EFFECT OF REPLACEMENT OF MAIZE WITH FINGER MILLET (ELEUSINE CORACANA) ON THE PERFORMANCE OF BROILERS

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by

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Dedicated to the memory of
my beloved father whose
unfailing love is a source
of inspiration throughout
my life....

CERTIFICATE

Certified that the thesis entitled, **"EFFECT OF REPLACEMENT OF MAIZE WITH FINGER MILLET (*ELEUSINE CORACANA*) ON THE PERFORMANCE OF BROILERS"**, submitted by **MOHAN RAMBHAU MANTHANWAR** in partial fulfillment of the requirements for the degree of **MASTER OF VETERINARY SCIENCE (M.V.Sc.)** in **POULTRY SCIENCE**, embodies the results of the record of bonafide research work carried out by him under the guidance of the University **Professor, DR. B.V. RAJMANE**, Associate Professor of Poultry Science, Bombay Veterinary College, Bombay, is to our satisfaction.

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INTRODUCTION

INTRODUCTION

Poultry plays an important role in fulfilling the food requirement of human civilization. Today, the scope of Indian poultry has been expanded from backyard farming into a scientific industry. Among that, the broiler industry has been growing by leaps and bounds in India, particularly in the recent past owing to its fast growing and efficient feed conversion ability. In addition, the fact that the returns on investment in broilers are quick, is also responsible for the present day growth of broiler industry in our country. The same is clearly evident from the increasing trend of 30 million broiler birds in 1980 to an estimated 200 million in 1989. The projected growth in the year 2000 A.D. is likely to attain the level of 650 million broilers (Indian Poultry Industry Yearbook, 1990).

For growth in general and of broilers in particular,the energy content of diet is very important which along with properly balanced other nutrients, helps to exploit the genetic potentials of these specially developed broiler strains to maximum extent. Cereals are the chief sources of energy in broiler mashes, which also constitute a major component of these diets. Commonly used cereal with definite advantage in conventional broiler rations is maize. The increase in demand and reduced availability of feed ingredients particularly the cereal like maize which forms the

major part of the broiler rations has lead to steady rise in the prices of poultry feed. Since, more than 70% of the cost of production of broilers is on feed, it is very much essential to keep its price as low as possible to ensure higher profitability in this business. The prices of poultry feed mainly depend upon the cost of feed ingredients used, particularly the maize, which is incorporated in large proportion. Therefore, to formulate economic rations, it is necessary to have a wide choice of ingredients, so that depending on the prevailing price and local availability, the ingredients can be selected.

The production of maize in the country has either remained stagnant or has dropped during last few years. On the other hand, the requirements of maize, both for human consumption as well as industrial uses like poultry feed and starch has been on the increase. The growing gap between availability and requirement is largely responsible for the escalation in maize prices. Therefore, it is very much essential to find out a suitable substitute for maize in broiler rations.

The other cereals like wheat, jowar, bajra, etc. are also now being used in the poultry rations without affecting the growth, egg and meat production as an alternative to maize. But these are staple food for human consumption and increasing population is a compete for it. Therefore, it is necessary for maximising the uses of cereals like rye, oat,

millet etc. which are rarely used for human consumption. Among these in India, millets seem to be the most promising substitute for maize in poultry ration.

Finger millet (*Eleusine coracana*) locally called as Nachni, a hill millet is widely cultivated in Maharashtra especially in Konkan region, where poultry industry of this state is widely spread. Finger millet is among the main cereal crops in the Konkan region. The area under cultivation of finger millet is 209 thousand hectares and production of finger millet is 214 thousand tonnes for the year 1987 - 88 (Epitome of Agriculture in Maharashtra, 1988 - 89). This millet can be grown in drought situation and gives yield within 90 - 100 days.

Though, there is production of finger millet in Maharashtra as a cereal and is cheaper than maize, it is not used in the poultry feed due to very scanty scientific reports available on the effect of inclusion of such grains in poultry feed on the performance of birds.

The present study was therefore, undertaken to find out the effect of partial replacement of maize with finger millet at different levels on the performance of broilers. The parameters studied were gain in weight, feed consumption, feed efficiency, energy metabolism and economics of broiler production.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

The present trial was undertaken to study the effect of replacing conventional energy source maize, with finger millet (*Eleusine coracana*) at three different levels i.e. 25, 50 and 75 percent on the performance of broilers. Hence, while scanning the literature emphasis was given on the references related to the use of various other energy sources for broiler feeding.

Raskopf *et al.* (1961) studied the effect of different levels of milo in diet for broilers. The basal diet had about 60% yellow maize. They noticed significant increase in body weight when milo replaced more than half of the maize. Feed efficiency, eviscerated yield, mortality and feathering were not significantly affected by any of the diet.

Gerencser *et al.* (1966) evaluated nutritive value of sorghum and maize in grower rations for broilers. Groups of 128 New Hampshire chickens were offered diets with 47% maize or half or all of it replaced by sorghum. They reported gain in weights of 808, 810 and 650 g by chicks on 100, 50 and 0% maize diets. The corresponding values for feed per kg gain were 2.76, 2.77 and 3.11 kg. In their second experiment, Lohmann hybrid chicken were given diets with maize only or half of it replaced by sorghum. They observed that the body weight gains were 679 and 600 g and feed/kg gain as 3.30 and 3.80 kg for respective groups.

Herstad *et al.* (1966) compared relative feed value of different cereals for chickens. In five experiments, different types and amounts of cereals were given to 1908 chickens of different breeds for 8 to 10 weeks of age. They found poor growth when feed contained more than 30% barley or oat or 58% sorghum. However, comparable body weights were recorded when maize was combined with barley, oats, wheat or sorghum.

Turek *et al.* (1966) studied the effect of feeding sorghum millet for fattening 2000 "Cobb" hybrid chicken for a period of 8 weeks. Maize was given as only cereal or 10%, 20% or 30% in terms of total feed was replaced by sorghum millet. They observed that sorghum had no significantly adverse effect on weight, feed required per kg gain or mortality. However, at all the levels of sorghum, insufficiently pigmented skin was noticed.

Bornstein and Bartov (1967) conducted 10 weeks battery trials, involving 1120 broiler chicks. They compared nutritive value of milo with that of maize. Similarly, they compared fresh and stored i.e. imported grains. Each comparison included five dietary treatments, one grain constituted 100, 75, 50, 25 and 0 percent of the cereal portion of the diet at the expense of the second grain. All diets were isonitrogenous. They reported no consistent difference between milo and maize or fresh and stored grains as far as growth rate and efficiency of feed utilization of broilers was concerned.

Polidori *et al.* (1967) studied the effect of replacing maize with grain sorghum in rations for broilers. Two series of diets were prepared containing four diets with maize or sorghum as the main cereal or two cereals in the ratios 2:1 or 1:2. At 8 weeks, the diet without sorghum gave greater weight and better feed efficiency. Carcass composition of breast muscle did not differ significantly. Further, it was seen that skin, toes were progressively less pigmented as proportion of sorghum in diet increased.

Ayyaluswami *et al.* (1967) studied the effect of incorporation of maize, ragi (*Eleusine coracana*) and cow dung in the chick mash. In each of 2 trials 5 groups of 22 and 12 White LegHorn chicken in the respective trial were fattened to 8 weeks of age. All the 5 diets were isocaloric and had 23% crude protein. Group I was given diet with 45% maize, group II with ragi 45% and group III with both maize 25% and ragi 20%, respectively. For the groups IV and V ground cow dung with 10% moisture replaced 10% of the diet with 45 or 25% maize. They reported that average gains in the first trial for groups with no dung were from 463 to 488 g; and in second were 514 to 555 g. Group with dung and more maize were 443 and 514 g in respective trials and with less maize they were 441 and 467 g. They noticed the averages were non-significant overall. Further, they concluded that ragi can be incorporated in chick mash successfully.

