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EFFECT OF PIGEON PEA AND COW PEA ON THE PERFORMANCE AND GUT IMMUNITY OF BROILER CHICKS

By

Yagoub Magboul Yagoub
B.V.Sc
Faculty of Veterinary Science
University of Khartoum
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To my parents, brothers and sisters

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ABSTRACT

Two experiments were conducted to examine the effect of pigeon pea and cow pea on the performance and gut immunity of broiler chicks. In experiment I, 3 experimental diets were formulated containing graded levels of pigeon pea (0.0%, 15% and 30%). In experiment II, similar graded levels of cow pea were maintained.

Diets were prepared containing 18.21, 18.25 and 18.25% crude protein and 3076.41, 3062.98 and 3075.86 Kcl/Kg metabolizable energy for experiment I. While diets of experiment II were prepared containing 18.21, 18.22 and 18.22% crude protein and 3076.41, 3080.5 and 3055.89 Kcl/Kg metabolizable energy. 120 Loghmann broiler chicks were equally allocated into 15 pens (8 chicks/pen). Then the experimental diets were randomly assigned to the pens.

Feed and water were provided *ad libitum* in both experiments. In experiment I, the results showed no significant differences were found in chick performance at day 45. The feed consumption and feed conversion ratio increased with the level of pigeon pea used. The pancreas mass was increased as the level of pigeon pea increases. In experiment 2 the results showed significant decrease in the body weight and feed intake at day 45, while the pancreas mass tend to increase with increasing level of cow pea in the diet.

Histological examination of small intestine slides showed no histopathological differences between the control and chicks fed cow pea and/or pigeon pea.

Immunological test revealed no significant difference between the control and chicks given cow pea and /or pigeon pea.

CHAPTER ONE

Introduction

Legumes are plants belonging to the family leguminosae, most of these plants are commonly grown in the warm climatic regions.

Grain legumes provide food of fairly high nutritive value to both human and domestic animals and they are very valuable in tropical countries where there is acute shortage of animal protein e.g. in Southern Sudan (Khatab and Khidir 1972) where tsetse fly restricting cattle husbandry, legumes can be a good source of protein.

Grain legumes are particularly used as a source of some essential amino acids such as lysine and threonine (Parpia 1973).

Also beside its content of protein grain legumes come second to cereal as a source of energy (Aykroyd and Doughty 1964).

Cow peas (Vigna ungiculata) grow vigorously and many varieties are quick maturing (60-80 days). The seeds are highly palatable, very nutritious and show low levels of toxic enzyme inhibitors than other legumes.

Pigeon pea (cajanus cajan) is more widely adapted in the tropics than many other legumes, the nutritive quality of the grain is excellent because the seed has a fairly high protein content and relatively low fibre contents.

Most of animal proteins are degraded quickly to amino acids after processing (heat treatment or cooking) in the alimentary tract while plant proteins are much resistant to such proteolytic breakdown (Linear 1976, Bressani & Elias 1980).

Digestion of plant proteins is generally slowed down by their content of some enzyme inhibiors e.g. protease inhibitors, tanin and lectins (Linear 1980, Elias *et al* 1979).

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Protease inhibitor has long recognized to interfer with the proper digestion of dietary proteins in the small intestine (Linear and Kakade 1980).

Now it is widely accepted that one of the main antinutritive effects of protease (trypsin inhibitors) is due to their overstimulation of the digestive secretion from pancreas (Chemick *et al* 1948, Layman and Lepkovsky 1957).

One of the main reasons why lectins are considered as strong antinutritive agents, is due to their extra-ordinary degree of resistance to proteolytic breakdown in the gut (Pusztai 1986, 1989).

In Sudan recently people started to consider legumes as part of their diet, but there is no work on legumes as an animal diet specially in poultry.

So the aim of this work is to investigate the effect of cow pea (vigna ungiculata) and pigeon pea (cajanus cajan) as plant protein sources on the performance and gut immunity of the broiler chicks.

