EFFECTS ON PERFORMANCE OF BROILERS FED DIFFERENT SOURCES AND LEVELS OF PROTEIN, WITH AND WITHOUT ANTIBIOTIC (CTC)

by

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INTRODUCTION

Many investigations have shown soybean to be a superior plant protein source in poultry diets. It contains the nutritionally important amino acids except the sulfur amino acids methionine and cystine which can easily be added as supplements in the feed. Soybean meal is therefore the popular plant protein supplement of poultry feeds in many countries including the United States where the plant (soybean) is grown extensively. In some other countries, including Nigeria, planting of soybean is not very popular, hence it is not produced in sufficient amount to meet the need of poultry farms. Some other plant protein sources are therefore in use, including cottonseed meal.

Cottonseed meal, considered as one of the major plant protein supplements in poultry feeds (Scott et al., 1976), has been reported unfavorable to chickens, especially when fed as the only protein supplement in the diet. It is deficient in lysine and methionine (Grau, 1946). It is also low in leucine. Even when degossypolized, many workers have reported that it has not promoted satisfactory growth responses in broilers.

Despite these defects, some farmers have found it necessary to include cottonseed meal in their poultry feeds, due either to scarcity of other plant protein supplements or to ready availability and cheapness of the cottonseed meal. If cottonseed meal is economical to purchase, it is pertinent to seek a way of improving it for poultry use. Many workers have reported that feeding cottonseed meal along with other supplements has resulted in significant nutritional improvement. Examples of other supplements include fish meal and antibiotics, for example chlortetracycline (CTC).

The objectives of this research were to investigate (1) the comparative nutritional value of cottonseed plus fish meal protein diets with soybean protein diets on the basis of:

(a) weight gain

(b) feed utilization

(c) feed intake

(d) mortality

(2) the effects of absence or presence of CTC in each of the four main diets in line with the above criteria, and (3) which of three protein levels of soybean protein diets (with or without antibiotic - CTC) will best support broiler growth rate and feed utilization.

REVIEW OF LITERATURE

Soybean meal has become the most important plant protein supplement in poultry feeds due in part to its low fiber content compared with cottonseed meal and other plant protein supplements (Nwokolo et al., 1976a).

Evaluation of supplemental protein sources for broilers by Galal et al. (1977) showed that soybean meal was far superior to cottonseed meal and single-cell protein (torula yeast) as a sole source of supplemental protein. They also showed that gain per unit of feed consumed declined linearly as cottonseed protein replaced soyprotein in the soy-cottonseed diet. Sanford and Aduku (1975) reported that soybean meal was superior to peanut meal.

Soybean meal having most of its hull usually contains 44% protein and when dehulled, 50% protein (Card and Nesheim, 1966). When comparing concentration and availability of amino acids from palm-kernel, cottonseed and rapeseed meals, soybean meal was superior to all (Nwokolo et al., 1976a). Netke and Scott (1968) reported that in solvent extracted soybean meal, all the essential amino acids were appreciably available. Manoukas et al. (1968) reported that the niacin (a B-complex vitamin) content of soybean meal was 100% available to the hen.

Evidence has been provided for the superiority of soybean meal over some other plant protein supplements in mineral availability, especially calcium, phosphorus, magnesium, manganese, zinc and copper (Nwokolo et al., 1976b; Griffith, 1968; Lease and Williams, 1967).

The feeding value of some of the soybean by-products also contributes to the importance of soybeans. For example, the increase in dietary soybean oil from 4 to 10% resulted in significant increases in xanthophyll deposition in the back skin of both 7 and 8 week old birds (Heath and Shaffner, 1972). Acidulated soybean soapstock was found to contain 168 - 260 mcg/gm xanthophylls and therefore may serve as a pigmenter for broilers (Bornstein and Budowski, 1967). Data obtained with growing chicks fed a semi-purified diet indicated that choline from crude soybean lecithin is as well utilized as synthetic choline chloride, on the basis of growth, relative liver weight and prevention of perosis (Lipstein et al., 1977).

Various workers have indicated a number of limitations in the use of soybean meal despite its superiority over other plant protein ingredients. Warnick and Anderson (1968) identified sulfur containing amino acids i.e. methionine and cystine as most limiting in all soybean meals studied, followed by threonine, valine and lysine. They indicated that most, if not all of the essential amino acids in the raw soybean meal were less available to the chick than they were in the same meal after heat treatment. They also reported that overheating the meals reduced the amount of available lysine.

As much as 40% cystine and 20 to 30% methionine may be destroyed during acid hydrolysis of soybean (Nelson et al., 1976). Feeding a 17% protein sorghum grain-soy diet unsupplemented with methionine, lysine and arginine, resulted in significant reduction in gain of 4-weeks old chicks (Waggle et al. 1967). Sanford (1978) obtained positive results supplementing corn-soy diets with zinc-methionine.

As much as $^{2}/_{3}$ of soybean meal phosphorus is found to be bound as phytate. Nelson et al. (1968) used a phytase produced by Aspergilus ficuum and other molds to hydrolyze phytate phosphorus in soybean meal. They found that chicks utilized this hydrolyzed phytate phosphorus as efficiently as they did inorganic phosphorus, whereas chicks did not utilize phytate phosphorus in untreated soybean meal.

Another problem with the use of soybean meal is that trypsin-inhibitor in raw soybean is one of the factors affecting its utilization by chicks (Ham et al., 1945), due to considerable reduction of trypsin proteolytic activity (Kakade et al., 1967). Raw soybean meal causes growth inhibition, pancreatic hypertrophy and reduced protein efficiency in the chick (Kakade et al., 1967; Saxena et al., 1961). Fisher (1963) contended that the nutritional defect in raw soybean diets resulted from unavailability of amino acids and poor caloric utilization.

Various problems with raw soybean have initiated various processing procedures. Commercial soybean meal is usually solvent extracted and it has proved to be the best compared to others obtained by various processing methods. In terms of converting feed to gain, Hull et al. (1968) reported that solvent extracted soybean meal was better than infra-red cooked meal, but of about the same quality as extruded meal. While pelletted feeds containing solvent extracted soybean meal did not affect growth or gain response, they found it significantly improved feed utilization of diets containing the infra-red cooked or extruded meal. White et al. (1966) reported that feeding of infra-red cooked, extruded or autoclaved soybean meals resulted in body weight gains and feed utilization that did not differ significantly from the commercial solvent-extracted soybean meal diets.

Evans et al. (1947) found that heated soybean meals were digested more completely than the raw ones, and that heating induces greater availability of amino acids (Smith and Scott, 1965; Gutteridge et al., 1961). Feeding of beans heated at 112°C for 20 minutes was found to give better growth response than feeding those heated at the same temperature for 5 to 8 minutes (Featherson and Rogler, 1966).

Another soybean processing method currently being investigated is fermentation. Chah et al. (1975; 1976) reported that feeding soybeans fermented with six species of Aspergilli gave significantly improved weight gain and feed efficiency, with responses being greater for the lowest protein diets. None of the cultures induced mortality. The economics of feeding fermented soybean to large flocks however had yet to be determined.

Cottonseed meal represents one of the most inexpensive sources of plant protein for poultry feeding in some parts of the world, especially in many tropical areas. Though some nutritional problems have been identified with the use of cottonseed meal, many workers have given encouraging reports regarding nutritive values of this meal. In an experiment conducted at a College of Agriculture in Iran, Bondari and Kazemi (1975) affirmed that proteins from cottonseed meal could replace animal proteins (fish meal and meat meal) in the ration without harmful effects. The animal protein free ration proved to be economically advantageous.