Quereshi (1967) compared the nutritive value of maize and bajra alone and with combination in the starting and growing rations for chicken. Star Cross chicken in 9 triplicate groups of 61 were given starting diet to 8 weeks of age and growing diet for 8 to 18 weeks. The diet contained maize or bajra alone as a cereal source or equal parts of both. They reported non-significant difference among diets in efficiency of feed conversion at 8 weeks. Further, at the end of 18 weeks they found non-significant difference among the groups for weight and efficiency.

Damron *et al.* (1968) evaluated three bird resistant varieties of sorghum grain viz. Bird 90, Ga 715 and AKS 614 and two non-resistant varieties viz. Paymaster-R-109 and Raider B. Vantress X White Plymouth Rock chicks of five weeks of age received corn and sorghum diet for three weeks. The varieties of sorghum replaced 50% of corn from basal diet. It was observed that the substitution did not depress the feed consumption or the body weight gain in all the varieties studied.

Tooth and Halmagyi (1968) used sorghum in diets for fattening chicken. In two trials with 5060 chicken, they noticed that 40 to 60 percent maize in starting and finishing diet could be replaced by sorghum without impairing growth, efficiency or skin colour. Further, they found that carotenoid content in liver and blood was less when sorghum was given.

Reddy and Reddy (1970) compared the performance of White LegHorn pullets fed diets containing various sources of grains. They observed that the bird fed ration containing ragi as the only cereal grain source gained significantly more than those fed bajra containing ration. However, there was no appreciable difference in birds fed either maize, jowar or bajra rations.

Simhaee *et al.* (1971) compared the nutritive value of corn, wheat and millet in broiler diets. The diets had 60 percent of either maize, millet or wheat or 30 percent each of maize and millet; maize and wheat or millet and wheat. The broilers initially two weeks of age, were offered one of the six diets until 11 weeks old. The average body weight gain during experiment were 2191, 2210, 2226, 2172, 2204 and 2210 g for the birds in that order with no significant difference. The feed efficiencies were 2.69,2,87,2.75,2.79,2.73 and 2.75 for the 6 diets, respectively. The feed efficiency of the chicks on the diet with millet as the only cereal source was significantly poorer than that on the other diets.

Shafique (1973) observed the performance of 600 broilers in triplicate lots, fed on four diets. The diets were formed by mixing maize, sorghum, wheat or barley in the proportion of 6:4 with a commercial supplement. Another two diets were used in which the cereal component was of equal parts of maize and barley or sorghum and barley. The corresponding gain in weights on the six diets were 635, 635, 628, 532, 612 and 605 g. The respective feed intake during the

period was 1583,1530,1601,1700,1636 and 1650 g with the feed conversion values of 2.45, 2.41, 2.55, 3.19, 2.67 and 2.72.

Palafox (1974) evaluated Hawaii grown grain sorghum and maize imported from United States. The performance of 180 cockerel and pullet broiler chicks were observed upto 8 weeks of age. It was reported that Hawaii grown grain sorghum was as good as or better than maize (w/w) as the only source of grain in broiler starter and finisher diets. Similarly, it was found that pullet fed on sorghum or maize, as the only source of grain in the diet did not differ significantly in body weight at eight weeks of age.

Singh and Barsaul (1975) conducted the experiments to replace maize by coarser grains like barely, sorghum and pearl millet on growth and meat production in White LegHorn (WLH) and Rhode Island Red (RIR) cockerels from 8 to 15 weeks of age. The birds were reared on 4 different mashes. The control mash had 40 percent maize, whereas in other mashes it was completely replaced by barley, sorghum and pearl millet. The weight gains in case of WLH chick were 1290, 1328, 1349 and 1310g, respectively. They concluded that maize can be completely replaced by barley, sorghum and pearl millet in mashes for growth and meat production.

Syed *et al.* (1975) replaced part or all of the maize by sorghum in broiler diet in two trials lasting for 8 weeks on 66 commercial hybrid chicken. There was no significant difference in feed intake, feed efficiency between treatment

and control groups. However, xanthophyll deficiency was noticed in birds given most sorghum.

Kraft *et al.* (1976) studied the effect of incorporation of two varieties of summer forage foxtail millet (*Setaria italica*) in rations for broilers. 920 Arbor Acre chicks were fattened upto 6 weeks of age on starter and finisher rations. Two groups had 40 percent foxtail millet at the expense of maize, which was the only source of cereal in control group. The levels of maize in starter and finisher control rations were 65 and 74 percent, respectively. At the end of six weeks, millet gave the highest body weight, although the difference from maize was not significant. They noticed no difference in pigmentation between the groups.

Lopez *et al.* (1976) reported no difference among weight gain or feed efficiency for the groups of 60 meat chicken fed on 60 percent maize diet or when it was replaced at 20,40 or 60 percent with other cereals like barley, pearl millet, proso millet, sorghum or buck wheat. They also found that all other grains had less energy than maize and when used, extra energy should be supplied by fat.

Saxena and Pradhan (1979) studied the effect of maize or sorghum diets on nitrogen retention and protein efficiency. Protein efficiency and nitrogen retention were higher for sorghum diets in the starting period, and for maize in the finishing period, However, for the overall period, the protein efficiency was higher in chicks receiving maize diet.

Sharma *et al.* (1979) incorporated wheat, yellow maize, pearl millet and sorghum in the diet of New Hampshire chicks from one to six weeks of age. The cereals contributed 4.2 or 6.3 MJ ME/Kg diet at two levels. They reported that food utilization was better with the higher inclusion rates of pearl millet and sorghum than with the lower inclusion rates. Further, they observed that feed conversion was significantly better with pearl millet than wheat and sorghum at either levels of inclusion and was better than sorghum at lower levels of inclusion rate. For weight gain millet was significantly better than wheat or sorghum. They also observed that at higher levels of inclusion rate, for efficiencies of energy and protein deposition, the cereals ranked as millet, sorghum, maize and wheat, respectively. They concluded that millet and sorghum can satisfactorily replace maize in broiler rations.

Luis *et al.* (1980) studied the nutritional value of three varieties of proso millet and bird resistant sorghum (BR-65) in two trials of four weeks with 180 broilers and compared the performance with that on corn. The grains comprised 70 percent of test diet. They reported that in millet and BR-65 diets, methionine and lysine supplementation significantly increased body weight and feed efficiency.

Sinha *et al.* (1980) determined comparative efficiency of utilization of maize, bajra, sorghum, wheat and rice polish in broiler chicks. The control mash had 40 parts

of maize which was replaced by one of the test materials in the other diets. The diets were made isonitrogenous and isocaloric with the help of casein, groundnut oil and sawdust fillings. The weight gains of the birds in a 4 weeks period were comparable for diets containing maize, bajra and rice polish, while sorghum and wheat gave significantly lower weight gains. The corresponding figures were 383, 390, 384, 282 and 289 g, respectively. The highest feed efficiency (2.09), was obtained with bajra in the diet followed by maize (2.35), rice polish (2.56), sorghum (3.05), and wheat (3.29). The efficiency of conversion of dietary metabolizable energy and protein into carcass energy and nitrogen was highest with bajra in diet and was closely followed by maize.

Luis and Sullivan (1982) compared the performance of broilers on diets based on corn, proso millet and BR-65, a sorghum variety with 15% protein. All the diets were isocaloric and isonitrogenous. The body weight of birds at the end of four weeks for corn, proso millet and BR-65 diets were 624, 542, and 363 g, respectively. The corresponding feed efficiency ratios were 1.83, 1.95 and 2.35. In the second trial, they supplemented these diets with methionine and observed improvement in body weight at four weeks of age. The respective weight were 667, 636, and 503 g and efficiency of 1.77, 1.80 and 1.97.

Baghel and Netke (1982) conducted an experiment to study the effect of incorporation of kangni (*Setaria italica*)

a small millet, in starter chick diet. Kangni replaced corn at o, 25, 50, 75 and 100 percent in the control diet with groundnut oil meal as a source of protein. They observed that when kangni replaced more than 50% of the maize in control diet, the efficiency of feed conversion was adversely affected. In another 2 trials, kangni replaced maize upto 100% in diets containing either soyabean meal or solvent extracted soyabean as a protein source, the body weight gain of the chicks on kangni based diet was significantly better than the control. Further, they concluded that kangni could replace corn in practical rations used for starter chicks with advantage.

