T₂ consumed the highest amount of feed during the experimental period followed by T₄, T₃ and T₁. However, on statistical analysis no significant differences were observed in total feed consumption among various treatments.

It is observed from Appendix Table 4.4 that birds of T₂ and T₃ groups have consumed more feed in 6th week in comparison to 5th week whereas birds from T₁ and T₄ groups have consumed more feed in 5th week in comparison to 6th week.

**Fig.4.8 Average total D.M.intake (6 weeks)
of broilers feeding at different levels
of copra cake (expeller)**

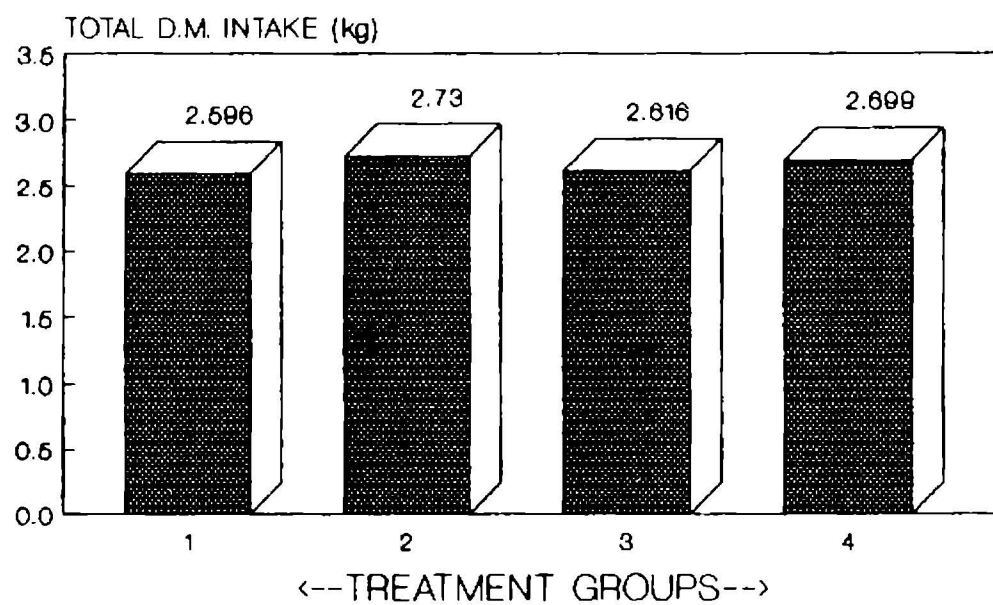
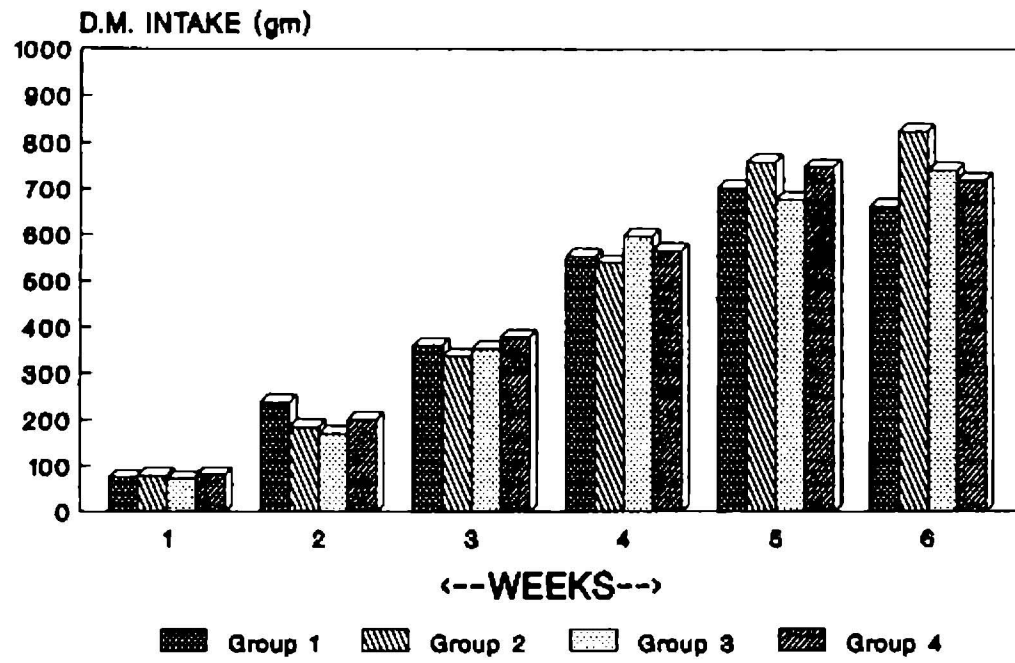


Fig.4.9 Average weekly D.M. intake of broilers feeding at different levels of copra cake (expeller)



The feed efficiency ratios were 2.227 ± 0.045 , 2.003 ± 0.066 , 2.070 ± 0.030 and 2.113 ± 0.040 respectively in groups T_1 , T_2 , T_3 and T_4 .