Waldroup et al. (1967; 1968) reported that glandless cottonseed meal could be used to replace part or all of the solvent extracted soybean meal in nutritionally adequate broiler diets. Lysine supplementation of cottonseed meal was necessary only when more than 75% of the soybean meal was replaced. It has also been reported by many workers that degossypolized cottonseed meal could be used to replace 50 to 80% of soybean meal in balanced rations for broilers (Curtin, 1954; Morgan and Willimon, 1954; West, 1955).

Supplementing cottonseed meal has also produced encouraging results. For example, when supplemented with five limiting amino acids (lysine, methionine, isoleucine, threonine and leucine) glandless cottonseed meal had a net protein utilization (N.P.U.) value equivalent to that of methionine-supplemented soybean meal or other high quality proteins (Fisher and Quisenberry, 1971). With 0.3% lysine supplementation, corn-cottonseed meal ration was 90% as effective as the corn-soybean meal ration (Farr and Watts, 1967). German and Sherwood (1948) found that using 4% fish meal supplements gave no significant difference between 20% soybean oil meal and 20% cottonseed oil meal with respect to the growth of starter chicks.

Cottonseed meal has also been shown to be of value in other areas of nutrition. Cantor and Scott (1972) revealed that biological availability of selenium is greater from cottonseed meal than from either soybean meal or menhaden fish meal. Cottonseed meal has also been shown to prevent toxicity of vanadium in chicks (Berg and Lawrence, 1971).

Limitations in the use of cottonseed meal have been associated by various workers with certain undesirable characteristics, for example presence of gossypol and phytin, deficiency of certain essential amino acids and high fiber content in some samples.

Gossypol is a yellow polyphenolic pigment in glanded cottonseed having deleterious physiological effects on chickens. Clark (1928) indicated that in cottonseed, gossypol is found both as free gossypol, which is extractable with aqueous acetone, and as bound gossypol which can be extracted only after acid treatment.

Gossypol binds protein, forming a protein-gossypol complex (Baliga and Lyman, 1957). Hill and Totsuka (1964) reported that levels of gossypol of 0.045% or higher significantly reduced metabolizable energy of a diet containing hexane-extracted glandless cottonseed meal to which the gossypol was added. There was also increase in pancreatic weight, suggesting interference by gossypol with functioning of pancreatic enzymes. Narain et al. (1957) also found 0.04% and higher levels of free gossypol were toxic and depressed body weight severely. Feed consumption was depressed at 0.02% or higher levels. However there was no mortality and replacement with a normal diet resulted in a remarkable recovery and weight gain.

Various workers have found some or all of the following amino acids limiting in cottonseed meal: lysine, methionine, isoleucine, threonine, leucine and valine (Rojas and Scotts, 1969; Fisher, 1965; Johnston and Watts, 1964; Grau, 1946). Available lysine in cottonseed meal is reduced during processing of the seed for oil by destruction (Martinez et al., 1961; Martinez and Frampton, 1958), and by the addition of gossypol to the seed protein through the formation of a schiff base with the epsilon amino groups of lysine (Conkerton and Frampton, 1959).

Naber and Morgan (1957) reported the fiber content of 44% cottonseed meal appeared to be responsible for the impaired feed utilization associated with feeding of the meal.

Phytin in cottonseed meal also poses a problem due to its interference with utilization of various minerals, particularly zinc (Lease and Williams, 1967), calcium (Pensack et al., 1958) and phosphorus (Nelson, 1967). Phytic acid reacts with mineral elements to form simple or mixed salts (phytate) as well as protein complexes. The phytate-protein complex reduces the solubility of proteins in cottonseed meal (Fontaine et al., 1946). Phytate in cottonseed meal also chelates zinc (Rojas and Scott, 1969).

Various processing methods and supplementations have been shown to improve the nutritional value of cottonseed meal. Heating has produced remarkable results. Hopkins et al. (1969) indicated, raw, glandless cottonseed meals contain a heat-labile growth inhibitor which is easily destroyed by heat during the direct solvent processing method. Johnston and Watts (1964) reported unheated hexane extracted glandless meals, when fed as the principal source of protein in a 21% protein ration, possesses a property which results in slight gumming around the beaks of the chicks. This effect was eliminated when the unextracted flakes were either mildly heated or were extracted with a homogenous solvent composed of commercial acetone, hexane and water (AHW).

Use of glandless cottonseed meal provides a way of overcoming gossypol toxicity. Mattson et al. (1960) indicated that the seed of glandfree cottonseed meal is essentially free of gossypol.

Enzymatic hydrolysis of phytin in the cottonseed meal by phytase enzyme produced by Aspergillus ficcum has been of nutritional value. Phytase hydrolyzes phytate to inositol and inorganic phosphate (Shield et al., 1969). Metabolizable energy is increased in phytase-treated meal (Miles and Nelson, 1974). Hydrolysis also caused release of phosphorus and protein (Rojas and Scott, 1969).

Supplementation of cottonseed meal diet with iron (ferrous ion) has produced weight gains over the unsupplemented diet (Davenport et al., 1969). Jonassen and Demint (1955) indicated that iron inactivates gossypol by chelation.

Processing methods of producing cottonseed meal have effects on the quality of the meal. Extraction of the raw glanded or glandless cottonseed flakes, cooked or uncooked, with a solvent mixture of AHW yielded a cottonseed meal that was richer in lysine than the conventional hexane-extracted meals (Kuck et al., 1975; King et al., 1961). Boatner et al. (1948) also reported that uncooked diethyl ether-extracted cottonseed meal and hydraulic-pressed cottonseed meal supported growth better than hexane-extracted meals.

Fish meals are commonly used at relatively low levels in poultry diets not only to supply an unidentified dietary factor, but also to supplement the proteins supplied by cereal grains and by vegetable protein supplements such as soybean and cottonseed meals (Bird et al., 1965). The effect of fish meal supplementation of poultry diets in promoting fast growth has been reported by many workers (Peischel et al., 1976; Miller et al., 1974; Hinners and McKinney, 1974; Griffith and Schexnailder, 1971; Smith and Scott, 1965).

Other values of fish meal in diets have been documented by various researchers. Spandorf and Leong (1965) reported the biological availability of calcium and phosphorus in fish meals fed to broiler chicks was about 10%. Fish meal has also been shown to be a rich source of selenium (Thompson and Scott, 1969) chloride and sulfate (Miller, 1970; Miller and Soares, 1972). Berg (1966) reported fish meal particles inhibited vanadium toxicity which produces growth depression in chick diet.

Summers (1959) reported fish solubles were a good source of unidentified growth factor (UGF). Hinton et al. (1972) indicated the UGF response from fish solubles could be attributed to their sulfate content. But in 1974, Miller reported the existence of UGF in fishery products was demonstrated by the increase in growth above that obtained by inorganic sulfate or methionine effects.

Fish meals usually differ in protein quality due primarily to the differences in biological availability of their amino acids. Soares et al. (1971) reported chicks fed poor-quality herring fish meal consistently excreted more amino acids than those fed a good quality protein regardless of environmental conditions. Waldroup et al. (1965) and Scott et al. (1962) also reported poor performance when chicks were fed fish meal of lower quality.

The level of fish meal in the diet has been shown to have an effect on its feeding value. Some workers in this area have reported contrasting results. For example, while Hinners and Costa (1973) reported progressive improvements from the fish meal diet as the feeding level increased from 0 to 10%, Hardin et al. (1964) found no significant difference in the growth rate of broilers on the three diets containing 5, 10 and 15% of a solvent extracted, 70% protein fish meal. Rojas et al. (1969) reported similar results. They found no significant differences in body weight gain or feed utilization by replacing soybean meal with peruvian fish meal in broiler diets at 3.5, 5, 8, 10, 15 and 20% levels. Anderson et al. (1968) obtained significantly greater weight gains and feed efficiency with a corn-soybean diet than with either herring or anchovy meal diets when the fish meal provided only 5% of the protein.