Patel (1983) conducted a trial to study the affect of substituting maize with hybrid jowar in broiler diets on the performance of the broilers for a period of seven weeks. One hundred and fifteen broiler chicks were given with 44% maize or 25 or 50% maize replaced by hybrid jowar. It was observed that the average gain in weight were 1166, 1163 and 1163 g and the feed intake per kg gain were 2.25, 2.21 and 2.30 kg, respectively. None of the differences were found to be significant. It was also observed that the carcass quality of the broilers was comparable in all the groups. Further, it was found that inclusion of hybrid jowar in broiler mashes reduced the cost of feeding without affecting performance. It was, therefore, concluded that hybrid jowar can be used to replace maize upto 50% in broiler diet.

Abte and Gomez (1983-84) studied the effect of substitution of maize with finger millet and bulrush millet (*Pennisetum typhoides*) in broiler diet. They replaced maize by finger millet and bulrush millet at 0,20, 40, and 60 percent in two different trials in broiler starter and finisher rations. At the end of 8 weeks, the average body weight gains with maize, finger millet and bulrush millet were 1594, 1580 and 1649 g. They observed that the performance on finger millet diet was comparable to that on maize.

Rao *et al.* (1984) studied the effect of replacing maize by variga (*Panicium milecium*) on the performance of White LegHorn male chicks, The diets were formulated replacing maize to the extent of 0, 25, 50, 75 and 100 percent by variga. They observed that at the end of 6 weeks, the highest body weight gain of chicks fed diet with 25 percent replacement of maize by variga. They also observed that the body weight gain of chicks fed diet with 75% replacement of maize by variga were significantly lower than that of chicks fed on other experimental diets. Further, They concluded that variga could be included in chicks rations replacing 50% of maize without any adverse effect.

Mohamedian *et al.* (1986) used millet, sorghum and maize as a cereal source of energy for broilers and observed that incorporation of millet resulted in slightly lower feed intake, live weight gain and feed conversion efficiency than with maize but was superior to sorghum. Similarly, final body

weights, cold eviscerated carcass weight and dressing percentage were higher ($P < 0.05$) with millet and maize and maize than with sorghum.

Rajini *et al.* (1986) replaced maize completely with jowar, ragi, cumbu (*Pennisetum tyhoides*) in broiler diet. The basal diet contained 35.7% maize. They noticed that the body weights at the age of 56 days were 1165, 1227, 1369, 1356 g, respectively with the feed efficiencies of 2.52, 2.47, 2.40 and 2.42. They noticed highest body weight and feed efficiency when ragi replaced maize completely.

Naik (1988) substituted maize from hybrid jowar at 33 and 66% levels and reported non-significant differences between body weights and gain in weights of chicks of maize and jowar group. The total gain in weights and at the end of seventh week were 1298.93, 1299.43, 1287.64 g for the control, 33 and 66% replacement diets, respectively. The total feed consumption by corresponding groups was 2763.18, 2780.36 and 2813.78 g. The differences among groups were non-significant. He also reported the efficiency of feed utilisation was best (2.14) for 33% replacement group. It was concluded that the maize in the diet of broilers can be successfully replaced by hybrid jowar upto 66% without affecting the performance of broilers.

Raikwar *et al.* (1989) reported that the growth rate of chicks was significantly more on proso millet diet than maize.

Sarag et al. (1990) compared feeding value of maize and proso millet (*Panicum miliaceum*) in White LegHorn chicks. The rations with 55% maize or proso millet were offered to the chicks from 0-8 weeks. They observed higher weekly body weights for proso millet than maize, however, the difference was non-significant. The weight gain was significantly ($P < 0.05$) depressed at 4th and 5th weeks of age on millet diet but weight gain was significantly increased during the 6th and 7th weeks of age on proso millet fed chicks. The difference in feed consumption and feed efficiency were also non-significant. They concluded that maize can be replaced completely by proso millet in chicks and was economical as compared to maize.

Reddy *et al.* (1990) conducted two experiments to incorporate bajra replacing maize in ground or unground forms, in isocaloric and isonitrogenous diets in broilers. When bajra substituted maize 0, 50, or 100% levels, the body weight, feed intake, feed efficiency, fat, liver and ready to cook yield were not significantly influenced by incorporation of bajra either in ground or unground forms in place of maize. While in second experiment, when bajra substituted maize at 0, 25, 50 or 100 percent levels, maximum weight gains and minimum feed intake was observed in groups of broilers receiving 100% bajra grain. Thus, they concluded that bajra can replace maize completely without adversely affecting the broiler performance.

The above cited literature indicated that some of the cereals like jowar, bajra, wheat and different millets can be used to replace a part of maize in the mash without affecting performance of broilers, thus reducing the cost of feed.

MATERIAL AND METHODS

MATERIALS AND METHODS

Maize, which is the main conventional source of energy in broiler mashes is becoming scarce and prohibitively costly. It is, therefore, essential to replace maize with other cheaper and newer sources of energy in poultry diet. Finger millet (*Eleusine coracana*), a hill millet, is widely cultivated in Maharashtra and is a cheaper source of energy. The present study was, therefore, undertaken to find out the effect of replacement of maize with finger millet at different levels in the broiler mashes, on the performance of broilers.

Experimental design and plan of work :

The present experiment was conducted on 200 day-old broiler chicks of "Anak 2000" strain obtained from M/s. Ashokkumar Hatcheries Pvt. Ltd., Nasik. The chicks were received from Nasik by road transport, packed in cardboard containers. On arrival, they were weighed on "OMEGA" balance of 5 kg capacity with 1 g sensitivity. After weighing, the chicks were randomly divided into four groups viz. A, B, C and D consisting of 50 birds in each group. The chicks were housed on deep litter in four separate compartments in the same shed. The trial was conducted in the Department of Poultry Science, Bombay Veterinary College, Parel, Bombay - 400 012.

Feed treatments :

The broiler mashes used for the four groups during this study were prepared at M/s. Shakti Feed India Pvt. Ltd., Panvel. A single mash feed formula was used throughout the experimental period. These treatments were allocated randomly to four different groups. Management practices were same for all the groups of chicks. The details of different feed treatments were as follows.

Group A : Control mash with maize.

Group B : 25% of the maize in control mash replaced with finger millet.

Group C : 50% of the maize in control mash replaced with finger millet.

Group D : 75% of the maize in control mash replaced with finger millet.

The details of the feed ingredients used and their proportions in the four different broiler mashes are presented in Table - 1.

The proximate and other analysis of the experimental mashes and finger millet were undertaken in the laboratory of the Animal Nutrition Department, Bombay Veterinary College as per A.O.A.C. (1970). The chemical composition and calculated ME of the four broiler mashes are presented in Table - 2. The chemical composition of finger millet is also presented in Table - 2.

Table - 1 : The proportions of feed ingredients used in the different broiler mashes.

INGREDIENTS	MASHES			
	A	B	C	D
Maize	48	36	24	12
Finger millet (*Eleusine coracana*)	_	12	24	36
Rice polish	12	12	12	12
Groundnut extraction	32	32	32	32
Fish meal	6	6	6	6
Min. Mix.	2	2	2	2
Lysine (g/100kg)	128	121	114	107
Methionine (g/100kg)	79	70	61	52
"Rovimix" (g/100kg)	10	10	10	10
"Rovibe" (g/100kg)	25	25	25	25
"Coccidol" (g/100kg)	50	50	50	50

Table - 2 : Chemical composition (%) and calculated M.E. values of the different broiler mashes and finger millet on dry matter basis.