CHAPTER TWO

Literature Review

2.1. Sources of Proteins:-

Johnson and Lay (1974) stated that plant proteins are less balanced than animal proteins, this imbalance of plant proteins led some to suggest more reliance on the animal proteins. In over populated developing countries it is realistic because animals produce proteins and calories less effectively than plants. Also animal protein cost more than plant protein.

Ahmed and Nour (1990) reported that leguminous seeds play a small role in Sudanese diet until people recently started to consider them as part of their diet due to escalating prices of animal products. The protein content of essential selected leguminous seed is high, e.g. faba bean (20%), cow pea (24-26%), pigeon pea (22%) and soya bean (38%).

2.2. Legumes as Sources of Plant Protein:-

It is well known that the protein content of cereals and millets which constitute the major component of a poor man's diet, are deficient in lysine and that they can be supplemented by legume. Legumes, however, not only rich in lysine but also in threonine (Venkat Rao *et al* 1964, Mustafa 1977).

In recent years considerable attention has been focused on improving the nutritional quality of legumes (Jain *et al* 1980), and factors influencing this have recently been reviewed by Singh and Eggum (1984) and Singh *et al* (1984) who concluded that cereal grains and legumes are important source of protein in human food and animal feed.

In Sudan as in most tropical countries little work has been carried out on composition or cultivation of legume crops.

Ahmed and Nour (1990) studied the protein quality of Common Sudanese Leguminous Seeds, and found that the protein of all leguminous seeds was rich in lysine, and all legumes were found to be deficient in sulphur containing amino acids (Methionine and Cysteine).

George and Delumen (1991) reported that legumes are the richest sources of protein among plant food but are deficient in sulphur containing amino acids.

2.3. Chemical Composition of Pigeon Pea:-

The grain has light brown or reddish seeds. (Tothil 1948). Purseglove (1968) reported the chemical composition of the whole seed which gave approximately 10.1% moisture, 19.2% protein, 1.5% fat, 57.3% carbohydrate, 8.1% fibre and 3.8% ash.

In Sudan Elhardalou, S.B. (1980) found that the chemical composition of pigeon pea (Cajanus cajan) was 6.1%, 19.3%, 2%, 6.4%, 3.6% for moisture, protein, fat, crude fibre and ash respectively.

Also in Sudan Ahmed and Nour (1990) studied the protein content of common Sudanese legumes and found that the protein content of pigeon pea was 22%.

Tangtaweewipat, S. and Elliot, R. (1989) found that chemical composition of pigeon pea was 21.3% protein, 1.2% ether extract, 4.4% ash, 1% tannin and 1.46% lysine.

2.4 Chemical Composition of Cow Pea:-

One of the cheapest in price among legumes is white black eyed cow pea, Bliss (1975) stated that cow peas are the principal sources of the dietary protein in Nigeria, West America, India and other tropical countries.

Duke (1983) reported that, based on several thousands cow pea cultivars, protein ranged from 18-29% with a potential of perhaps up to 35%.

Ahmed and Nour (1990) found that most of Sudanese legumes including cow pea were found to be rich in lysine most of which is found in available form, but these Sudanese legumes are deficient in sulphur containing amino acids (Methionine and Cystine).

Abdalla, M.I. (1997) found that the chemical composition of the cow pea was 7.8% moisture, 26% crude protein, 6.7% crude fibre, 3.5% fat and 1.5% ash.

2.5. Uses of Legumes in Poultry Diets:-

In recent years, considerable attention has been focused on improving the nutritional quality of legumes (Jain *et al*, 1980).

Conventional sources of protein for animals, such as fish-meals and Soya bean meals are often in short supply and generally expensive. Other grain legumes offer an alternative to oil - extracted Soya bean meal (SBM) because they have similar amino acid profile (Ravindran & Blair, 1992) and are often cheaper.