Schumaier and McGinnis (1969) indicated fish meal will not support maximum chick growth when it is the only source of protein. Supplementation of fish meal protein with other proteins may improve growth rate of chicks by improving amino acid balance or by some undetermined factor. Miller and Kiffer (1970) reported that fish meal fed as a sole source of protein resulted in excessive dietary level of lysine. When fish meal replaced all soybean meal in the diet, growth of broilers was significantly depressed (Waldroup et al., 1965).

Miller et al. (1970) reported length of storage at room temperature of fish meal produced a growth depressing effect on chickens.

Presence of fishy flavor in broiler meat has been one of the limitations to the use of fish meal. Webb et al. (1974) reported feeding 6.0, 8.0 and 10.0% fish meal for 16 weeks with no withdrawal produced turkey meat which was significantly more fishy and more rancid than the control. Contrarily, Hardin et al. (1964) indicated up to 15% solvent extracted fish meal in a broiler diet did not produce a fishy flavor in broiler meat.

Dansky (1962) found that 1% Menhaden fish oil in the diet of broilers was acceptable, 2% was borderline and 3 to 4% resulted in definite undesirable fishy flavor. Sala and Chiarella (1963) reported no fishy flavor was found in broilers fed 24% anchovy meal which contributed only 1.4% fish oil to the diet. Carrick and Hange (1962) found that supplementing the diet with 2% cod-liver oil did not result in off-flavor of the products but at 4% levels, serious fishy flavors were noted.

The nutritive value of fish meal can be affected by heat treatment. Smith and Scott (1965) reported a loss of available lysine to the chick upon heat treatment of fish meal. Dry heating of fish meal at about 120°C in a forced draft oven increased severity of gizzard erosion in broilers (Hopkins et al., 1976; Rinehart et al., 1976). Gizzard lining erosions were quite prevalent and severe when chicks were fed inadequate methionine; conditions were improved considerably but not totally prevented by the 0.7 to 1.25% levels of sulfur amino acids in the diet (Muller et al., 1975).

Treatment of fish meal with anti-oxidant has also resulted in improving nutritional value of the meal. Ousterhout and Matterson (1968) reported ethoxyquin additions to fish meal generally improved metabolizable energy contents and lysine availability up to 20%.

Inclusion of antibiotics especially chlortetracycline (CTC) in poultry feeds has been reported to be of great value to the birds. CTC is an antibiotic isolated from Streptomyces aureofaciens.

Chlortetracycline addition to poultry diets was reported by many workers not only to prevent disease occurrence, but also promote growth and feed efficiency (Miller, 1979; Begin, 1971; Robblee and Biely, 1970; Borgo and McGinnis, 1968; Moran and McGinnis, 1968; Turk, 1967). Fowler and Quisenberry (1968) indicated CTC increased feed consumption of hens during summer. CTC has been reported to prevent mortality due to Pasteurella multocida (Wang et al., 1973; Prier, 1950), Salmonella typhimurium (Quarles et al., 1977), Mycoplasma gallisepticum (Simkins et al., 1970) and aflatoxicosis (Smith et al., 1971).

The efficacy of antibiotics in promoting growth has been explained to be due to their action against those intestinal microbes interfering with absorption of nutrients (Eyssen and DeSommer, 1963). Supporting this view, Lotenkov and Podluzknaya (1967) reported that CTC at 20 mg/kg feed stimulated intestinal absorption of amino acids in chicks. Pensack and Huhtanem (1963) postulated dietary antibiotics exert their growth stimulating effect during a limited critical period early in the life of the chick. During this period malabsorption of feed nutrients is suppressed, resulting in increased weight gains, improved feed efficiency and decreased fecal output. Biely and March (1951) on the other hand explained growth response due to antibiotics may be due, in some instances, to a sparing effect on the dietary requirement for B-complex vitamins.

The tetracycline antibiotics have been reported to lose their potency due to heat and alkaline treatment (Cima and Berti, 1955), and due to presence of calcium ions in the intestine (Price et al., 1958). The calcium ions cause formation of non-absorbable CTC-calcium complexes at the site of CTC absorption in the intestinal tract, thereby reducing or preventing CTC absorption.

Many workers have reported that sodium sulfate has successfully potentiated CTC, thus reducing the non-absorbable CTC-calcium complexes and increasing the blood level of CTC much higher than in birds fed CTC alone (Stuart et al., 1966; Gale and Baugn, 1965; Nelson et al., 1964; Nelson and Peeler, 1961). Peterson (1958) in another work reported, terephthalic acid also potentiated CTC significantly.

Some side effects of CTC have been reported. Menge (1973) stated CTC had no significant growth stimulatory effect on birds when fed animal protein diets. March and Biely (1967) reported antibiotics administration increased the incidence of curled toe paralysis in chicks fed a riboflavin-deficient diet.

MATERIALS AND METHODS

Four broiler starter diets were formulated containing three different levels of protein, 24, 22, 20 and 20%, respectively. The first three, i.e. the 24, 22 and 20% protein diets contained soybean meal as the source of protein. The fourth diet contained degossypolized cottonseed meal and menhadden fish meal as combined sources of protein.

The formulated diets were mechanically mixed at the Department of Grain Science and Industry feed mill, bagged, labelled, conveyed and kept at the Poultry Research Center. The diets were isocaloric. These diets constituted the first four treatments of the experiment (Treatments 1, 2, 3 and 4). To each of these diets was added 23 gms of the antibiotic chlortetracycline (CTC) per 100 lbs ration (1 lb/ton). These made up treatments 5, 6, 7 and 8. These eight diets were fed to chicks for the first four weeks of Experiments I and II. Tables of the formulated diets are contained in the Appendix (Tables A1 and A2).

The broiler finisher diets fed for the last four weeks (5 to 8 weeks of age) contained 20, 18, 16 and 16% protein, respectively. Each was 4% less than the starter diets. They were treated similar to the starter diets; the first three contained soybean meal and the fourth, cottonseed and fish meals. To each also was added 23 gms CTC per 100 lbs diet. All eight diets were also isocaloric and contained ground corn and sorghum grain as basal ingredients.

A total of 240 day-old meat-strain, Hubbard broiler male chicks were used for each Experiment. The chicks were randomized into lots, 10 chicks per lot. Lots were randomly assigned to battery pens. Three lots constituted the replicates for each diet treatment. Eight diet treatments with 3 replications each were used for a total of 24 lots as shown in the design below:-

Table 1. Experimental design

	Lots Per Diet Treatment				
	24%P S.B.M.	22%P S.B.M.	20%P S.B.M.	20%P C.S.M. + F.M.	Total
Without CTC	3	3	3	3	12
With CTC	3	3	3	3	12
					24

The chicks were vaccinated with intraocular Newcastle disease vaccine on arrival at the Poultry Research Center. All chicks were wing-banded, individually weighed and kept in electrically heated brooder batteries with wire floor for the first four weeks. They were later transferred to unheated batteries for the last four weeks where five birds were placed in each battery compartment.

Throughout the 8-week period of each experiment, feed and water were provided ad libitum. The birds were individually weighed in grams every two weeks and feed remaining was weighed back to determine the amount of feed consumed by two week periods. The first experiment was conducted during April to June and the second between August and October. This made it possible to avoid some of the hot summer months between late June and early August because there were no effective cooling facilities in the building.

The data were analyzed statistically using the two-way and pooled analyses of variance as described by Snedecor and Cochran (1971). Weight gain, feed utilization and feed intake were the main factors analyzed and compared for the treatments.