NUTRIENTS	MASHES				
	A	B	C	D	Finger Millet
Dry matter	91.43	91.03	92.52	92.44	99.08
Crude protein	23.33	22.23	21.14	21.14	5.83
Ether extract	4.01	3.91	3.98	3.42	0.73
Crude fibre	3.42	2.82	2.45	4.36	5.82
Nitrogen free extract	62.56	64.47	65.42	63.97	85.92
Total ash	6.66	6.57	7.01	7.11	1.70
Metabolizable energy (Kcal/kg)	2939.2	2846.2	2754.4	2662.0	--

Housing and Management :

Chicks from all the groups were reared in separate compartments in a well ventilated deep litter shed of the dimension 50' x 20'. Before the start of the experiment, the shed was thoroughly cleaned and disinfected with 10% solution of formalin. During first 2 weeks of the experiment, the chicks from each treatment were confined in separate area of 5' x 5' near the brooders by a brooder guard of 1.5' height. Provision for three electric bulbs of 60 watts each was made for each compartment during the first three weeks, for providing warmth to the chicks. For the next three weeks one bulb of 60 watts each was provided in each compartment to provide adequate light during the night. During the first seven days of the experiment "Hostacycline" was administered in the drinking water to all the chick at the rate of 1g/litre of water. On the sixth day of the experiment the chicks were vaccinated against "Ranikhet" disease with 'F' strain of Lasota vaccine.

All the groups were provided with adequate feed and water troughs which were put to use only after thorough cleaning.

At the end of three week of the experiment, the floor space for each group was increased to 10' x 5' , so as to provide adequate floor space for each bird.

Feeding Schedule :

Group feeding practice was followed throughout the experiment. The feeding space available to the birds was as per the standard requirements. Weighed quantity of feed was offered to each group of birds four times a day. The leftover feed was weighed next day morning at 7 a.m. to arrive at the daily feed consumption. From this data, the average daily and weekly feed consumption for all the groups were calculated. Fresh and clean drinking water was made available daily to all the groups throughout the experimental period.

Observations recorded :

The body weights of individual chicks were recorded on the first day and then at weekly intervals. From these data, average weekly live weights and gain in weights per chick were calculated for the respective groups. The feed consumption data were maintained daily. The weekwise and overall feed efficiency was calculated for each group using average weekly gain in weight and weekly feed consumption. Group wise record of mortality was also maintained.

Metabolic trial :

During sixth week of this study a metabolic trial of seven days duration was conducted to find out the nitrogen retention and to estimate the metabolizable energy values of the different mashes. For this purpose, three birds (one male

and two females) from each group were randomly selected and housed in separate metabolic cages in the same room. The cages were fitted with feeders and waterers and arrangement was made for the total collection of excreta. A clean, dry, weighed polythene sheet was spread over the dropping tray to collect excreta. The same feeding practice as described earlier was followed during the metabolic trial. The total excreta for 24 hours was collected daily at 7.00 a.m. and was made free from feathers and extraneous feed material. A representative samples from each group was drawn at the rate of 1/20th and 1/100th part of the total excreta voided, for moisture and nitrogen estimation, respectively. To latter sample, 5% Sulphuric acid was added as a preservative at the rate of 10 ml per 50 g of excreta. The preserved pooled sample of seven days from each group was used for estimation of nitrogen in excreta. The samples drawn daily for moisture estimation, were oven dried till constant weight was obtained. This oven dried pooled sample of each group was then ground and used for the energy estimation.

Energy Estimation :

The representative samples of the mash and the excreta were used to estimate the metabolizable energy values by making use of "Parr Adiabatic Oxygen Bomb Calorimeter". The metabolizable energy was estimated as per ISI (1968).

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

A study on the evaluation of finger millet (*Eleusine coracana*) as energy source at different levels was undertaken on 200 "Anak 2000" broiler chickens from day - old to six weeks of age. Finger millet was used to replace 25, 50 and 75 percent of the maize in the control mash. The performance of the birds on treatment mashes was compared with those of the control.

GROWTH STUDIES

1. LIVE WEIGHT :

The weekly live weights data of chicks from day - old to six weeks of age on different treatments are presented in Table - 3 . It is seen from the table that the average live weights of day - old chicks in control (Gr.A) and experimental groups B,C and D were 41.23, 41.27, 42.69 and 42.68 g, respectively. The corresponding live weights at the end of six weeks were 1670.95, 1722.95, 1688.53 and 1497.21 g. The maximum live weights were observed in experimental group B in which 25 percent of the maize was replaced with finger millet. This was followed by groups C, A and D, respectively.

It was observed that chicks from group B weighed 52.00 g (3.11 %) more than control while the live weights of the chicks from group C were comparable to those of control. However, the chicks from group D weighed 173.74 g (10.40%) less than control.

Table - 3 : Average weekly live weights (g) of chicks on different treatments from day - old to six weeks.

WEEKS	GROUPS			
	A	B	C	D
Day - old	41.23	41.37	42.69	42.68
I	128.15	121.94	122.60	117.61
II	283.89	263.23	283.04	228.38
III	517.09	474.96	499.31	397.33
IV	848.64	797.62	828.08	666.55
V	1261.36	1202.15	1241.21	1065.68
VI	1670.95	1722.95	1668.53	1497.21
Average	678.76[a]	660.59[a]	672.21[a]	573.63[b]

N.B.: Those means with common superscript do not differ significantly.

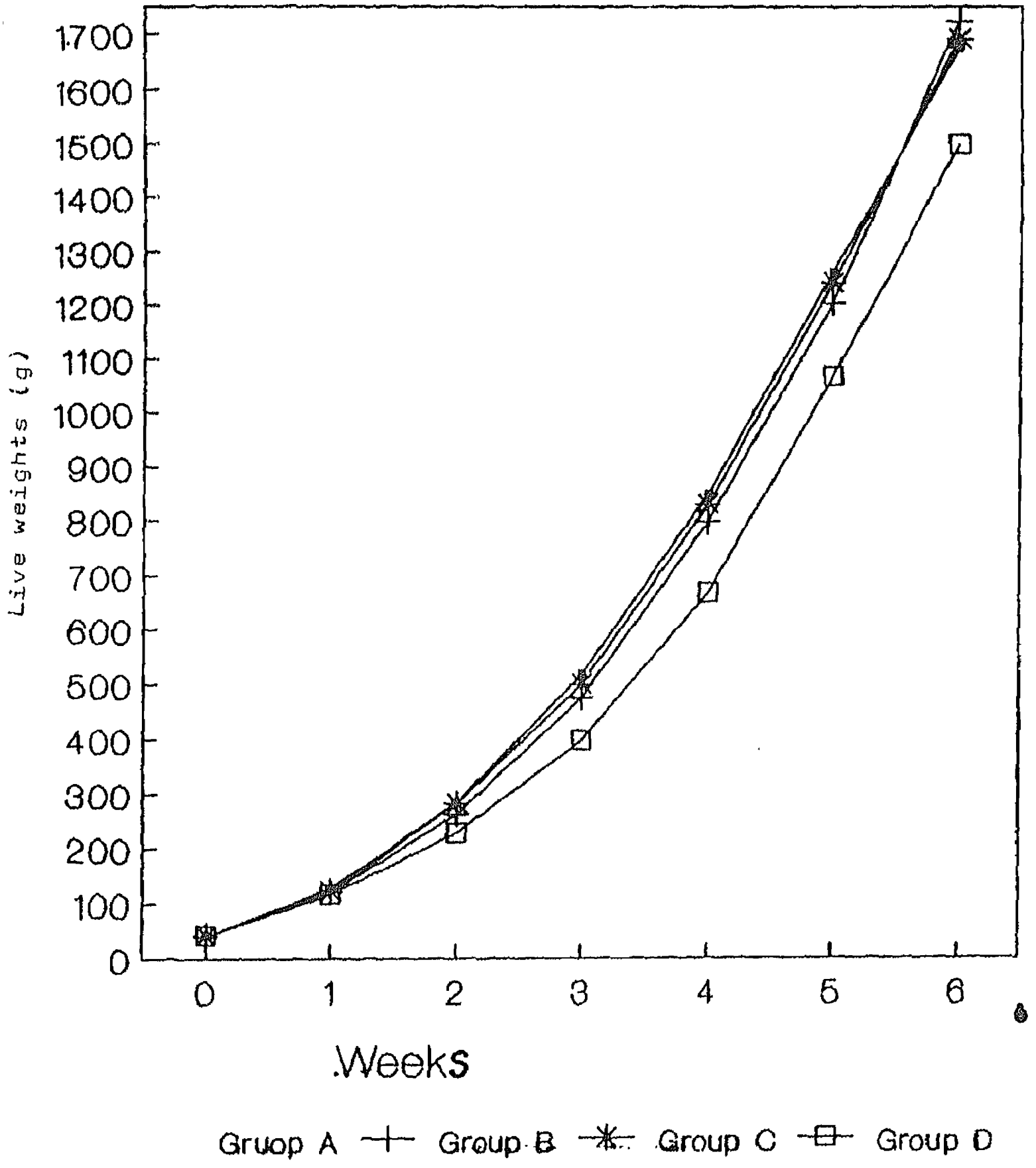
Table - 4 : Analysis of variance

Sources	D.F.	S.S.	M.S.S.	F
Treatments	3	50464.16	16821.39	8.94**
Weeks	6	8521837.20	1420306.20	755.13**
Error	18	33855.84	1880.68	
Total	27	8606157.20		

** - Significant at 5% level.

C.D. value for treatment means at 5% level = 48.70

Figure - 1. Average weekly live weights (g) of chicks on different treatments from day - old to six weeks.