On statistical analysis feed efficiency showed significant ($P < 0.01$) differences among the treated groups. T_2 and T_3 groups showed significantly better feed efficiency than that of T_1 (control) and T_4 groups.

The performance of broilers indicated that expeller copra cake could safely be included in the diet upto a maximum level of 8.40% (as studied here) in the total ration replacing 60% red til cake nitrogen of reference diet with the advantage of higher weight gain and better feed efficiency.

Sarker and Banerjee (1987) have also reported that deoiled copra cake could safely be included in the diet of upto a maximum level of 8.58% replacing 20% deoiled groundnut cake nitrogen of reference diet. The result of this experiment is in close agreement with that of Sarker and Banerjee (1987).

Panigrahi et al. (1987) found that there were no significant difference in 7 week body weights of chickens fed on the control diet and diets containing copra, 125 and 250 gm/kg.

III) Effects of feeding copra cake at different levels on cut-up parts, slaughter characteristics and vital organs of broilers

The object of this study was to examine the slaughter parameters of broiler on feeding expeller variety of copra cake at different levels. Four birds from each group (one male and one female from each replicate) were slaughtered for this purpose after termination of growth study on 44 days of age. The following parameters were studied.

- a) Cut-up parts : (expressed as percentage of eviscerated weight)
 - 1) Neck weight, 2) Wing weight, 3) Leg weight, 4) Breast weight and 5) Back weight.
- b) Slaughter characteristics :
 - 1) Live weight, 2) Eviscerated weight
 - 3) Giblet weight (percentage of live weight)
- c) Vital organs : (expressed as percentage of live weight)
 - 1) Liver weight, 2) Heart weight, 3) Kidney weight,
 - 4) Pancreas weight, 5) Spleen weight, 6) Gizzard weight,
 - 7) Intestinal weight with its contents.

(a) Cut-up parts :

The data on cut-up parts are presented in Table 4.10 which showed that the average per cent of neck weight as on

Table - 4.10 Effect of feeding copre cake at different levels on cut-up parts (expressed as % of eviscerated weight) of broilers

Gr. Rep.	Evis- cera- ted (ev) wt. (gm)	Wing wt. (gm)	% of		Gr. av.	Breast wt. (gm)	% of		Gr. av.	Neck wt. (gm)	% of		Gr. av.	Leg wt. (gm)	% of		Gr. av.	Back wt. (gm)	% of		Gr. Av.	
			wt.as on ev. wt.	wt.as on ev. wt.			wt.as on ev. wt.	wt.as on ev. wt.			wt.as on ev. wt.	wt.as on ev. wt.			wt.as on ev. wt.	wt.as on ev. wt.						
T ₁	A	743.15	77	10.36	148	19.92	50	6.73	247	33.24	217	29.22	27.79	230	29.92	228	29.11	27.79	199	27.10	152	25.72
	B	768.80	70	9.11	186	24.19	51	6.63	230	29.92	228	29.11	30.78	220	29.92	199	27.10	152	25.72	210	25.24	25.65
T ₂	A	735.30	73	9.93	192	26.11	46	6.26	220	29.92	199	27.10	31.78	262	30.86	229	26.98	24.50	255	25.87	210	25.24
	B	592.30	56	9.46	165	27.86	34	5.74	178	30.05	152	25.72	31.77	265	32.58	199	24.50	25.65	210	25.24	210	25.24
T ₃	A	849.10	84	9.89	215	25.32	52	6.12	262	30.86	229	26.98	31.78	265	32.58	199	24.50	25.65	210	25.24	210	25.24
	B	813.30	85	10.45	202	24.84	60	7.38	265	32.58	199	24.50	31.77	265	32.58	199	24.50	25.65	210	25.24	210	25.24
T ₃	A	984.80	95	9.65	241	24.47	72	7.31	313	31.78	255	25.87	31.78	265	31.85	210	25.24	25.65	210	25.24	210	25.24
	B	832.00	83	9.98	202	24.28	60	7.21	265	31.85	210	25.24	31.77	265	31.85	210	25.24	25.65	210	25.24	210	25.24
T ₃	A	763.50	70	9.17	185	24.23	54	7.07	251	32.87	196	25.61	32.87	251	32.87	196	25.61	25.61	210	25.24	210	25.24
	B	782.40	72	9.20	208	26.58	57	7.29	240	30.67	200	25.62	31.37	240	30.67	200	25.62	25.62	210	25.24	210	25.24
T ₃	A	856.80	85	9.92	206	24.04	57	6.65	270	31.51	226	26.35	31.51	270	31.51	226	26.35	26.35	210	25.24	210	25.24
	B	762.30	63	8.26	172	22.56	64	8.39	232	30.43	221	29.03	30.43	232	30.43	221	29.03	29.03	210	25.24	210	25.24
T ₃	A	713.70	70	9.81	182	25.50	48	6.73	219	30.69	181	25.32	30.69	219	30.69	181	25.32	25.32	210	25.24	210	25.24
	B	822.10	79	9.61	188	22.87	54	6.57	260	31.63	233	28.36	31.63	260	31.63	233	28.36	28.36	210	25.24	210	25.24
T ₃	A	897.30	87	9.69	226	25.19	68	7.58	272	30.31	236	26.33	30.31	272	30.31	236	26.33	26.33	210	25.24	210	25.24
	B	741.40	68	9.17	195	26.30	47	6.34	235	31.69	187	25.27	31.69	235	31.69	187	25.27	25.27	210	25.24	210	25.24