Although grain legumes are produced seasonally for human consumption, spreading production throughout the year (Davis, 1980, Food and Agriculture Organization 1989) would result in increased amounts of legumes becoming available for stockfeed.

At present time, however, the utilization of grain legume sources of protein for poultry is limited due to uncertainty about their nutritional qualities.

2.6. Pigeon Pea Meal in Poultry Diets:-

Although the principal market for pigeon pea would be as high quality grain for human consumption, grain would inevitably become available as animal feed. The use of pigeon pea as an energy or protein source in diets for monogastrics would be an attractive alternative to expensive oil-seed meals and cereal grains.

However feeding trials using young growing pigs (Falvey and Visitpanich 1980, a) have demonstrated that pigeon pea meal have to be moist-heat treated to prevent depressions in animal growth rate.

2.7. Effect of Pigeon Pea in Broiler Performance:-

Tantaweewipat and Elliot (1989) fed broiler chicks different levels of pigeon pea meal (0, 100,200, 300, 400 and 500 g/Kg) pigeon pea replacing maize and Soya bean meal. They observed no palatability problems and a high feed intake was recorded for the broilers fed diets containing the highest levels of pigeon pea. They also found that the growth rate of chicks was not significantly different from those fed the maize soya bean diets.

In recent years pigeon pea has been investigated for use as a component of poultry feed. It was found that up to 20-30% of pigeon pea could be used in broiler diets, and layer ration at peak production without affecting performance (Tangtaweewipat and Elliot 1988, 1989). In broiler trials there were no significant differences between the growth rate of birds fed 30-50% pigeon pea and the control, even though pigeon pea contains trypsin inhibitor (Visitpanich *et al* 1985 a). This may be due to the concentration of methionine in the feed, which was adjusted to a level in excess of the chick requirements, and the ability of methionine to compensate for the un available sulphur containing amino acids caused by protease inhibitor in pigeon pea.

Boonlom & Tangtaweewipat (1989) fed broiler diets containing 0%, 30%, 40%, 50% pigeon pea. They found that there were no significant differences among the treatments in mass gain. They also found that the feed consumption of birds fed diets containing pigeon pea was higher than that of the control. There was no significant difference in mortality. The pancreas mass tended to increase with the level of pigeon pea incorporated in the diet.

2.8 Antinutritive Effects of Legumes:-

Legumes are important source of protein and energy for farm animals. However, the inclusion of legumes in diet of growing animals as the only source of protein almost invariably leads to significant impairment in growth (Apata 1989) and other undesirable physiological and biochemical alterations (Aletor and Aladetimi 1989).

Begbie and Pusztai (1989) found that plant protein are more resistant to breakdown in the alimentary tract than animal protein because of the presence of antinutritive factors in the plants.

Of many and various factors which may be present in food, particularly in food of plant origin, two main classes of protein antinutrients, the lectins and proteolytic enzyme inhibitors are probably the most important in nutrition.

2.8.1 Protease (trypsin inhibitors)

Trypsin inhibitor has been shown to interfere with proper digestion of dietary proteins in the small intestine (Pusztai 1967, Linear and Kakade 1980).

It is less widely recognized that the direct effects of protease inhibitors on the digestibility of food proteins may be limited because, in normal healthy chicks, there is usually an ample supply of pancreatic protease. Thus the protease inhibitors present in the diet may inhibit only part of the digestive enzymes. Clearly the activity of protease which remain unattached to the inhibitors will not be affected. Additionally Soya bean trypsin inhibitors are eventually degraded and inactivated during their passage through the small intestine, at least in chicks (Madar *et al* 1979).

Even with the possibility that some inhibitors may be resistant to breakdown in the gut, their amounts in the diet are limited and dietary protease inhibitors may at most, only slow down the rate of luminal digestion. The net result of this is that part of the nutrients will be digested in the more distal parts of the small intestine, so less absorption will occur.