The growth response of various groups is graphically presented in Figure - 1. It is evident from the figure that the live weights of the chicks from groups A,B and C did not differ much from each other, However, chicks from group D recorded consistently lower body weights.

The statistical analysis of the average weekly live weights data from day - old to six weeks is presented in Table - 4. The analysis revealed that feed treatments and weeks significantly ($P < 0.01$) affected the average live weights of the broilers. Therefore, the treatment means were further compared by critical difference test. It was noticed that replacement of maize by finger millet at 25 and 50 percent level had no significant effect on body weights of the birds as compared to control. However, 75 percent replacement of maize by finger millet significantly lowered the body weights of the birds.

Damron *et al.* (1968) reported non - significant differences in the body weights of birds when sorghum replaced 50 percent of corn from basal diet. Patel (1983) also observed non - significant differences in the final live weights of broilers given diet containing sorghum replacing upto 50 percent of maize.

Reddy *et al.* (1984) reported that variga (*Panicum miliacium*) did not affect the body weight of chicks when replaced upto 50 percent of the maize in control mash but 75

percent replacement of the maize in the control mash significantly lowered the body weight. The results of the present trial are in agreement with the above findings.

GAIN IN WEIGHT :

The average weekly gain in weights by the chicks from various treatments from day - old to six weeks are presented in Table - 5 . It is seen from the table that the average total gain in weights of the chicks from groups A, B, C and D were 1629.72, 1681. 68, 1645.84 and 1454.53 g, respectively. It was observed that the chicks from group B which received diet in which 25% of maize was replaced by finger millet gained most as compared to other groups. However, the chicks from group C gained almost comparable to control. The chicks receiving mash with 75% of maize replaced by finger millet (Gr.D) gained 175.19 g less than the control. The growth response of various groups is also presented graphically in Figure - 2.

The statistical analysis of the data of the gain in weights is presented in Table - 6 . The statistical analysis revealed that the apparent differences among the various treatments for the gain in weights were non - significant. It indicated that inclusion of finger millet in broiler mash did not significantly affect gain in weights.

Table - 5 : Average weekly gain in weights (g) of chicks on different treatments from day - old to six weeks.

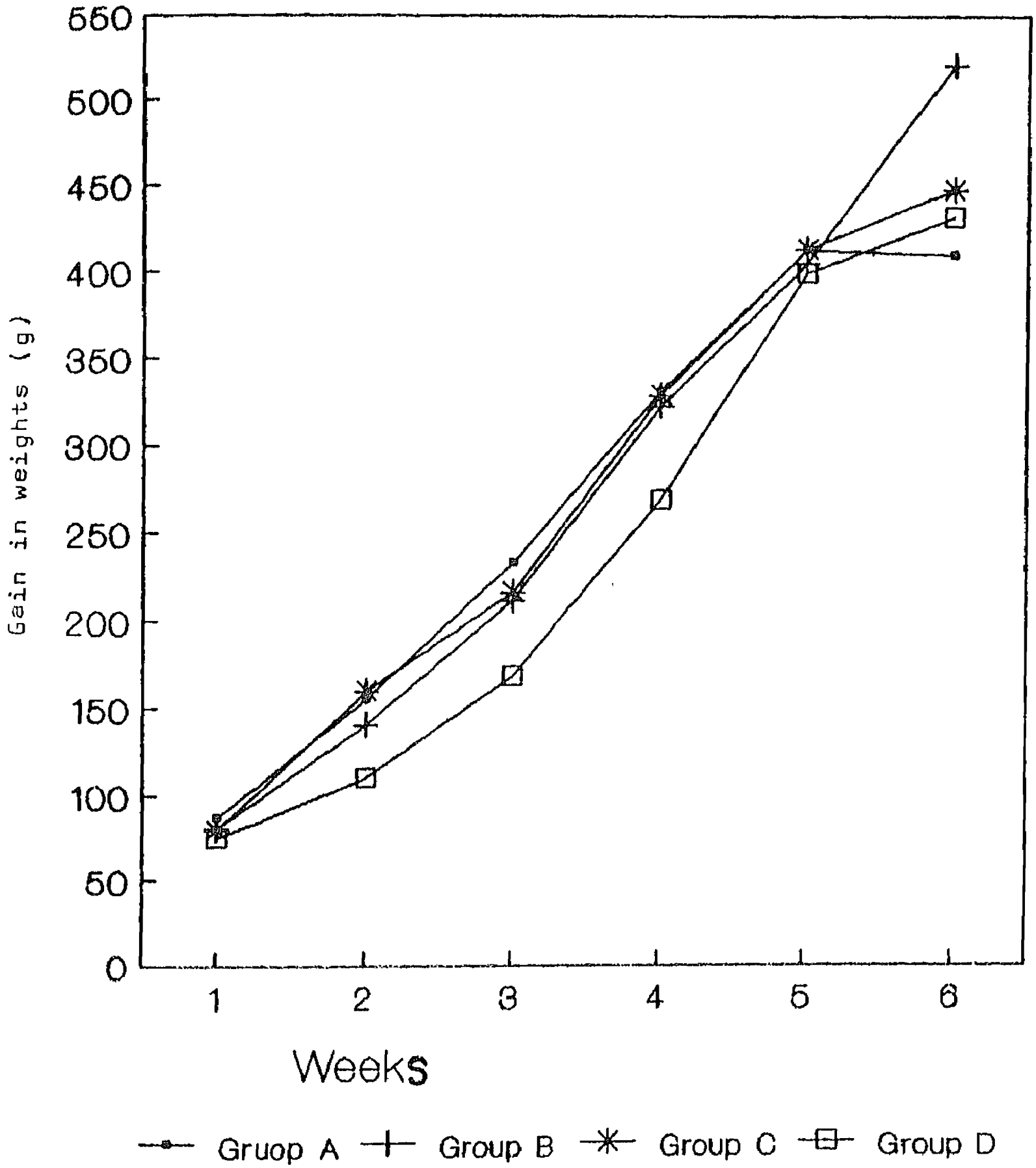
WEEKS	GROUPS			
	A	B	C	D
I	86.92	80.67	79.91	74.93
II	155.74	141.29	160.44	110.77
III	238.20	211.73	216.27	168.95
IV	331.55	322.66	328.77	269.22
V	412.72	404.53	413.13	399.13
VI	409.59	520.80	447.32	431.53
Total	1629.72	1681.68	1645.84	1454.53
Average	271.62	280.28	274.31	242.42

Table - 6 : Analysis of variance

Sources	D.F.	S.S.	M.S.S.	F
Treatments	3	5130.50	1710.17	3.05^{NS}
Weeks	5	440215.90	88043.18	157.20**
Error	15	8401.30	560.08	
Total	23	453747.70		

** - Significant at 1% level.

Figure - 2. Average weekly gain in weights(g) of chicks on different treatments from day - old to six weeks.