ev. = eviscerated

eviscerated weight of different groups are 6.34 ± 0.22 , 7.00 ± 0.30 , 7.35 ± 0.37 and 6.80 ± 0.27 in group T_1 , T_2 , T_3 and T_4 respectively, the average per cent of wing weight as on eviscerated weight of different groups are 9.76 ± 0.38 , 9.99 ± 0.17 , 9.14 ± 0.34 and 9.57 ± 0.14 in T_1 , T_2 , T_3 and T_4 respectively.

The average per cent of leg weight as on eviscerated weight are 30.78 ± 0.82 , 31.77 ± 0.35 , 31.37 ± 0.55 and 31.08 ± 0.34 in T_1 , T_2 , T_3 and T_4 respectively. The average per cent of breast weight as on eviscerated weight are 24.52 ± 1.71 , 24.73 ± 0.23 , 24.36 ± 0.83 and 24.96 ± 0.74 in T_1 , T_2 , T_3 and T_4 respectively. The average per cent of back weight as on eviscerated weight are 27.79 ± 0.84 , 25.65 ± 0.53 , 26.65 ± 0.81 and 26.32 ± 0.72 in T_1 , T_2 , T_3 and T_4 respectively.

The average per cent of different cut-up parts weight as on eviscerated weight were subjected to statistical analysis and no significant differences were observed among the various treated groups.

b) Slaughter characteristics :

The data on slaughter characteristics of broilers in different treatment are presented in Table - 4.11.

Table - 4.11 Effect of feeding expeller copra cake at different levels on dressing characteristics of broilers

	Group	Rep.	Live wt. (gm)	eviscerated wt. (excluding heart, liver, gizzard) (gm)	Eviscerated %	Av. of the plicates	Group Av.	Giblet wt. (gm) (heart, liver, gizzard)	Ratio of Giblet wt. to % plicate of live wt.	Av. of the re-	Group Av.
T ₁	A		1240	743.2	59.93	61.04	59.47	82.21	6.63	6.31	6.54
			1237	768.8	62.15			74.21	5.99		±0.20
	B		1300	735.3	56.56	57.89	±1.15	85.83	6.60	6.77	
			1000	592.3	59.23			69.39	6.93		
T ₂	A		1450	849.1	58.56	59.18	62.05	97.02	6.69	5.84	5.68
			1360	813.3	59.80		±1.77	67.93	4.99		±0.43
	B		1485	984.8	66.32	64.91		73.07	4.92	5.52	
			1310	832.0	63.51			80.08	6.11		
T ₃	A		1260	763.5	60.59	61.10	61.22	55.55	4.41	4.96	5.26
			1270	782.4	61.61		±0.23	70.06	5.52		±0.32
	B		1400	856.8	61.20	61.34		82.97	5.93	5.55	
			1240	762.3	61.48			64.19	5.18		
T ₄	A		1200	713.7	59.47	60.19	60.45	59.99	4.99	5.14	5.70
			1350	822.1	60.89		±1.34	71.39	5.29		±0.43
	B		1560	897.3	57.52	60.72		108.23	6.94	6.27	
			1160	741.4	63.91			64.91	5.59		

The average eviscerated percentage were 59.47 ± 1.15 , 62.05 ± 1.77 , 51.22 ± 0.23 and 60.45 ± 1.34 in T_1 , T_2 , T_3 and T_4 respectively. On statistical analysis insignificant differences were obtained among the different treatments.

The average giblet weight per cent as on live weight are 6.54 ± 0.20 , 5.68 ± 0.43 , 5.26 ± 0.32 and 5.70 ± 0.43 in T_1 , T_2 , T_3 and T_4 respectively. The data were statistically analysed but no significant differences were obtained among the various groups.

Thus from the above observations, it may be inferred that the feeding of different levels of expeller copra cake have no effect on slaughter characteristics of broilers.

c) Effect on vital organs :

The data on feeding of copra cake on vital organs of broilers in different treatments have been presented in Table 4.12. The weight of all the vital organs have been expressed as the percentage on live weight.

The average liver weight percentage as on live weight are 3.37 ± 0.17 , 3.08 ± 0.27 , 2.58 ± 0.31 and 3.01 ± 0.45 in T_1 , T_2 , T_3 and T_4 respectively.