RESULTS AND DISCUSSION

Data were analyzed for averages of weight gain, feed utilization and feed intake for the 0-2, 2-4, 4-6, 6-8, 0-4, 0-6 and 0-8 weeks growing periods, respectively. Results will be presented and discussed under the heading of Source of protein, Addition of CTC, and Protein levels.

Analyses of variance and pooled means for weight gain, feed utilization and feed intake of Experiments I and II are presented in Tables 2-4. Analysis of variance data showed there were significant differences between results obtained from the two experiments during some of the growing periods. Since the two Experiments were run at different months of the year (Experiment II following Experiment I) and the birds, though same breed and from same hatchery, were hatched at different periods, these could constitute possible sources of variation in the two Experiments. Pooled data for the two Experiments is therefore a useful average. Discussion will therefore be based on these pooled results. Data for average weight gain, feed utilization and feed intake of Experiments I and II are in the Appendix (Tables A-10 to A-15).

Source of Protein

The soyprotein diets were significantly superior to the combined cottonseed and fish meal protein diets with regards to average weight gains during all the growing periods (Table 2, Figure 1). These results are consistent with the work of Nwokolo et al. (1976) and Galal et al. (1977) who reported soybean meal was of higher nutritional quality than cottonseed meal as a protein supplement in broiler diets.

Table 2. Analysis of variance of average weight gain in Expts. I & II (Pooled)

Sources of Variation	d.f.	Growing Periods (Weeks) 0-2	2-4	4-6	6-8	0-4	0-6	0-8
		Mean Squares						
Treatments	8	26824.38**	59835.96**	50212.77**	11234.21	159498.38**	382500.16**	500183.46**
Error	39	209.24	936.39	2771.39	6982.45	1308.63	3786.48	16438.52
Diets	3	57822.91**	157783.22**	127161.24**	22912.75*	409616.40**	984489.47**	1286143.90**
Antibiotics	1	414.19	432.00	3316.69	18096.33	2187.00	560.33	12128.52
Diets X Antibiotics	3	134.02	1633.56	922.35	638.00	2810.17	355.17	1508.30
Replication (Expt.)	1	40310.02**	5.33	14179.69**	990.08	36520.33**	104907.00**	126382.69**
Diets		Means - Weight gain (grams)						
1 (24%P - S.B.)		275.58[a]	544.83[a]	742.67[a]	756.33[a]	820.42[a]	1565.83[a]	2331.33[a]
2 (22%P - S.B.)		264.42[a]	530.00[a]	748.50[a]	779.83[a]	787.00[b]	1542.58[a]	2323.33[a]
3 (20%P - S.B.)		276.00[a]	534.67[a]	709.03[a]	763.83[a]	810.67[ab]	1521.75[a]	2287.25[a]
4 (20%P - C.S. + F.M.)		133.58[b]	307.50[b]	530.50[b]	681.50[b]	437.58[c]	971.67[b]	1660.33[b]
(1-4) - CTC		234.46[e]	476.25[e]	691.00[e]	725.96[e]	707.17[e]	1403.88[e]	2134.67[e]
(1-4) + CTC		240.33[e]	482.25[e]	674.38[e]	764.79[e]	720.67[e]	1397.04[e]	2166.46[e]

*Significant ($P < 0.05$)
**Significant ($P < 0.01$)
Means with the same letter are not significantly different at 5% level of probability.

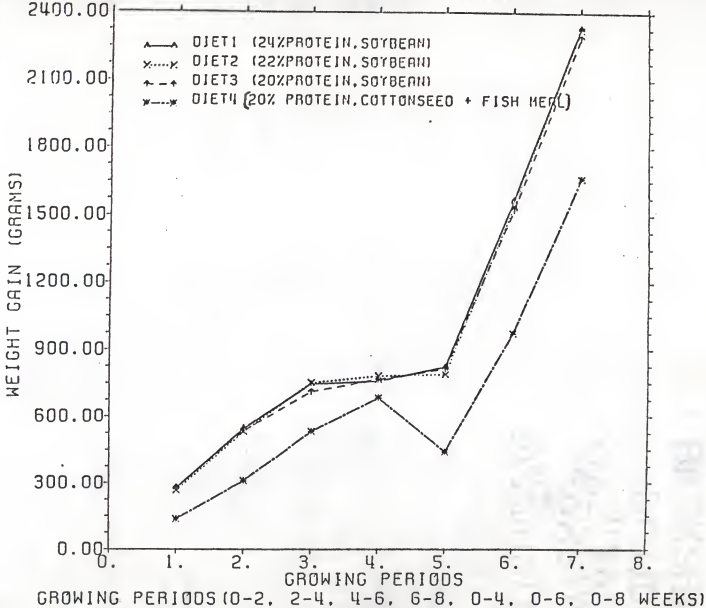

Fig. 1 Effect of Diets on Weight Gain during each Growing Period

Table 3. Analysis of variance of average feed utilization in Expts. I & II (Pooled)

Sources of Variation	d.f.	Growing Periods (Weeks) 0-2	2-4	4-6	6-8	0-4	0-6	0-8
		Mean Squares						
Treatments	8	316602.44**	146991.27**	45640.16	125221.62**	196763.06**	94709.83**	48342.55**
Error	39	10663.19	13517.26	23650.79	36703.97	8062.56	7822.44	12067.01
Diets	3	832108.13**	370111.53**	85315.58*	81225.69	509757.53**	232469.58**	96493.61**
Antibiotics	1	15444.19	10890.19	990.08	271201.33**	11011.02	33285.33*	80524.08*
Diets X Antibiotics	3	5877.91	9446.08	17017.47	1095.94	2073.63	1280.17	2077.81
Replication (Expt.)	1	3417.19	26367.19	57132.00	483606.75**	27600.02	23144.08	10502.08
Diets		Means - Feed Utilization (Kg Feed per Kg Gain)						
1 (24%P - S.B.)		1.424[c]	1.731[c]	2.249[b]	2.766[a]	1.628[c]	1.928[c]	2.241[b]
2 (22%P - S.B.)		1.501[bc]	1.782[bc]	2.240[b]	2.672[ab]	1.708[b]	1.966[c]	2.229[b]
3 (20%P - S.B.)		1.551[b]	1.863[b]	2.407[a]	2.741[ab]	1.749[b]	2.061[b]	2.336[a]
4 (20%P - C.S. + F.M.)		2.009[a]	2.126[a]	2.370[ab]	2.582[b]	2.095[a]	2.240[a]	2.420[a]
(1-4) - CTC		1.639[e]	1.890[e]	2.321[e]	2.766[e]	1.810[e]	2.075[e]	2.347[e]
(1-4) + CTC		1.604[e]	1.860[e]	2.312[e]	2.615[f]	1.780[e]	2.022[f]	2.266[f]

*Significant ($P < 0.05$)
**Significant ($P < 0.01$)
Means with the same letter are not significantly different at 5% level of probability

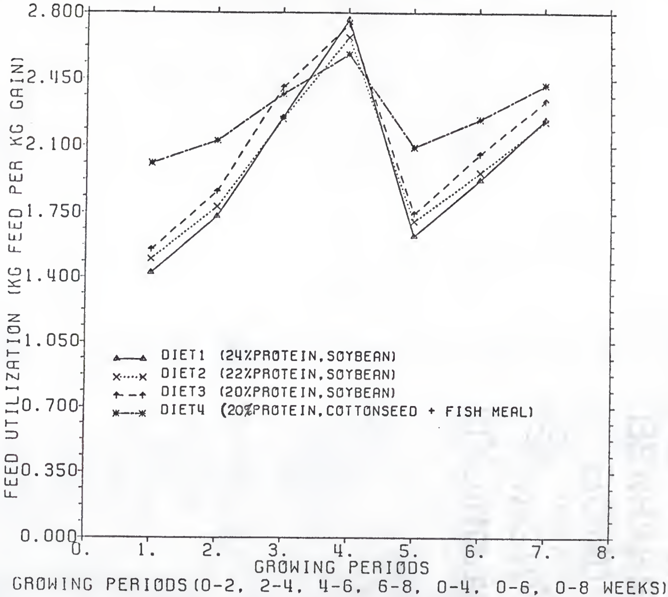

Fig. 2 Effect of Diets on Feed Utilization during each Growing Period

Table 4. Analysis of variance of average feed intake in Expts. I & II (Pooled).