Naik (1988) reported non - significant differences in body weight gains when hybrid jowar replaced maize upto 66 percent. The present findings corroborated with the above.

FEED CONSUMPTION:

The average weekly feed consumption of the chicks in different treatments from day - old to six weeks is given in Table - 7 . From the table it is evident that the average feed intake of the birds from group C was maximum followed by groups A, B and D, respectively. The average daily feed consumption per bird were 90.40, 87.20, 93.92 and 88.62 g, respectively for groups A, B, C and D. Thus, inclusion of finger millet at various levels in broiler mash did not affect the feed intake of the birds. The same trend is also evident from Figure - 3.

The average weekly feed consumption data were subjected to statistical analysis and the results are presented in Table - 8. The results revealed significant ($P < 0.05$) differences among the various treatments. Hence, the data were further subjected to critical difference test for the comparison of the treatments. It was seen that chicks from group C consumed significantly more feed than groups B and D. However, the differences between the groups A, B and D were statistically non - significant. Similarly, the difference between control and 50% replacement group C was also statistically non - significant. It was also seen that

Table - 7 : Average weekly feed consumption (g) of chicks on different treatments from day - old to six weeks.

WEEKS	GROUPS			
	A	B	C	D
I	140.10	128.33	129.36	123.68
II	277.71	264.49	331.12	252.54
III	462.44	437.07	468.23	447.95
IV	605.72	603.84	634.67	576.28
V	836.02	775.48	825.73	831.22
VI	932.50	929.93	992.16	958.55
Average	542.41^{ab}	523.19^{a}	563.54^{b}	531.70^{a}

N.B. : Those means with common superscript do not differ significantly from each other.

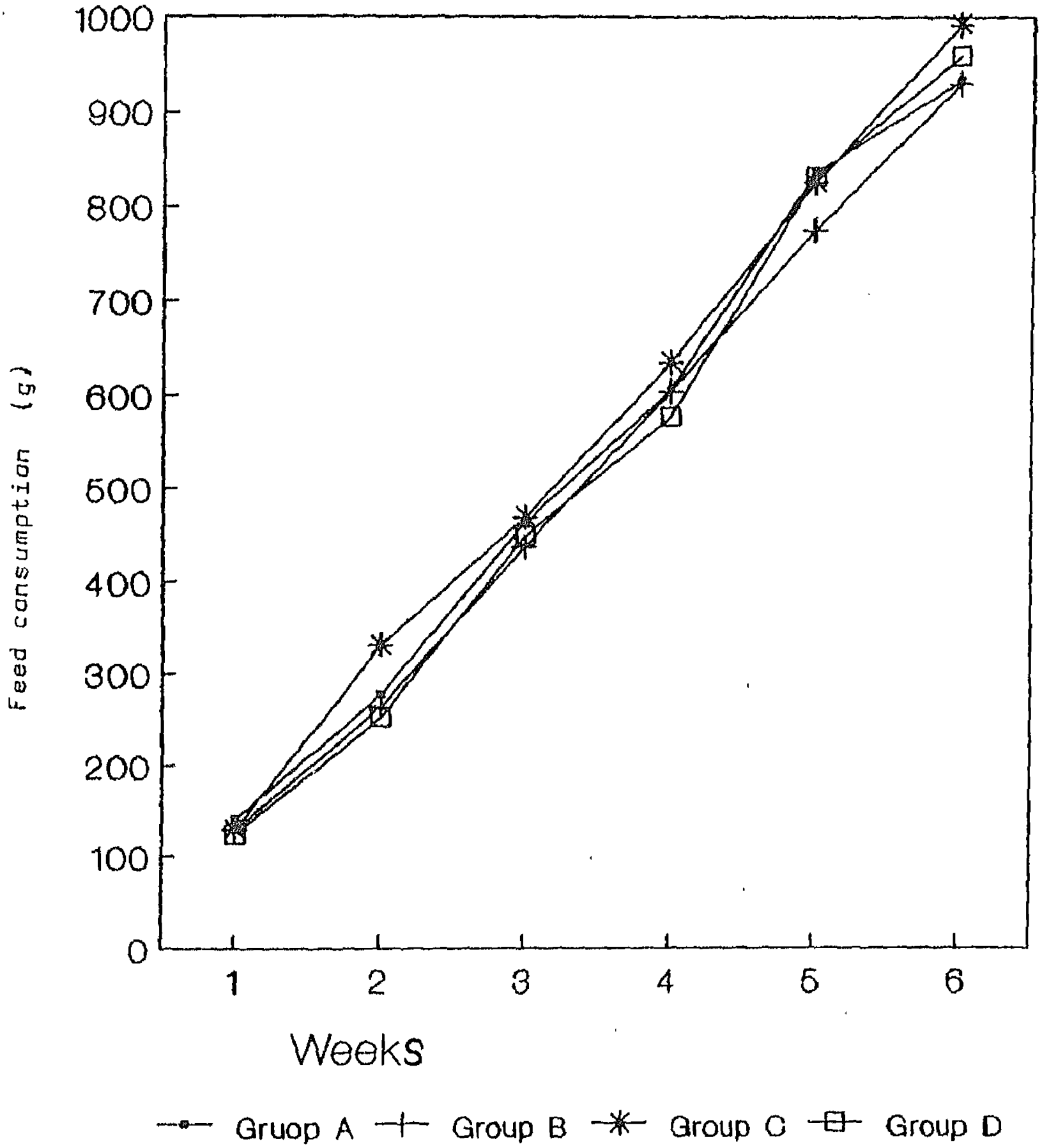
Table - 8 : Analysis of variance

Sources	D.F.	S.S.	M.S.S.	F
Treatments	3	5468.11	1822.70	5.00*
Weeks	5	1975542.40	395108.48	1084.37**
Error	15	5465.49	364.37	
Total	23	1986476.00		

* - Significant at 5% level. ** - Significant at 1% level.

C.D. value for treatment means at 5% = 23.48

Figure - 3. Average weekly feed consumption (g) of chicks on different treatments from day - old to six weeks.



chicks from group B consumed less feed, but gained more than the other groups. This suggested that finger millet did not adversely affect the feed consumption of the birds when included in broiler mash to replace maize upto 75% level.

Damron *et al*. (1968) reported no adverse effect on feed intake when sorghum replaced 50 percent of maize in diet. Syed *et al*. (1975) also reported no adverse effect on feed intake of broilers receiving 25,50,75 or 100 percent of maize replaced with sorghum. The findings of the present trial are in agreement with these.

FEED EFFICIENCY :

The average weekly feed efficiency in terms of feed intake per unit gain for different groups from day - old to six weeks is presented in Table - 9. The same is also presented graphically in *Figure* - 4. The average feed efficiency ratio for the control and groups B,C and D were 1.92, 1.85, 2.00 and 2.17, respectively. This indicated that the efficiency of utilization of feed was better in chicks from group B, followed by groups A, C and D, respectively.

The data of weekly average feed efficiency were subjected to statistical analysis and the results of the same are presented in Table - 10 . The results revealed significant ($P < 0.01$) differences among the different treatments and weeks. Therefore, the different treatment means further subjected to critical difference test for comparison. It was noticed that

Table - 9 : Average weekly feed efficiency of chicks on different treatments from day - old to six weeks.

WEEKS	GROUPS			
	A	B	C	D
I	1.61	1.59	1.62	1.65
II	1.78	1.87	2.06	2.27
III	1.98	2.06	2.16	2.65
IV	1.83	1.87	1.93	2.14
V	2.02	1.92	2.00	2.08
VI	2.28	1.78	2.21	2.22
Average	1.92^{a}	1.85^{a}	2.00^{ab}	2.17^{b}

N.B.: Those means with at least one common superscript do not differ significantly from each other.