Table - 4.12 Effect of feeding expeller copra cake at different levels on organ weights (expressed as percentage of live weight) of broilers

Gr.	Live Heart		Liver		Ratio of liver		Sp. leen		Ratio of sp. leen		Kidney		Ratio of kidney		Gr. Av.
	wt. (gm)	wt. (gm)	wt. (gm)	wt. (gm)	wt. to % of live wt.	wt. to % of live wt.	wt. (gm)	wt. to % of live wt.	wt. to % of live wt.	wt. (gm)	wt. (gm)	wt. (gm)	wt. (gm)	wt. to % of live wt.	
T ₁	A	1240	7.20	0.58	0.53	42.06	3.39	3.28	2.11	0.17	0.15	13.15	1.06	1.09	1.14
	B	1237	6.05	0.49	0.65	39.29	3.18	3.37	1.69	0.14	0.14	13.78	1.11	1.09	
T ₂	A	1300	8.58	0.66	±0.09	49.92	3.84	3.47	±0.17	1.95	0.15	15.29	1.18	1.20	±0.04
	B	1000	8.89	0.89	0.77	30.92	3.09	3.47	1.18	0.12	0.13	12.32	1.23	1.20	
T ₃	A	1450	9.29	0.64	0.53	54.53	3.76	3.29	3.49	0.24	0.20	19.11	1.32	1.15	1.05
	B	1360	5.60	0.41	0.57	38.52	2.83	3.29	3.08	2.22	0.16	13.30	0.98	0.96	
T ₄	A	1485	8.02	0.54	±0.07	34.55	2.33	2.86	±0.27	1.63	0.11	14.80	0.99	0.96	±0.05
	B	1310	9.24	0.71	0.62	44.45	3.39	2.86	3.10	0.24	0.17	12.00	0.92	0.96	
T ₅	A	1260	6.58	0.52	0.56	26.33	2.09	2.51	2.78	0.22	0.20	13.51	1.07	1.03	1.06
	B	1270	7.54	0.59	0.56	37.20	2.93	2.51	2.58	2.31	0.18	12.46	0.98	0.98	
T ₆	A	1400	7.94	0.57	±0.01	43.77	3.13	2.65	±0.31	2.23	0.16	16.79	1.19	1.09	±0.05
	B	1240	6.79	0.55	0.56	26.92	2.17	2.65	2.01	0.16	0.16	12.30	0.99	1.09	
T ₇	A	1200	10.25	0.85	0.71	25.73	2.14	2.43	1.54	0.13	0.15	13.67	1.14	1.02	1.03
	B	1350	7.69	0.57	0.68	36.59	2.71	2.43	3.01	2.29	0.17	12.27	0.89	1.02	
T ₈	A	1560	10.17	0.65	±0.06	66.53	4.26	3.58	±0.45	4.38	0.28	17.30	1.11	1.04	±0.06
	B	1160	7.27	0.63	0.64	33.67	2.90	3.58	1.97	0.17	0.22	11.37	0.98	1.04	

Table - 4.12 (Contd.....)

T	Gr. Rep.	Live wt. (gm)	Pen-creas wt. (gm)	Ratio of pan-creas		Gr. Av.	Gizzard Ratio		Rep. Av.	Gr. Av.	Intes-tine wt. (gm)		Ratio of intestine wt. to % of live wt.	Gr. Av.
				wt. to % of live wt.	wt. to % of live wt.		wt. (gm)	% of live wt.			wt. (gm)	% of live wt.		
T ₁	A	1240	4.20	0.34	0.35	0.30	32.96	2.66	2.49	2.35	82.12	6.62	5.89	5.64
	B	1237	4.39	0.35	0.26	±0.03	28.87	2.33	2.19	±0.33	63.72	5.15	±0.34	
T ₂	A	1300	2.98	0.23	0.26	0.27	18.76	1.44	2.02	2.03	67.17	5.17	4.79	5.34
	B	1000	2.88	0.29	0.27	±0.01	29.51	2.95	2.03	±0.11	56.12	5.61	±0.33	
T ₃	A	1450	4.17	0.29	0.26	0.29	33.20	2.29	1.89	2.12	68.42	4.72	5.74	5.69
	B	1360	3.25	0.24	0.28	±0.02	23.81	1.75	2.34	±0.15	66.35	4.88	±0.45	
T ₄	A	1260	3.24	0.26	0.27	0.27	22.64	1.79	2.00	2.02	64.61	5.13	5.68	5.65
	B	1270	4.06	0.32	0.28	±0.04	25.33	1.99	2.04	±0.02	80.74	6.36	±0.33	
T ₄	A	1400	4.51	0.32	0.28	0.27	31.26	2.23	2.00	2.02	66.46	4.75	5.68	5.65
	B	1240	3.08	0.25	0.28	±0.04	30.48	2.46	2.04	±0.02	81.21	6.55	±0.33	
T ₄	A	1200	3.53	0.29	0.27	0.27	24.02	2.00	2.00	2.00	65.16	5.43	5.68	5.65
	B	1350	3.25	0.24	0.28	±0.04	27.11	2.00	2.04	±0.02	80.10	5.93	±0.33	
T ₄	A	1560	3.01	0.19	0.28	0.27	31.54	2.02	2.04	2.04	75.97	4.87	5.62	5.65
	B	1160	4.20	0.36	0.28	±0.04	23.97	2.07	2.04	±0.02	73.99	6.38	±0.33	

Gr. = Group; rep. = replicates;

The average heart weight percentage as on live weight are 0.65 ± 0.09 , 0.57 ± 0.07 , 0.56 ± 0.01 and 0.68 ± 0.06 in T_1 , T_2 , T_3 and T_4 respectively.