		Growing Periods (Weeks)						
Sources of Variation	d.f.	0-2	2-4	4-6	6-8	0-4	0-6	0-8
		Mean Squares						
Treatments	8	33537.35**	109412.31**	206415.94**	189629.75**	235467.05**	925195.37**	1860438.26**
Error	39	406.51	1163.23	4566.58	17342.56	1915.07	21176.62	74601.25
Diets	3	59791.35**	288178.58**	541607.37**	380466.70**	605712.93**	2383732.80**	4630591.17**
Antibiotics	1	130.02	172.52	20460.02*	17.52	108.00	89441.33*	101936.33
Diets X Antibiotics	3	783.19	2130.08	144.58	2531.74	4518.50	3763.28	8766.50
Replication (Expt.)	1	86445.19**	4200.02	5611.69	368025.19**	52934.08**	149633.33*	863496.75**
Diets		Means - Feed Intake (grams)						
1 (24%P - S.B.)		390.92^b	942.50^b	1668.17^a	2087.83^a	1333.42^b	3017.33^a	5220.50^a
2 (22%P - S.B.)		396.92^b	943.83^b	1674.17^a	2082.33^a	1343.92^b	3030.33^a	5178.08^a
3 (20%P - S.B.)		425.75^a	988.92^a	1690.58^a	2082.33^a	1414.33^a	3131.25^a	5332.33^a
4 (20%P - C.S. + F.M.)		266.67^c	651.50^c	1253.17^b	1728.08^b	920.33^c	2174.08^b	4008.08^b
(1-4) - CTC		368.42^e	883.58^e	1592.17^e	1995.75^e	1251.50^e	2881.42^e	4980.83^e
(1-4) + CTC		371.71^e	879.79^e	1550.88^f	1994.54^e	1254.50^e	2795.08^f	4888.67^e

*Significant ($P < 0.05$)
**Significant ($P < 0.01$)
Means with the same letter are not significantly different at 5% level of probability.

Table 5. Mortality rate

Diet	Total Mortality		Pooled Total	
	Expt. I	Expt. II	No.	%
1 (24%P - S.B.M.)	3	5	8	13.3
2 (22%P - S.B.M.)	-	4	4	6.6
3 (20%P - S.B.M.)	3	4	7	11.6
4 (20%P - C.S.M. + F.M.)	6	-	6	10.0
(1-4) - CTC	7	8	15	6.25
(1-4) + CTC	5	5	10	4.17

The significantly lower consumption of the cottonseed diet could explain why birds fed this diet grew significantly poorer than those on the soyprotein diets (Table 4). Naber and Morgan (1957) suggested the high fiber content of cottonseed meal could be responsible for impaired feed utilization associated with the meal. Low palatability as well as less acceptability could be possible causes of the significantly low consumption of the cottonseed diet.

Chicks fed the soyprotein diets had significantly better feed utilization at 0-2, 2-4, 0-4 and 0-6 weeks (Table 3, Figure 2). At 4-6 weeks, there was no significant difference in feed utilization between the diets containing the two main sources of protein. This could be due to the age of the birds. From 0-4 weeks they were on starter diets. After 4 weeks they had probably adjusted to the feed and were able to utilize it better at 4-6 weeks. At 6-8 weeks, diet 4 (Cottonseed diet) was significantly better utilized than diet 1 (24% soyprotein diet), but not significantly better than diets 2 and 3 (22 and 20% soyprotein diets). At this 6-8 weeks period, the birds on cottonseed diet were believed to have made some compensatory gains, hence the significant improvement in feed utilization.

At 0-8 weeks, diets 1 and 2 were significantly better utilized than diets 3 and 4. At this period there was no significant difference in feed utilization between diets 3 and 4 (the 20% soyprotein diet and the 20% cottonseed diet). Compensatory gains as well as better feed utilization of the cottonseed diet at 4-6 and 6-8 weeks could have been responsible for this. This result complements the report of Fisher and Quisenberry (1977) that supplemented cottonseed meal had an equivalent net protein utilization with soybean meal.

Consumption of cottonseed diet did not increase mortality when compared to soyprotein diets as seen in Table 5. This result suggests that the cottonseed diet only reduced the thriftiness of the birds as the birds ate less and gained less weight but that the diet did not contain a toxin that would cause mortality. With this kind of diet mortality could be a problem if there was a disease outbreak or if the birds were exposed to infection because of their unthriftiness.

Addition of CTC

Analyses of variance showed that there was no significant interaction between diets and antibiotic with regards to weight gain, feed utilization and feed intake (Tables 2-4). This indicates that each diet had the same effect on weight gain, feed utilization or feed consumption with or without addition of the antibiotic. This non-interaction effect could be due to the raising of the birds in cages rather than floor or possible reduction in potency of the antibiotic. If birds were raised on the floor where they would be exposed to their feces with greater risk of infections, CTC might improve the effect of the diets. Cima and Berti (1955) reported tetracycline antibiotics lose their potency under heat treatment. The hot weather under which the birds were raised could reduce the potency of the CTC and hence produce less effect on the birds. These same reasons could probably explain why the CTC did not have any significant effect on weight gain throughout the growing period (Table 2).

Chlortetracycline produced a significant improvement on feed utilization at 6-8, 0-6 and 0-8 weeks (Table 3). This is in agreement with Borgo and McGinnis (1968). There was significant reduction in feed consumption as a result of CTC addition at 4-6 and 0-6 weeks (Table 4). At 4-6 weeks, the birds changed diet to finisher rations which was lower in protein. This could be a possible reason for the lowered feed consumption. This result however disagrees with the observation of Fowler (1968) that CTC increased feed consumption of hens especially during summer.

Addition of CTC to diets reduced total mortality rate from 6.25 to 4.17% (Table 5). This is expected and it agrees with Miller (1979).

Protein levels

There were no significant differences in average weight gains of broilers on the three protein levels (24, 22 and 20%) during all the growing periods except at 0-4 weeks (Table 2). At 0-4 weeks, weight gain from diet 1 (24% protein) was significantly higher than diet 2 (22% protein). There were no significant differences between diets 1 and 3 and between diets 2 and 3. Considering the average weight gains diet 3 (the lowest protein level diet) would be more preferable from an economic standpoint.

Diet 1 had significantly better feed utilization than diet 2 only at 0-4 weeks. But diet 1 was significantly better utilized than diet 3 at all periods except 6-8 weeks. At 6-8 weeks there was no significant difference between the three diets (Table 3). Diet 2 was significantly better than diet 3 at 4-6, 0-6 and 0-8 weeks. Considering feed utilization result, diet 2 would be recommended.

Consumption of diet 3 was significantly higher than diets 1 and 2 at 0-2, 2-4 and 0-4 weeks (Table 4). At other periods, there was no significant difference between the diets. There was no significant difference in consumption of diets 1 and 2. Average feed consumption of diet 3 at 0-8 weeks was higher though not significant, than either diet 1 or 2. Higher feed consumption relative to a proportional normal gain is not an advantage. From these results, diet 2 will be of preference.