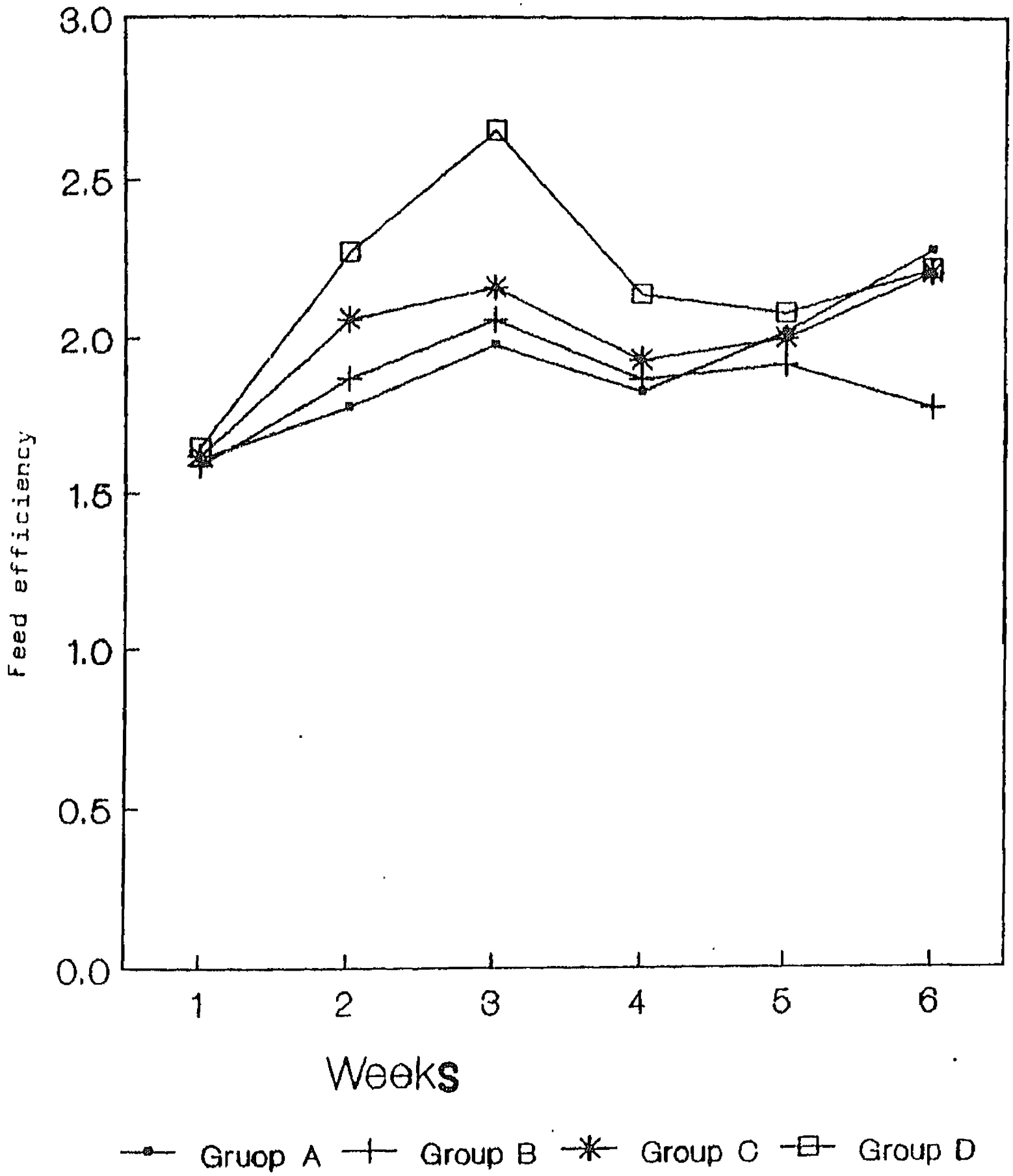
Table - 10 : Analysis of variance

Sources	D.F.	S.S.	M.S.S.	F
Treatments	3	0.342417	0.114139	5.67^{**}
Weeks	5	0.831950	0.166380	8.26^{**}
Error	15	0.302083	0.020139	
Total	23	1.476450		

** - Significant at 1% level.

C.D. value for treatment means at 5% = 0.17

Figure - 4. Average weekly feed efficiency of chicks on different treatments from day - old to six weeks.



there is no significant difference among the feed efficiency of chicks in groups A, B and C. However, the feed efficiency of chicks in group D was significantly lower than those from groups A and B. This indicated that incorporation of finger millet in broiler mash to replace maize upto 50 percent did not affect efficiency of utilization of feed.

Patel (1983) reported non-significant difference in feed efficiency when hybrid jowar replaced maize upto 50 percent level. Similar findings are also reported during this study.

The overall data of growth, feed consumption and feed efficiency for the six weeks period are presented in Table - 11.

Table - 11 : Overall performance of the broilers on different feed treatments.

Groups	Initial live weight (g)	Final live weight (g)	Total gain in weight (g)	Total feed consumption (g)	Feed efficiency (Feed /gain)
A	41.23	1670.95	1629.72	3254.49	1.92
B	41.27	1722.95	1681.68	3139.14	1.85
C	42.69	1686.53	1645.84	3381.27	2.00
D	42.68	1497.21	1454.53	3190.22	2.17

The table revealed that the initial live weights for the groups A,B,C and D were 41.23, 41.27, 42.69 and 42.68 g, respectively. The corresponding final live weights were 1670.95, 1722.95, 1688.53 and 1497.21 g. The average total gain in weights during six weeks period were 1629.72, 1681.68, 1645.84 and 1454.53 g for the groups A, B, C and D, respectively.

The chicks receiving diet with 25 percent maize replaced by finger millet gained the most followed by those receiving 50 percent maize replaced by finger millet. The average total feed consumption by groups A, B, C and D was 3254.49, 3139.14, 3381.27 and 3190.22 g, respectively. The overall feed efficiency ratios were 1.92, 1.85, 2.00 and 2.17 for the groups A, B, C and D. The best feed efficiency was recorded by group B, followed by groups A, C and D, respectively. Groups A and C showed almost similar feed efficiency. Thus, from the overall performance of the broilers, it was concluded that maize in the broiler mashes can be replaced satisfactorily by finger millet upto 50 percent level.

During the entire experimental period, the record of mortality was also maintained. The mortality for groups A, B, C and D was 2,2,1 and 2 birds, respectively.

ENERGY ESTIMATION OF DIFFERENT MASHES :

A metabolic trial of seven days duration was conducted during the sixth week of the experimental period, to

study the nitrogen retention and metabolizable energy of the different treatment mashes. Three birds from each group were selected randomly and housed in separate metabolic cages. During the metabolic trial, birds from each group were fed the respective mashes as per the same daily routine. The records of the metabolic trial are presented in Appendix - I . The gross energy values for the respective mashes and excreta were estimated in the "Parr Adiabatic Oxygen Bomb Calorimeter".

The average daily nitrogen intake, total nitrogen excretion, total and percent nitrogen retention for the different groups are presented in Table - 12.

Table - 12 : Average daily nitrogen intake, excretion and retention per bird.

Groups	Total nitrogen intake (g)	Total nitrogen excreted (g)	Total nitrogen retention (g)	Nitrogen retention (%)
A	4.05	1.96	2.09	51.60
B	4.13	1.45	2.15	52.06
C	4.07	2.51	1.56	38.33
D	5.17	2.90	2.27	43.91

From the table, it is seen that the highest nitrogen intake was by group D, followed by groups B,C and A, respectively, whereas groups D and C excreted the most nitrogen followed by groups A and B, in that order. The

percent nitrogen retention were higher for group B with 25 percent replacement of maize by finger millet as compared to other groups. These results are in agreement with the findings of Saxena and Pradhan (1979) who reported higher nitrogen retention for the sorghum groups than for maize groups in starting period. The average daily gain in weights during the metabolic trial for groups A, B, C and D were 57.28, 73.97, 62.76 and 60.79 g, respectively. It was noticed that higher percent nitrogen retention was seen with group B which correlated with higher body weight gain than the other experimental groups. However, for the other experimental groups no consistent trend in nitrogen retention and gain in weights was observed during the metabolic trial.

The results of the metabolic trial are presented in Table - 13.