The average kidney weight percentage as on live weight are 1.14 ± 0.04 , 1.05 ± 0.09 , 1.06 ± 0.05 and 1.03 ± 0.06 in T_1 , T_2 , T_3 and T_4 respectively.

The average pancreas weight percentage as on live weight are 0.30 ± 0.03 , 0.27 ± 0.01 , 0.29 ± 0.02 and 0.27 ± 0.04 in T_1 , T_2 , T_3 and T_4 respectively.

The average Gizzard weight percentage as on live weight are 2.35 ± 0.33 , 2.03 ± 0.11 , 2.12 ± 0.15 and 2.02 ± 0.02 in group T_1 , T_2 , T_3 and T_4 respectively.

The average spleen weight percentage as on live weight are 0.14 ± 0.01 , 0.19 ± 0.03 , 0.18 ± 0.01 and 0.19 ± 0.03 in T_1 , T_2 , T_3 and T_4 respectively.

The average intestine (with its content) weight percentage as on live weight are 5.64 ± 0.34 , 5.34 ± 0.33 , 5.69 ± 0.45 and 5.65 ± 0.33 in T_1 , T_2 , T_3 and T_4 respectively.

On statistical analysis no significant difference among the different treatments of the above parameters were

obtained. Thus, from the above observations, it may be inferred that the feeding of expeller copra cake at different levels have no effect on the ratio of vital organs weight to percentage of live weight of broilers as studied here.

iv) Effect of feeding copra cake (expeller) on hematology of broilers :

Some blood parameters of broilers were studied to ascertain the effect of feeding expeller copra cake at different levels in the experimental ration and the data are presented in Table - 4.13. The Erythrocyte sedimentation rate (mm/1st hour) as has been obtained here are 1.300 ± 0.11 , 1.275 ± 0.13 , 1.175 ± 0.10 and 1.225 ± 0.15 in T_1 , T_2 , T_3 and T_4 respectively.

The PCV percentage as obtained in the present experiment are 31.88 ± 0.72 , 33.88 ± 1.48 , 32.75 ± 1.11 and 34.00 ± 1.41 in T_1 , T_2 , T_3 and T_4 respectively.

The Hb (gm/100 ml) percentage as has been obtained here are 7.60 ± 0.07 , 7.65 ± 0.07 , 7.68 ± 0.13 and 7.85 ± 0.22 in T_1 , T_2 , T_3 and T_4 respectively.

All the data were subjected to statistical analysis and showed no marked differences among various groups.

Table - 4.13 Effect of feeding copra cake (expeller) at different levels on blood parameters of broilers

Group	Replli- cate	Average Hb% (gm/100 ml)	Average of two replica- tes	Average PCV %	Average of two replli- cates	Average ESR (mm/hr)	Average of of two replli- cates
T ₁	A	7.65	7.60	31.5	31.88	1.15	1.30
	B	7.55	±0.07	32.25	±0.72	1.45	±0.11
T ₂	A	7.60	7.65	31.75	33.88	1.25	1.28
	B	7.70	±0.07	36.00	±1.48	1.30	±0.13
T ₃	A	7.55	7.68	31.50	32.75	1.15	1.18
	B	7.80	±0.13	34.00	±1.11	1.20	±0.10
T ₄	A	7.60	7.85	35.00	34.00	1.15	1.23
	B	8.10	±0.22	33.00	±1.41	1.30	±0.15

Experiment - 2Determination of Metabolizable Energy (ME) value of
expeller copra cake

The energy balance data of all the diets employed in the present experiment are summarised in Table - 4.14 and Table 4.15. Table 4.14 showed that the classical ME values of the diet - B and diet - C were 3.0094 ± 0.04 and 2.7746 ± 0.03 KCal/gm respectively which were less than that of the reference diet (3.2317 ± 0.002 KCal/gm). Table 4.15 showed that nitrogen-corrected ME values of the diet-B and diet-C were 2.8755 ± 0.04 and 2.6604 ± 0.03 KCal/gm respectively which were also less than that of the reference diet (3.0739 ± 0.004).

The data on the ME values of different diets were subjected to statistical analysis which showed significant difference at 1% level ($P < 0.01$) between diet-A, diet-B and diet-C both in case of classical ME and nitrogen-corrected ME, which suggests that ME values may be altered by incorporating expeller copra cake at 20% and 30% levels in the ration.