Percentage mortality from the three diets were 13.3, 6.6 and 11.6 respectively (Table 5). This also puts diet 2 above the others.

From all these results, diet 2 (the 22% soyprotein starter diet) would be recommended.

SUMMARY AND CONCLUSIONS

This study was designed to find which of three levels of protein in soyprotein diets would best support broiler growth; effect of combined cottonseed meal and fish meal as protein sources in the diet; and effect of the addition of chlortetracycline to each of the diets.

Two experiments were conducted, one replicating the other, using four main diets, with and without chlortetracycline (CTC). The first three starter diets contained 24, 22 and 20% soybean meal as the source of protein. The fourth starter diet contained 20% protein using a combination of cottonseed and fish meals as sources of protein. The finisher diets contained 4% less protein than the starter diets.

Each experiment was conducted for a period of eight weeks. A total of 240 broilers were used, 30 birds per diet treatment. Weight of the birds as well as feed consumed was measured every two weeks. Data were analyzed for weight gain, feed utilization and feed consumption using the two way and pooled analysis of variance techniques.

The following conclusions could be drawn from results obtained from this research:-

1. Among the soybean protein diets, the 22% protein starter diet (18% finisher) was more preferable than either the 24 or 20% diet because it had significantly better feed utilization. It was least consumed and it supported the least mortality rate. There was no significant difference in average weight gain from the three diets.
2. The combined cottonseed plus fish meal protein diet was generally inferior to the soyprotein diets in terms of weight gain and feed intake.

Consumption of the cottonseed diets was generally below what could be considered normal, hence weight gains of birds consuming it were generally poor.

3. Feed utilization of the 20% protein soybean diet was not significantly different from that of 20% protein cottonseed meal plus fish meal diet. The later was, however, significantly poorer than the 22 and 24% protein soybean diets in feed utilization.
4. There were no significant interactions between CTC and diets for weight gain, feed utilization and feed intake.
5. It was observed that CTC produced significant improvement in terms of feed utilization at 6-8, 0-6 and 0-8 weeks. This effect was noticed when all results from four diets were pooled.
6. There was lower mortality rate among birds fed the CTC supplemented diets.
7. Though the cottonseed diet did not support weight gain and feed utilization as well as the soyprotein diets, it was found that the cottonseed diet did not increase the mortality rate.

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APPENDIX

Table A-1 Composition of the broiler starter diets

Ingredients	Concentration (lbs/100 lbs)			
	Diets (with Percent Protein)			
	24%P	22%P	20%P	20%P
Corn, ground	22.0	24.0	28.0	27.5
Sorghum grain, ground	22.0	27.0	28.5	29.0
Fat	6.0	5.0	5.0	6.0
Alfalfa meal, dehy., 17% Prot.	2.0	2.0	2.0	2.0
CDDGS[1]	1.5	1.5	1.5	1.5
Soybean meal, 44% Prot., sol. extr.	44.0	38.0	32.5	-
Cottonseed meal (degossypolized)	-	-	-	24.0
Fish meal	-	-	-	7.5
Premix A				
Dicalcium phosphate	1.0	1.0	1.0	1.0
Limestone	1.0	1.0	1.0	1.0
Salt	0.5	0.5	0.5	0.5
Total	100.0	100.0	100.0	100.0

Premix B^2 (gms)

Vitamin A (10,000 IU/gm)	-	15
Vitamin D_3 (15,000 ICU/gm)	-	6
Vitamin B_{12} (20mg/lb)	-	12
B-Complex vitamin mix[3]	-	46
D-L Methionine	-	35
Trace mineral mix[4]	-	23
Corn, ground	-	44.6
Total		181.6 gms (0.4 lb)

Antibiotic[5]

[1] Corn distillers dried grains with solubles

[2] Added in equal amounts to all rations

[3] B-complex vitamin mix supplying in mg/lb: riboflavin 8,000; Pantothenic acid 14,720; niacin 24,000; choline chloride 80,000.

[4] Trace mineral mix supplying by %: Mn 10; Fe 10; Cu 1; Zn 5; I_2 0.3; Co 0.1.

[5] Chlortetracycline (Aureomycin or aurofac 50) was added as second treatment to each of the diets at the rate of 23gms/100 lbs diet.

Table A-2 Composition of the broiler finisher diets

Ingredients	Concentration (lbs/100 lbs)			
	Diets (with percent protein)			
	20%P	18%P	16%P	16%P
Corn, ground	26.0	29.5	32.0	32.5
Sorghum grain, ground	25.5	29.0	32.0	32.0
Fat	9.0	8.0	8.0	8.5
Alfalfa meal, dehy. 17% Prot.	2.0	2.0	2.0	2.0
CDDGS[1]	1.5	1.5	1.5	1.5
Soybean meal, 44% Prot., sol. extr.	33.5	27.5	22.0	-
Cottonseed meal (degossypolized)	-	-	-	16.0
Fish meal	-	-	-	5.0
Premix A				
Dicalcium phosphate	1.0	1.0	1.0	1.0
Limestone	1.0	1.0	1.0	1.0
Salt	0.5	0.5	0.5	0.5
Total	100.0	100.0	100.0	100.0

Premix B^2 (gms)

Vitamin A (10,000 IU/gm)	-	15.0
Vitamin D_3 (15,000 ICU/gm)	-	6.0
Vitamin B_{12} (20mg/lb)	-	12.0
B-complex vitamin mix[3]	-	46.0
D-L methionine	-	35.0
Trace mineral mix[4]	-	23.0
Corn, ground	-	90.0
Total		227.0 gms (0.5 lb)

Antibiotic[5]

[1]Corn distillers dried grains with solubles

[2]Added in equal amounts to all rations

[3]B-complex vitamin mix supplying in mg/lb: riboflavin 8,000; pantothenic acid 14,720; niacin 24,000; choline chloride 80,000.

[4]Trace mineral mix supplying by %: Mn 10; Fe 10; Zn 5; Cu 1; I_2 0.3; Co 0.1.

[5]Chlortetracycline (Aureomycin or aurofac 50) was added as second treatment to each of the diets at the rate of 23gms/100 lbs diet.

Table A-3. Average 0-2 week weight gains and feed utilization, Pooled Experiments (I & II)

Diets[3]	Av. Wt. gain (gms)	Av. Feed Utilization[1]
1	275.58	1.424
2	264.42	1.501
3	276.00	1.551
4	133.58	2.009

Ranked diets for average Wt. gains[2]	3	1	2	4
Ranked diets for Av. Feed utilization[2]	4	3	2	1

[1]Kg Feed per kg gain

[2]Ranked diets are based on Duncan's Multiple Range test. Any diets not underscored by the same line are significantly different.