It is now widely accepted that one of the main antinutritive effects of protease (Trypsin inhibitors) in the diet is due to their stimulation of the secretion of digestive enzymes from exocrine pancreas, (Chemick *et al* 1948, Layman and Lepkovsky, 1957).

2.8. 2 Lectins:-

Lectins constitute specific class of proteins widely distributed in nature. Seeds and particularly legume seeds are rich sources of lectins. Diets based on raw legume seeds usually contain lectins, some of which may possess strong antinutritive properties. Although some lectins can be inactivated by proper heat treatment, such processes are expensive therefore, avoided in commercial feed production. Additionally 30-40% of the naturally occurring lectins are difficult to inactivate by heating.

One of the main reason why lectins can possess strong antinutritive properties is to be found in the extraordinary degree of their resistance to proteolytic breakdown in the gut (Pusztai 1986, 1989, Pusztai *et al* 1986). In common with a number of other tropical legumes, both the foliage and the seeds of the Jak beans (Canavalia ensifomis) contain toxic substances, which affect their nutritional values. The best known of these substances is the lectin, concananvalin A (Con A), which has been reported to reduce nutrient utilization (D'mello *et al* 1985). Concanavanine, a thermostable poisonous alkaline amino acid and structural analogue of arginine, has been reported in Jak bean seeds at concentrations of more than 3g/Kg of dry matter (Bressani *et al* 1987).

The nutritional value of grain legumes has generally been found to be significantly lower than that predicted by either protein content or amino acids composition, this has been mainly due to the presence of various antinutritive factors such as protease inhibitors, lectins and tannins (Linear & Kakade 1980).

Although the antinutritive factors of faba beans have been extensively studied in rats and chickens, there is little information available on their effect on the pancreatic and intestinal cytopathology in the growing chick.

Ahmed and Nour (1990) on studying the protein quality of common Sudanese leguminous seeds found that all plant proteins and their preparations appear to have some trypsin inhibiting activity, and subjecting these proteins to moist heat was found to be effective in decreasing this activity and improving their nutritional quality. Although heat treatment can reduce the activity of antinutrient factors in grain legumes (Van der Poel 1990, Anderson Hafermann *et al* 1992, Singh *et al* 1993), such treatments will probably increase the cost of the feed. In addition excessive heating could lead to reduce the nutritive value of the legume meal.

2.9. Effect of Legume on Poultry:-

(Rubio *et al* 1989) conducted an experiment to see the histological alterations to the pancreas and intestinal mucosa produced by raw faba bean diets in growing chicks. They found that, body weight and relative pancreas weight of chicks fed on diet contains 250 and 500 g/Kg of raw faba bean were significantly lower than those of the chicks fed the control diet. The efficiency of food utilization decreased when the amount of raw faba bean was increased in the diet.

Thus feeding chickens on a diet containing raw legumes depressed growth (Ologhobo*et al*, 1993) inhibited amino acid absorption

(Santidariane *et al*, 1988) induced pancreatic hypertrophy (Roebuck 1986), and caused marked alterations in the normal activities of some hepatic and extrahepatic enzymes (Aletor and Fetuga 1984). The deleterious effects of ingested raw legumes have been attributed to the presence of various toxic substances such as trypsin inhibitors, haemogglitinins, tannins, cyanogenic glycosides, saponins and phytates.

Ologhobo *et al* (1993) reported that utilization of raw jack bean and jack bean fractions in diet for broiler chicks significantly reduced weight gain and feed intake compared with the control. They also showed that the weight of pancreas was increased with dietary treatments (Johnson and Eason 1990) showed that inclusion of 80, 140 and 200 g/Kg of field pea (Pisum sativum), lupin (lupinus angustifolus) or chick pea (Cicer arietinum) in a sorghum and wheat based diet did not affect the performance of broiler chicken, but the same level of narbon beans (Vicia narbonensis) significantly depressed growth.