Table - 13 : Results of the metabolic trial

Groups	Gross energy of mashes (Kcal/Kg)	Gross energy of excreta (Kcal/Kg)	Gross energy of excreta/g of dry matter consumed (Kcal/g)	Nitrogen retention / g dry matter consumed (g)	Metaboli zable energy (Kcal/Kg
A	4213.98	3441.26	0.9984	0.0192	3057.8
B	4263.64	3671.27	1.2030	0.0185	2909.0
C	4141.21	3399.17	1.0925	0.0129	2942.7
D	4110.58	3407.23	1.3070	0.0148	2681.9

It is seen from the table that the gross energy values of the different mashes ranged from 4110.58 to 4263.64 Kcal/Kg. The gross energy of mash B was highest followed by mashes A, C and D. The nitrogen retention per gram of dry matter consumed varied from 0.0129 to 0.0192 g. The maximum metabolizable energy was observed in the control group, followed by groups C, B and D.

The lowest metabolizable energy values for group D correlated with its poor performance during the trial. However, no clear relation was seen between gain in weights and metabolizable energy. It was noticed that replacement of maize at various levels reduced the metabolizable energy, though the trend was not consistent.

ECONOMICS OF BROILER PRODUCTION :

The economics of broiler production is presented in Table - 14 . From the table, it is seen that the cost per kg of the mash for groups A, B, C and D was Rs. 5.41, 5.15, 4.85 and 4.57, respectively. This indicated that the inclusion of finger millet reduced the cost of mash. The total cost of production per bird during six weeks period was Rs. 27.60, 26.26, 26.40 and 24.58 for the groups A, B, C and D, respectively. The corresponding profit per bird was Rs. 10.83, 13.34, 12.43 and 9.85. Similarly, the average profit per kg gain in weight was Rs. 6.48, 7.76, 7.38 and 6.60 for the respective groups. This indicated that broilers fed the mashes

Table - 14 : Economics of broiler production

Items	GROUPS			
	A	B	C	D
Average feed consumed /bird(g)	3254.49	3139.14	3381.27	3190.22
Average body weight /bird(g)	1670.95	1722.95	1688.53	1497.21
Cost of mash (Rs./kg)	5.41	5.15	4.85	4.57
Cost of mash consumed(Rs.)/bird	17.60	16.16	16.40	14.50
Miscellaneous cost (Rs.)/bird *	10.00	10.00	10.00	10.00
Total production cost(Rs.)/bird	27.60	26.26	26.40	24.58
Average price realised/bird on sale **	38.43	39.60	38.82	34.43
Average profit per bird(Rs.)	10.83	13.34	12.43	9.85
Cost of production per Kg gain (Rs.)	16.52	15.24	15.62	16.40
Profit /Kg gain(Rs.)	6.48	7.76	7.38	6.60

* = Includes chicks, labour, medication, vaccination and other overheads.

** = Broilers sold @ Rs.23.00 /Kg live weight.

in which maize was replaced at 25 and 50 percent levels by finger millet made more profit as compared to control group. Further, highest profits were realised with the broilers given mash with 25 percent replacement of maize by finger millet.

The birds fed with 75 percent replacement of maize with finger millet realised less average profit per bird than the control, however, profit per kg gain in weight was marginally higher than the control.

In general, it is observed from this study that maize in the broiler mashes can be replaced successfully by finger millet upto 50 percent level. Further, the inclusion of finger millet reduced the cost of mash without affecting the performance and thus resulted in better profitability of the broilers.

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

The experiment on feeding of finger millet (*Eleusine coracana*) as a substitute for maize, the principal energy source was conducted on "Anak 2000" broiler chicks. For the trial, two hundred day-old chicks were randomly divided into four groups viz. A, B, C and D and housed in separate compartments in a deep litter shed. Group A received the control mash with maize. The groups B, C and D received mash containing finger millet replacing maize at 25, 50 and 75%, respectively. The entire experiment lasted for six weeks and single mash formula was used throughout the experimental period.

The weekly body weights, gain in weights, feed consumption and feed efficiency were studied during the experiment. A metabolic trial of seven days duration was conducted during the sixth week of the experimental period on three birds from each group. "Parr Adiabatic Oxygen Bomb Calorimeter" was used for the estimation of gross energy of different mashes and excreta.

The average body weights at the end of sixth week for groups A, B, C and D were 1670.95, 1722.95, 1688.53 and 1497.21 g, respectively. The statistical analysis revealed that the differences among the experimental group A, B and C were non-significant. Group B with 25% replacement of maize with finger millet gained more body weight than the other

experimental groups. However, significant depression was observed in live weight of birds fed diet with 75% replacement of maize with finger millet as compared with the other experimental groups.

The total gain in weight during six weeks period were 1629.72, 1681.68, 1645.84 and 1454.53 g for groups A, B, C and D, respectively. Highest weight gain was observed in group B followed by groups C, A and D, respectively. It was observed that the differences in weight gain among the control, group, B and C were non-significant, while the body weight gain was significantly lower in group D as compared to other groups.

The average total feed consumption per bird for the six weeks period in groups A, B, C and D were 3254.49, 3139.14, 3381.27 and 3190.22 g, respectively. The statistical analysis of the average weekly feed consumption revealed that there was non-significant differences among feed consumptions of the control and experimental groups B, C and D. However, group C differed significantly from group B and D.

The average feed efficiency ratio for the entire period of six weeks was 1.92, 1.85, 2.00 and 2.17 for groups A, B, C and D, respectively. On statistical analysis it was noticed that the differences among the control, and the experimental groups B and C were non-significant. While group D differed significantly from groups A, B and C. The feed

efficiency ratio of the bird from the group B was better than the other groups indicating better feed utilization.

The result of the metabolic trial revealed that the average daily nitrogen retention for groups A, B, C and D was 2.09, 2.15, 1.56 and 2.27 g, respectively. The corresponding estimated metabolizable energy values were 3057.8, 2909.0, 2942.7 and 2881.9 Kcal/Kg. It is observed that higher nitrogen retention in group B correlated with higher body weight gain. It was noticed that the inclusion of finger millet reduced the metabolizable energy content of the mash, however, the performance of the broilers remained unaffected when it was incorporated to replace maize upto 50% level.

The overall profit per bird calculated for the entire trial period for the groups A, B, C and D was Rs. 10.83, 13.34, 12.43 and 9.85, respectively. It is observed that the maximum profit was realised when finger millet replaced 25% of maize, followed by the group with 50% replacement of maize by finger millet.

Thus, the overall results of the study indicated that maize in the broiler mashes can be successfully replaced by finger millet upto 50 percent without affecting the performance of the broiler. Further, the inclusion of finger millet reduced the cost of the mash and resulted in better profitability.

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APPENDIX

Appendix - I

Results of metabolic trial

Items	GROUPS			
	A	B	C	D
Daily feed consumed (g)	118.90	127.33	130.14	165.57
Dry matter in feed (%)	91.43	91.03	92.50	92.44
Dry matter intake /day(g)	108.71	115.91	120.38	153.05
Daily fecal matter excreted (g)	113.14	140.57	133.57	213.33
Dry matter in the excreta (%)	27.88	27.00	28.97	27.52
Dry matter excreted in feces (g)	31.54	37.95	38.69	58.71
Fecal dry matter/g of dry matter intake (g)	0.2901	0.3274	0.3213	0.3836
Nitrogen in the feed (%) (on dry matter basis)	3.73	3.56	3.38	3.38
Total nitrogen intake (g)	4.05	4.13	4.07	5.17
Nitrogen in wet feces (%)	1.73	1.41	1.88	1.36
Total nitrogen excreted (g)	1.96	1.98	2.51	2.90
Total nitrogen retained (g)	2.09	2.15	1.56	2.27
Nitrogen retained/g of dry matter intake (g)	0.0192	0.0185	0.0129	0.0148

The figures represented in this table indicate an average of seven days and three birds for respective groups.

CERTIFICATE

The Viva-Voce examination of **MOHAN RAMBHAU MANTHANWAR** was conducted on 14/8/1992 and the necessary corrections/ modifications suggested by the external Examiner and the advisory committee members have been duly carried out and the thesis is submitted in the bound form for onward transmission.

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