The classical ME values (Table - 4.16) of the test ingredient calculated at 20% and 30% inclusions of expeller

Table 4.14 Classical metabolizable energy (ME) of experimental diet at 4th week of age

Diets	Repli- cates	Total DM consumed (gm) A	Total energy consumed (KCal) B	Total energy excreted (KCal) C	Total energy retained (KCal) (B-C) = D	Classical ME/gm of DM D/A	Average classical ME
Diet-A	1	160.169	675.0146	156.9867	518.0279	3.2342	3.2317 ^a ±0.002
	2	124.873	526.2680	123.0218	403.2462	3.2292	
Diet-B	1	139.662	590.3324	164.4491	425.8833	3.0494	3.0094 ^b ±0.04
	2	151.567	640.6583	190.5930	450.0653	2.9694	
Diet-C	1	143.905	613.5020	209.6050	403.8970	2.8067	2.7746 ^c ±0.03
	2	153.850	655.8948	233.9492	421.9456	2.7426	

Values bearing the different superscript in same column differ significantly (P < 0.01)

Table - 4.15 N₂ corrected ME value of experimental diet at 4th week of age

Diets	Repl. cate	Total N ₂ intake (gm)	Total N ₂ excreted (gm)	Nitrogen retained (gm)	gm of N ₂ retention per gm of DM consumed	$\frac{D-E}{A} \times 8.22$ (F)	N ₂ corrected ME/gm DM	Average	
		(A)	(D)	(E)	(gm)	$\frac{B-E}{A}$	$(\frac{B-C}{A}) - F$	$(\frac{B-C}{A}) - F$	\pm
Diet-A	1	160.1691	5.0562	1.8399	3.2162	0.0201	0.1644	3.0698	3.0739 ^a
	2	124.8730	3.9420	1.6373	2.3048	0.0185	0.1512	3.0780	± 0.004
Diet-B	1	139.6620	4.2658	1.9557	2.3100	0.0165	0.1356	2.9138	2.8755 ^b
	2	151.5670	4.6294	2.1923	2.4372	0.0161	0.1322	2.8372	± 0.040
Diet-C	1	143.9050	4.6165	2.5132	2.1033	0.0146	0.1200	2.6867	2.6604 ^c
	2	153.8500	4.9355	2.8968	2.0387	0.0133	0.1085	2.6341	± 0.030

B = Total energy consumed in 3 days

C = Total energy excreted in 3 days

Values bearing the different superscript in the same column differ significantly (P < 0.01)

Table - 4.16 Classical ME value of test ingredient

Diets	Repli- cate	Classical ME/gm of DM	Average classical ME/gm of DM	Average
Diet-B	1	2.3200	2.1200 ^a ±0.20	1.9140 ±0.206
	2	1.9200		
Diet-C	1	1.8150	1.7080 ^a ±0.11	
	2	1.6013		

ME values bearing the same superscript do not differ significantly ($P < 0.05$)

copra cake were 2.1200 ± 0.20 and 1.7080 ± 0.11 KCal/gm respectively with an average value of 1.9140 ± 0.206 whereas the nitrogen-corrected ME value (Table - 4.17) at 20 and 30% levels of inclusion were 2.0819 ± 0.19 and 1.6956 ± 0.09 KCal/gm with a mean value 1.8887 ± 0.193 KCal/gm.

Table - 4.17 Nitrogen corrected ME value of test ingredient

Diets	Repl- cate	N ₂ corrected ME/gm DM	Average N ₂ -corrected ME/gm DM	Average
Diet-B	1	2.2734	2.0819 ^b ±0.19	1.8887 ±0.193
	2	1.8904		
Diet-C	1	1.7832	1.6956 ^b ±0.09	
	2	1.6079		

ME values bearing the same superscript do not differ significantly ($P < 0.05$)

The ME value of expeller copra cake as determined here is somewhat higher than the ME value (1.190 KCal/gm) of copra cake (de-oiled) reported by Lodhi et al. (1975) which might be due to higher oil content i.e. due to expeller variety of this cake. ME values of deoiled copra cake as reported by other workers are 1.540 KCal/gm (Scott et al., 1969) and 1.495 KCal/gm (Sarkar and Banerjee, 1987).

Chapter—5

SUMMARY AND CONCLUSION

Experiments were conducted to examine the effect of feeding expeller Jangli badam (Sterculia foetida) cake and expeller copra (Cocos nucifera) in replacement of conventional costly oil cakes in broiler ration with an idea to prepare economic rations. The salient observations are listed below.

A. Chemical composition of expeller jangli badam (Sterculia foetida) cake showed that it contained DM - 93.10%, CP - 8.51%, EE - 6.01%, CF - 19.92%, NFE - 60.97%, total ash - 4.59% Ca - 0.28% and P - 0.54%.

Results on growth study with expeller variety of jangli badam cake at 0, 10, 20, 30 and 40 per cent levels of inclusion replacing basal portion of the ration (groups being T₁, T₂, T₃, T₄ and T₅ respectively) for a period of 8 weeks showed that all the birds of groups T₃, T₄ and T₅ died within 7 days after starting the experiment, whereas 75% of the birds of T₂ died within 56 days of experimental period.

Live birds of group - T_2 showed poor body weight gain and wider feed efficiency ratio as compared to control.