The discrepancy in the results between the legumes may be due to difference of the activity of antinutritional factors, such as protease inhibitors, tannins and /or the presence of non digestive carbohydrates in some species or cultivars leading to reduce digestibility, possibly because of low accessibility of the legume protein to digestive enzymes (Gatel, 1994, Linear 1994).

2.10 Histological Alterations to the Intestinal Tract caused by Legume diets:-

In recent investigations inclusion of genus phaseolus at *ad libitum* of different amounts of isolated lectins to rat and pig diets has been shown to disrupt the structure of the gut and the function of its brush border (Pusztai et al 1981, King *et al* 1983, Rouanet *et al* 1985, Aletor 1987).

The antinutritive effects of lectins is due to their binding to carbohydrates moities, this binding interfer with morphology and the prop· er functioning of the epithelial cells. (King *et al* 1982).

The binding of the lectin to epithelial cells is followed by extensive endocytosis (King *et al* 1986). Similar effects have been observed with all other lectins which can bind to the mucosa (Pusztai 1989, Begbie and Pusztai 1989). Thus concavalin or wheat germ agglutinin (WGA) a lectin which is regarded as non-toxic, accelerate cell turn over and loss from the brush border of the proximal small intestine (Lorenzsonn and Olsen, 1982).

It is now generally recognized that lectins from food or bacteria and bacterial toxins may cause intestinal damage. It is clear that the erossion of the absorptive surface of the small intestine, by exposure to dietary lectins will appreciably reduce the efficiency of nutrient conversion in the animal.

The tannins in the seed primarily form complexes with proteins and polymers (Reddy *et al* 1985),Tannins-protein complexes are reported to be responsible for growth depression, low protein digestibility, decreased amino acid availability and increased feacal nitrogen (Elias *et al* 1979). Although few studies have been conducted on the direct action of tannins on the alimentary canal epithelium,Vohra *et al* (1966) reported sloughing of mucosa in the oesophagus, subcutaneous oedema and the thickening of the crop when chicks were fed on diets containing 50g/Kg tannic acid. When tannins are present in sufficient amounts they may cause loss of mucous, epithelial oedema, irritation and breakdown of the alimentary tract (Mitjavila *et al* 1977). In case of the faba bean, tannin concentration is not high enough (2.49 g/Kg) to produce this kind of lesion in the intestine.

Rubio *et al* (1989) studied the histological alterations in the pancreas and the intestinal tract produced by raw faba bean diets in growing chicks. They found that the small intestine epithelium of the bean-fed birds indicated morphological changes, mainly in the jejenum. The villi were shortened, at the higher magnification, these lesions are accompanied by an increase proliferation enterocytes with degeneration and a discrete oedema in the connective tissue of the villus core.

Ologhobo *et al* (1993) conducted an experiment on the utilization of raw Jack bean (Canavalia esenformis) and Jack bean fractions in diet for broiler chicks and found that in the chicks fed raw jack bean there was intestinal enteritis.

2.11 Antinutritive Factors of Pigeon Pea and Cow pea:-

Most of the food legumes contain antimetabolic and toxic constituents during the course of their development. Several toxic factors in grain legumes have been reported (Linear, I. E 1962).

Condensed tannins have been reported to occur in some grain seeds that are important as human food and animal feed (Martin-Tangwy *et al* 1977, Ma Yu and Bliss, F.A. 1978). Price *et al* (1980). Analysed 10 cultivars each of cow peas, chick peas, pigeon peas, and mung peas for condensed tannin content and tanin concentration and found that it was ranging from 0 - 0.7% for cow peas, 1-0.2% for pigeon peas and essentially no tannin in chick peas and mung peas