[3]Diets:
1 - 24%P Soybean
2 - 22%P Soybean
3 - 20%P Soybean
4 - 20%P Cottonseed + Fish meal

Table A-4. Average 2-4 week weight gains and feed utilization, Pooled Experiments (1 & II)

Diets	Av. Wt. gain (gms)	Av. Feed Utilization
1	544.83	1.731
2	530.00	1.782
3	534.67	1.863
4	307.50	2.126

Ranked diets for Av. Wt gains	1	3	2	4
Ranked diets for Av. Feed utilization	4	3	2	1

Table A-5. Average 4-6 week weight gains and feed utilization, Pooled Experiments (I & II)

Diets	Av. Wt. gain (gms)	Av. Feed utilization
1	742.67	2.249
2	748.50	2.240
3	709.08	2.407
4	530.50	2.370

Ranked diets for Av. Wt. gains	2	1	3	4
Ranked diets for Av. Feed Utilization	3	4	1	2

Table A-6. Average 6-8 week weight gains and feed utilization, Pooled Experiments (I & II)

Diets	Av. Wt. gain (gms)	Av. Feed utilization
1	756.33	2.766
2	779.83	2.672
3	763.83	2.741
4	681.50	2.582

Ranked diets for Av. Wt. gains 2 3 1 4

Ranked diets for Av. Feed Utilization 1 3 2 4

Table A-7 Average 0-4 week weight gains and feed utilization, Pooled Experiments (I & II)

Diets	Av. Wt. gain (gms)	Av. Feed utilization
1	820.42	1.628
2	787.00	1.708
3	810.67	1.749
4	437.58	2.095

Ranked diets for Av. Wt. gains 1 3 2 4

Ranked diets for Av. Feed utilization 4 3 2 1

Table A-8. Average 0-6 week weight gains and feed utilization, Pooled Experiments (I & II)

Diets	Av. Wt. gain (gms)	Av. Feed utilization
1	1565.83	1.928
2	1542.58	1.966
3	1521.75	2.061
4	971.67	2.240

Ranked diets for Av. Wt. gains: 1 2 3 4 (1, 2, 3 underlined together)

Ranked diets for Av. Feed utilization: 4 3 2 1 (2, 1 underlined together)

Table A-9. Average 0-8 week weight gains and feed utilization, Pooled Experiments (I & II)

Diets	Av. Wt. gain (gms)	Av. Feed Utilization
1	2331.33	2.242
2	2323.33	2.229
3	2287.25	2.336
4	1660.33	2.420

Ranked diets for Av. Wt. gains: 1 2 3 4 (1, 2, 3 underlined together)

Ranked diets for Av. Feed utilization: 4 3 1 2 (4, 3 underlined together; 1, 2 underlined together)

Table A-10. Analysis of variance of average weight gain in Experiment I

Sources of Variation	d.f.	0-2	2-4	4-6	6-8	0-4	0-6	0-8
		Growing Periods (Weeks)						
		Mean Squares						
Treatments	7	9021.50**	36926.55**	18569.43**	7648.00	85903.05**	161090.80**	128667.60**
Error	16	79.33	447.13	1905.38	2951.96	577.5	3135.83	5728.83
Diets	3	20875.28**	85680.94**	40235.22**	5315.78	198910.22**	373130.70**	287883.28**
Antibiotics	1	228.17	1.50	3456.00	27880.17**	42.66	1820.04	19837.50
Diets X Antibiotics	3	98.83	480.50	1941.44	3236.17	1516.00	2141.15	5728.61
Diets		Means - Weight gain (grams)						
1 (24%P - S.B.)		236.17^{b}	533.17^{ab}	735.17^{a}	708.67^{a}	769.67^{b}	1504.67^{a}	2222.00^{a}
2 (22%P - S.B.)		228.17^{b}	527.33^{b}	723.83^{a}	725.00^{a}	755.67^{b}	1479.33^{a}	2204.33^{a}
3 (20%P - S.B.)		248.50^{a}	556.50^{a}	644.33^{b}	754.33^{a}	805.00^{a}	1449.67^{a}	2199.67^{a}
4 (20%P - C.S. + F.M.)		120.83^{c}	301.33^{c}	558.67^{c}	775.33^{a}	415.00^{c}	981.17^{b}	1771.00^{b}
(1-4) - CTC		205.33^{e}	479.33^{e}	677.50^{e}	706.75^{f}	685.00^{e}	1362.42^{e}	2070.50^{e}
(1-4) + CTC		211.50^{e}	479.83^{e}	653.50^{e}	774.92^{e}	687.67^{e}	1345.00^{e}	2128.00^{e}

**Significant ($P < 0.01$)
Means with the same letter are not significantly different at 5% level of probability.

Table A-11. Analysis of variance of average weight gain in Experiment II

Sources of Variation	d.f.	Growing Periods (Weeks) 0-2	2-4	4-6	6-8	0-4	0-6	0-8
		Mean Squares						
Treatments	7	16621.57**	32979.40**	45234.38**	32375.79**	93337.43**	270371.61**	490713.14**
Error	16	104.67	1169.13	1155.88	2112.58	1661.25	2022.29	5523.79
Diets	3	38657.15**	74732.28**	104786.93**	73961.94**	214930.56**	628502.47**	1140263.93**
Antibiotics	1	187.04	793.50	513.38	541.50	3552.67	84.38	222.04
Diets X Antibiotics	3	64.15	1955.17	588.82	1401.06	1672.56	2336.49	4659.38
Diets		Means - Weight gain (grams)						
1 (24%P - S.B.)		315.00[a]	556.50[a]	750.17[a]	804.00[ab]	871.17[a]	1627.00[a]	2440.67[a]
2 (22%P - S.B.)		300.67[b]	532.67[a]	773.17[a]	834.67[a]	818.33[b]	1605.83[a]	2442.33[a]
3 (20%P - S.B.)		303.50[ab]	512.83[a]	773.83[a]	773.33[b]	816.33[b]	1593.83[a]	2374.83[a]
4 (20%P - C.S. + F.M.)		146.33[c]	313.67[b]	502.33[b]	587.67[c]	460.17[c]	962.17[b]	1549.67[b]
(1-4) - CTC		263.58[e]	473.17[e]	704.50[e]	745.17[e]	729.33[e]	1445.33[e]	2198.83[e]
(1-4) + CTC		269.17[e]	484.67[e]	695.25[e]	754.67[e]	753.67[e]	1449.08[e]	2204.92[e]

**Significant ($P < 0.01$)
Means with the same letter are not significantly different at 5% level of probability.

Table A-12. Analysis of variance of average feed utilization in Experiment I.

Sources of Variation	d.f.	Growing Periods (Weeks) 0-2	2-4	4-6	6-8	0-4	0-6	0-8
		Mean Squares						
Treatments	7	191996.09**	116868.29**	62834.04*	138185.02**	144584.33**	42698.38*	18208.89
Error	16	7933.88	4884.58	17873.66	26896.04	4183.79	11422.71	14085.29
Diets	3	447963.47**	2683343.67**	142777.49**	257736.27**	333961.17**	84363.63**	31697.04
Antibiotics	1	1.04	1204.17	35.04	168002.67*	950.04	16016.67	30317.04
Diets X Antibiotics	3	27.04	3947.61	3823.60	8694.56	3085.60	9927.00	684.71
Diets		Means - Feed Utilization (Kg Feed per Kg Gain)						
1 (24%P - S.B.)		1.468^{b}	1.771^{b}	2.273^{b}	2.751^{a}	1.678^{b}	1.953^{c}	2.253^{a}
2 (22%P - S.B.)		1.497^{b}	1.798^{b}	2.302^{b}	2.645^{a}	1.707^{b}	1.997^{bc}	2.209^{a}
3 (20%P - S.B.)		1.516^{b}	1.812^{b}	2.580^{a}	2.678^{a}	1.720^{b}	2.117^{ab}	2.361^{a}
4 (20%P - C.S. + F.M.)		2.039^{a}	2.215^{a}	2.249^{b}	2.286^{b}	2.172^{a}	2.215^{a}	2.344^{a}
(1-4) - CTC		1.630^{e}	1.892^{e}	2.350^{e}	2.674^{e}	1.813^{e}	2.096^{e}	2.327^{e}
(1-4) + CTC		1.630^{e}	1.906^{e}	2.352^{e}	2.506^{f}	1.826^{e}	2.045^{e}	2.256^{e}

*Significant ($P < 0.05$)
**Significant ($P < 0.01$)
Means with the same letter are not significantly different at 5% level of probability.