Standard assays and fatty acid compositions of Jangli badam oil revealed that it is some what different from some of the edible oils like groundnut/rapeseed/coconut.

At the expeller jangli badam cake cause 75% mortality of the chicks at even 10% level of replacement and 100% mortality at 20, 30 and 40% level of inclusions replacing basal portion of the reference ration, a study was conducted (from 4th to 8th week of age of bird) to find out whether the toxin/deleterious factor(s) is/are present in the oil portion of the cake or elsewhere. The study showed that the inclusion of pure Jangli badam oil cause 10, 20, 70 and 100% mortality in groups T_6 (5.6 gms oil/kg ration), T_7 (11.2 gm oil/kg ration), T_8 (16.8 gm oil/kg ration) and T_9 (22.4 gms oil/kg ration) respectively. Treated groups also showed poor body weight gain and wider feed efficiency ratio than control.

Pathological studies were performed on the vital organs of dead and slaughtered birds of all the treatments (T_1 to T_9) having either Jangli badam cake or Jangli badam oil which showed massive coagulative necrosis of liver. The necrosis was seen towards the central vein as well as in

the periportal areas. Section of kidney showed congestion and massive coagulative necrosis both in tubules and glomeruli whereas that of hearts showed coagulative necrosis.

From the overall results of this experiments, it may be concluded that some unidentified toxin deleterious factor(s) is/are present most probably in the oil portion of the Jangli badam. As a result, this cake (expeller variety) is not at all suitable for inclusion in the ration of broilers.

B. Chemical composition of expeller copra cake showed that it contained DM - 91.73%, CP - 23.05%, EE - 12.75%, CF - 9.39%, NFE - 49.05%, Total ash - 5.76%, Ca - 0.23% and P - 0.62%.

In a growth study with broiler expeller copra cake was fed substituting red til cake on isonitrogenous basis at the levels of 0, 20, 40, 60 per cent as T₁, T₂, T₃ and T₄ groups respectively for a period of 6 weeks. Average body weight (gm) gain per bird at 6 weeks of age showed significant differences among various groups, being significantly higher in T₂ group (20% replacement) than that of T₁(control).

The highest dry matter intake was observed in T₂ (20% replacement) group whereas wider feed efficiency ratio was observed in T₁ (control) group.

Studies in carcass parameters of broilers showed that the incorporation of expeller copra cake even upto 60% level of substitution of red til cake on isonitrogenous basis did not impart any significant effect on dressing characteristics, cut-up parts and ratio of vital organs to percentage live weight of broilers.

The blood parameters like ESR (mm/1st hour), PCV% and Hb (gm/100 ml) also did not show any marked differences among different treatments.

The classical and nitrogen corrected ME values of expeller copra cake in broilers at 28 day's of age were found to be 1.9140 and 1.8887 KCal/gm respectively.

From the above observations, it may be concluded that expeller copra cake could safely be included in the diet of broilers upto a maximum level 8.40% replacing 60% protein of red til cake of the reference diet with the advantages of better weight gain and feed efficiency ratio.

Chapter—6

FUTURE SCOPE OF RESEARCH

FUTURE SCOPE OF RESEARCH

The present investigations were carried out to evaluate the nutritive potentiality of expeller jangli badam (Sterculia foetida) cake and its oil as an energy rich and expeller copra (Cocos nucifera) cake as a protein rich feed ingredient in the ration of broilers.

Studies on the expeller variety of Jangli badam cake showed that it can not be used in the broilers' ration as such, so attempts may be made to include the deoiled variety of this cake. The exact cause of toxicity may also be identified.

From the work on expeller variety of copra cake it is evident that it may be used in the broiler's ration upto a maximum level of 8.40% replacing 60% of red til cake nitrogen on isonitrogenous basis without any deleterious effect on birds. As it has been reported by some workers that copra cake is deficient in some amino-acids particularly

like lysine and methionine further investigations may be conducted on the expeller variety of copra cake by supplementing with these amino acids.

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APPENDIX

Appendix Table - 4.1 Average weekly body weight of broilers feeding at different levels of Jangli badam cake and its oil