Singh, U. (1984) showed that chick pea and pigeon pea contain considerable amounts of polyphenolic compounds which may or may not be tannins. Based on this study it may be concluded that, the polyphenolic compounds of chick pea and pigeon pea adversely affect the activities of the digestive enzymes, and that this effect will have nutritional implications in terms of nutrient utilization. (Falvey and Visitpanich 1980 a, Visitpanich *et al* 1985 a) have demonstrated that pigeon pea meal has to be moist-heat treated to prevent depression in animal growth rate. The effect of antinutritive factors, present in pigeon pea, on the productivity had not been well investigated. Springhall *et at* (1974) concluded that broiler chicks could tolerate up to 300 g/Kg inclusion of the raw grain in a grower diet. Tangtaweewipat, S. and Elliot R.(1989) studied the nutritional value of pigeon pea meal in poultry diet and found that in broiler experiment with exception of birds fed on diet containing 20% pigeon pea, there was a linear increase in pancreas weight with increasing level of pigeon pea inclusion, indicating the presence of protease inhibitors. Also in the highest levels of pigeon pea inclusion (330, 350 and 400 g/Kg) most birds lost weight, whereas birds fed diets containing 100 and 200 g/Kg made considerable weight gain during the experiment.

CHAPTER THREE

Materials and Methods

3.1 Materials

3.1.1 Experimental Site and Duration:-

Two experiments were conducted concurrently, in the premises of the Poultry Research Unit in the Faculty of Animal Production at Khartoum North (Shambat) during the period from July to August 1997.

3.1.2 Experimental Housing, Pens and Equipment:-

The experiments were carried out in an open sided deep litter poultry house. The house ($5x4m^2$) was partitioned into 15 pens ($1x1m^2$) with enough working space allowances. the house was cleaned, washed and disinfected. Bedding of saw dust was laid at each pen. Each pen was provided with a feeder and a drinker. The light was maintained for 24 hours throughout the experiment.

3.1.3 .Experimental Diets:-

Pigeon pea and cow pea were purchased from Khartoum North local market then the sample of each were analysed following the procedures of Association of Official Analytical Chemist (AOAC 1975). The results are shown in Table (1).

Based on this analysis six experimental diets were prepared which were approximately isocaloric, isonitrogenous and equal in sulphur containing amino acids (methionine & cystine). In experiemnt one three experimental diets containing 0%, 15%, 30% pigeon pea meal were prepared lysine and methionine supplementation to meet the requirements for these amino acids for broiler chicks outlined by the National Research Council (1984), see table (2).

In experiment two three experimental diets containing 0%, 15%, 30% cow pea Table (3) and supplemented with lysine and methionine to meet the requirement for the essential nutrients for broiler chicks.

The determined analysis of the experimental diets are presented in table (6).

3.1.4 Experimental Birds:-

150 day-old unsexed broiler chicks (loghmann), were obtained from the Arab Animal Development Company in Jabel Awlia South of Khartoum, and upon arrival were given the control diet for one day.

3.2. METHODS

3.2.1 Husbandry and procedure:-

At day two 120 chicks were selected and allotted randomly into 15 experimental pens in groups of 8 chicks per each pen. The initial body weights of all chicks in each pen were adjusted to be approximately the same. The experimental diets were randomly assigned to the pens, and a number with 3 pens for each treatment as replicate (3 replicate/treatment). In both experiments feed and water were provided *ad libitum* and 24 hours light were maintained throughout the experimental period. Feed intake, body weight and weight gain were recorded weekly for the individual replicate of each dietary treatment. Also mortality was recorded as it occurred.

3.2.2 Measurements, Chemical analysis, Experimental Design and Statistical Analysis:-

A complete randomized design was used in both experiments. As the end of the experiments, (at day 45) birds were starved for overnight, one bird of each replicate was randomly selected, wing banded and individually weighed. Then it was slaughtered by jugular severing and blood for serum samples was taken. After that it was dissected and spleen and pancreas were excised and weighed. Also part of the small intestine was taken and its mucous content was squeezed. The small intestine part were immediately rinsed in 10% buffer formalin, and the serum and mucous sample were kept at -20°C. After that slides from the small intestine were prepared by normal histological procedures as described by Culling C.F.A. (1974). These slides were then examined under a light microscope.