Table A-13. Analysis of variance of average feed utilization in Experiment II.

Sources of Variation	d.f.	0-2	2-4	4-6	6-8	0-4	0-6	0-8
		Growing Periods (Weeks)						
		Mean Squares						
Treatments	7	180606.86**	72765.09**	58557.28**	30548.09	94251.43**	73851.50**	47128.42**
Error	16	13131.50	16946.83	5915.75	21134.54	7634.58	2562.33	10257.87
Diets	3	399322.00**	142566.49**	119732.15**	32691.22	203367.33**	161621.39**	89567.71**
Antibiotics	1	30530.67	33227.04	2542.04	106666.67*	32120.17	17280.67*	51615.38*
Diets X Antibiotics	3	11917.11	16143.04	16054.16	3032.11	5845.94	4938.56	3193.49
Diets		Means - Feed Utilization (Kg Feed per Kg Gain)						
1 (24%P - S.B.)		1.381^{c}	1.691^{c}	2.226^{b}	2.782^{a}	1.579^{c}	1.902^{c}	2.230^{b}
2 (22%P - S.B.)		1.506^{bc}	1.766^{bc}	2.179^{b}	2.699^{a}	1.710^{b}	1.934^{c}	2.249^{b}
3 (20%P - S.B.)		1.587^{b}	1.914^{ab}	2.233^{b}	2.804^{a}	1.778^{b}	2.006^{b}	2.310^{b}
4 (20%P - C.S. + F.M.)		1.979^{a}	2.037^{a}	2.491^{a}	2.879^{a}	2.018^{a}	2.264^{a}	2.497^{a}
(1-4) - CTC		1.649^{e}	1.889^{e}	2.292^{e}	2.858^{e}	1.808^{e}	2.053^{e}	2.368^{e}
(1-4) + CTC		1.577^{e}	1.815^{e}	2.271^{e}	2.724^{f}	1.735^{e}	2.000^{f}	2.275^{f}

*Significant ($P < 0.05$)
**Significant ($P < 0.01$)
Means with the same letter are not significantly different at 5% level of probability

Table A-14. Analysis of variance of average feed intake in Experiment I.

		Growing Periods (Weeks)						
Sources of Variation	d.f.	0-2	2-4	4-6	6-8	0-4	0-6	0-8
		Mean Squares						
Treatments	7	8495.09**	61273.09**	111492.80**	32850.17*	112600.38**	465250.07**	541948.52**
Error	16	176.13	1182.95	3578.33	12194.29	1662.58	22372.45	48337.88
Diets	3	19445.71**	142318.37**	248795.82**	60732.72*	261433.60**	1020381.50**	1237848.93**
Antibiotics	1	435.04	0.38	18205.04*	22570.67	672.04	79120.17*	1053.38
Diets X Antibiotics	3	234.48	652.04	5285.71	8394.11	1076.60	38828.61	26346.49
Diets		Means - Feed Intake (grams)						
1 (24%P - S.B.)		346.83^{b}	944.17^{b}	1666.67^{a}	1942.50^{a}	1291.33^{b}	2938.83^{a}	5002.67^{ab}
2 (22%P - S.B.)		341.33^{b}	948.17^{b}	1664.50^{a}	1914.17^{a}	1289.50^{b}	2953.83^{a}	4867.83^{b}
3 (20%P - S.B.)		376.83^{a}	1007.67^{a}	1656.33^{a}	2005.67^{a}	1384.50^{a}	3067.17^{a}	5184.33^{a}
4 (20%P - C.S. + F.M.)		245.50^{c}	664.17^{c}	1255.33^{b}	1768.00^{b}	913.83^{c}	2169.83^{b}	4147.67^{c}
(1-4) - CTC		323.42^{e}	891.17^{e}	1588.25^{e}	1876.92^{e}	1214.50^{e}	2839.83^{e}	4807.25^{e}
(1-4) + CTC		331.83^{e}	890.92^{e}	1533.17^{f}	1938.25^{e}	1225.08^{e}	2725.00^{e}	4794.00^{e}

*Significant ($P < 0.05$)
**Significant ($P < 0.01$)
Means with the same letter are not significantly different at 5% level of probability.

Table A-15. Analysis of variance of average feed intake in Experiment II.

		Growing Periods (Weeks)						
Sources of Variation	d.f.	0-2	2-4	4-6	6-8	0-4	0-6	0-8
		Mean Squares						
Treatments	7	18749.33**	63738.86**	130642.00**	188551.57**	151594.47**	602063.02**	1678239.80**
Error	16	261.17	1403.33	4475.96	5028.25	1845.29	15541.67	38420.88
Diets	3	43025.44**	146594.44**	296034.78**	424550.57**	349292.47**	1378030.50**	3845285.70**
Antibiotics	1	20.17	322.67	4537.50	24384.38	126.04	20068.17	175617.04*
Diets X Antibiotics	3	716.28	2022.00	7284.06	7274.93	4385.93	20093.83	12068.15
Diets		Means - Feed Intake (grams)						
1 (24%P - S.B.)		435.00^b	940.83^a	1669.67^a	2233.17^{ab}	1375.50^b	3095.83^a	5438.33^a
2 (22%P - S.B.)		452.50^b	939.50^a	1683.83^a	2250.50^a	1398.33^{ab}	3106.83^a	5488.33^a
3 (20%P - S.B.)		474.67^a	970.17^a	1724.83^a	2159.00^b	1444.17^a	3195.33^a	5480.33^a
4 (20%P - C.S. + F.M.)		287.83^c	638.83^b	1251.00^b	1688.17^c	926.83^c	2178.33^b	3868.50^b
(1-4) - CTC		413.42^e	876.00^e	1596.08^e	2114.58^e	1288.50^e	2923.00^e	5154.42^e
(1-4) + CTC		411.58^e	868.67^e	1568.58^e	2050.83^f	1283.92^e	2865.17^e	4983.33^f

*Significant ($P < 0.05$)
**Significant ($P < 0.01$)
Means with the same letter are not significantly different at 5% level of probability.

EFFECTS ON PERFORMANCE OF BROILERS FED DIFFERENT SOURCES AND LEVELS OF PROTEIN, WITH AND WITHOUT ANTIBIOTIC (CTC)

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Four diets, with and without chlortetracycline (CTC) were tested in two experiments to determine which of three protein levels of soyprotein diets would best support broiler growth; the comparative effects of combined cottonseed and fish meal protein diets with other diets on broiler performance; and the benefits of CTC supplementation in each of the diets. The first three of the four main diets contained three levels of protein, 24, 22 and 20%, respectively in starter diets with soybean as the source of protein. The fourth diet contained 20% protein with combined cottonseed and fish meals as protein sources. Broiler finisher diets contained 4% less protein than the starter diets. There were a total of eight diets and each was fed to 30 birds for eight weeks in each experiment. Weight gain and feed utilization were the main criteria for evaluation of these diets.

It was found that the 22% protein soybean diet was more preferable than either the 24 or 20% diet because it had significantly better feed utilization. Among the three diets, it was least consumed. It supported the least mortality rate. Average weight gain was not significantly different for the three diets.

The cottonseed diet was generally inferior to the soyprotein diets in terms of weight gain, feed utilization and feed consumption. Consumption of the cottonseed diet was abnormally low. However feed utilization from 20% soyprotein diet was not significantly different from that of the 20% protein cottonseed diet. Mortality due to the cottonseed diet was also found to be no higher than the soybean diets.

Supplementation with CTC had no significant effect on weight gain, feed utilization and feed intake but it did reduce mortality.