Gr. Rep.	0 day	1st wk.	2nd wk.	3rd wk.	4th wk.	5th wk.	6th wk.	7th wk.	8th wk.	Av.
T1	A	35.9	79.6	137.2	288.3	488.8	757.0	962.2	1182.5	1475.0
	B	35.5	76.6	134.4	287.3	482.5	751.0	1020.1	1243.8	1517.5
T2	A	35.5	73.5	131.6	286.3	476.2	745.0	1078.0	1305.0	1560.0
	B	37.2	61.8	117.3	165.1	216.4	300.1	420.5	473.3	609.2
T3	A	36.8	63.6	132.0	183.3	228.0	340.5	466.8	540.0	703.3
	B	37.2	61.8	117.3	165.1	216.4	300.1	420.5	473.3	609.2
T4	A	35.9	79.6	137.2	288.3	488.8	757.0	962.2	1182.5	1475.0
	B	35.5	76.6	134.4	287.3	482.5	751.0	1020.1	1243.8	1517.5
T5	A	35.5	73.5	131.6	286.3	476.2	745.0	1078.0	1305.0	1560.0
	B	37.2	61.8	117.3	165.1	216.4	300.1	420.5	473.3	609.2
T6	A	36.8	63.6	132.0	183.3	228.0	340.5	466.8	540.0	703.3
	B	37.2	61.8	117.3	165.1	216.4	300.1	420.5	473.3	609.2
T7	A	35.9	79.6	137.2	288.3	488.8	757.0	962.2	1182.5	1475.0
	B	35.5	76.6	134.4	287.3	482.5	751.0	1020.1	1243.8	1517.5
T8	A	35.5	73.5	131.6	286.3	476.2	745.0	1078.0	1305.0	1560.0
	B	37.2	61.8	117.3	165.1	216.4	300.1	420.5	473.3	609.2
T9**	A	35.9	79.6	137.2	288.3	488.8	757.0	962.2	1182.5	1475.0
	B	35.5	76.6	134.4	287.3	482.5	751.0	1020.1	1243.8	1517.5

* All the birds were died within 6-9 days after starting the experiment, so no data are available

** All the birds were died within 2 weeks after starting the experiment, so no data are available.

Appendix Table - 4.2 Average weekly feed intake of broilers feeding at different levels of expeller Jangli badam cake and its oil

Group	Rep-	1st wk.	2nd wk.	3rd wk.	4th wk.	5th wk.	6th wk.	7th wk.	8th wk.	Av.					
T ₁	A	61.0	151.0	153.5	283.0	294.0	460.0	442.0	554.6	687.6	713.3	811.0	843.4	869.5	838.8
	B	66.0	±2.5	156.0	± 2.5	305.0	±11.0	424.0	±18.0	625.0	739.0	±25.7	875.8	±32.4	808.0
T ₂	A	49.0	82.5	90.3	139.2	134.6	115.7	152.0	263.4	326.0	416.6	365.7			
	B	47.0	±1.0	98.0	±17.8	130.0	± 4.6	188.4	±36.3						
T ₃															
T ₄															
T ₅															
T ₆										368.5	512.5	622.0	635.5		
T ₇										332.0	445.0	580.5	590.4		
T ₈										250.0	533.4	552.4	411.1		
T ₉										262.5	370.7				

* All the birds were died within 6-9 days after starting the experiment, so no data is available.

** All the birds were died within 2 weeks after starting the experiment, so no data are available.

Appendix Table - 4.3 Average weekly body weight of broilers feeding at different levels of Copra cake (expeller)

Gr. Rep.	Day Old	1st wk.	Avg.	2nd wk.	Avg.	3rd wk.	Avg.	4th wk.	Avg.	5th wk.	Avg.	6th wk.	Avg.
T ₁	A	43.92	97.70	229.50	428.65	722.22	997.20	1219.33	1209.39				
	B	42.80	88.50	229.20	453.72	729.44	1053.88	1199.44	± 35.89				
T ₂	A	44.58	106.40	238.55	439.10	721.50	1066.88	1368.13	1387.50				
	B	43.95	103.55	230.10	446.62	764.29	1136.88	1406.88	± 33.85				
T ₃	A	43.00	101.00	216.35	436.44	716.66	1027.50	1271.42	1306.42				
	B	41.75	97.70	218.25	444.75	735.00	1059.28	1341.42	± 41.94				
T ₄	A	43.40	103.70	219.75	408.10	702.50	1035.00	1275.00	1318.93				
	B	41.70	101.95	219.70	419.55	716.66	1135.00	1362.85	± 45.82				

Appendix Table - 4.4 Average weekly feed intake of broilers feeding at different levels of Copra cake (expeller)

Group	Rep- licate	1st wk.	Ave.	2nd wk.	Ave.	Third wk.	Ave.	4th wk.	Ave.	5th wk.	Ave.	6th wk.	Ave.
T ₁	A	81.0	76.00	245.9	239.42	360.0	361.25	548.5	553.00	667.2	703.85	662.2	662.75
	B	71.0	±3.54	232.9	± 4.61	362.5	± 0.88	557.5	± 3.18	740.5	±25.92	663.3	± 0.39
T ₂	A	83.1	80.65	198.6	186.20	355.3	338.65	557.5	540.00	760.9	760.00	822.5	824.35
	B	78.2	±1.73	173.8	± 8.77	322.0	±11.77	522.5	±12.37	759.1	± 0.64	826.2	± 1.31
T ₃	A	74.5	73.35	166.4	172.35	362.3	353.75	607.8	598.05	695.1	677.30	673.8	741.20
	B	72.2	±0.81	178.3	± 4.21	345.2	± 6.05	588.3	± 6.89	659.5	±12.59	808.6	±47.66
T ₄	A	80.4	81.65	201.0	201.80	368.5	379.15	563.0	566.15	656.5	750.05	683.7	719.95
	B	82.9	±0.88	202.6	± 0.57	389.8	± 7.53	569.3	± 2.23	843.6	±66.15	756.2	±25.63