The serum and mucous samples were taken to the Institute of Endemic Diseases and subjected to ELISA technique described by Monica Cheesbrough (1987). The data of body weight gain and feed conversion ratio from the two experiments was statistically analyzed according to the analysis of variance as described by Snedecor, G.W. and Cochran, W.G. (1980). While the data of spleen and pancrease weights were analysed by covariance analysis as described by Gomez and Gomez (1984).

Table (1) Chemical analysis of pigeon and cow pea

Item	Pigeon pea	Cow pea
Ether extract %	10.76	11.65
Crude protein %	21.87	26.25
Moisture %	6.43	6.63
Ash%	4.31	4.15
Crude fibre %	10.67	11.30

Table (2): Nutrient Composition of the experimental diets.

Experiment (1) Pigeon Pea.

Ingredient	Level of Pigeon pea in diets %		
	0%	15%	30%
Pigeon pea	00.00	15.00	30.00
Maize	63.22	57.54	54.74
Groundnut meal	08.00	00.00	00.00
Sesame meal	09.00	13.25	09.00
Super concentrate*	05.00	5.00	05.00
Wheat bran	13.50	8.00	00.00
Oyster shell	0.50	0.50	0.50
Salt	0.25	0.25	0.25
Lysine	0.31	0.31	0.31
Methionine	0.22	0.15	0.20
Total	100.00	100.00	100.00

* Super concentrate composition

Protein 45%, Fibre 3%, calcium 12%, phosphorous 6%

Methoionine 4.25%, Meth + Cystine 4.75%, Lysine 11%,

NaCl 2.8-3% M.E. Kcl/Kg 2000

Table (3): Calculated Composition of the Experimental Diets

Experiment 1 (Pigeon pea)

Component	0%	15%	30%
Crude protein %	18.21	18.25	18.25
ME, Kcl/Kg	3076.41	3062.98	3075.86
Calcium%	1.04	1.09	1.03
Phosphorous%	0.63	0.66	0.68
Lysine%	1.16	1.16	1.2
Methionine%	0.695	0.65	0.66
Cystine%	0.173	0.21	0.2

Table (4) Nutrient Composition of the Experimental diets %

Experiment (2).

Ingredients	Level of Cow pea in the diets %		
	0%	15%	30%
Cow pea	00.00	15.00	30.00
Maize	63.22	60.24	56.64
Groundnut meal	8.00	00.00	00.00
Sesame meal	9.00	11.00	4.00
Super concentrate	5.00	5.00	5.00
Wheat bran	13.50	7.50	2.60
Oyster shell	0.50	0.50	0.90
Salt	0.25	0.25	0.25
Lysine	0.31	0.31	0.31
Methionine	0.22	0.20	0.30
Total	100.00	100.00	100.00

Table (5) Calculated Composition of Experimental Diets

Experiment (2)

Ingredient	Level of Cow pea in the diet %		
	0%	15%	30%
Crude protein%	18.21	18.22	18.20
Metabolizable energy Kcl/Kg	3076.41	3080.50	3055.89
Calcium%	1.04	1.03	1.05
Phosphorus%	0.63	0.64	0.64
Lysine%	1.16	1.14	1.14
Methionine%	0.695	0.676	0.7
Cystine%	0.173	0.19	0.16

Table (6): Determined Diets Composition

Item	% Pigeon pea			% Cow pea		
	0%	15%	30%	0%	15%	30%
Ether extract%	3.7	3.8	3.3	3.7	2.7	2.9
Crude protein%	18.6	18.6	21.0	18.6	19.25	21.0
Moisture%	6.7	6.7	6.8	6.7	6.9	6.5
Ash%	8.7	7.6	7.7	8.7	7.4	6.7
Crude fibre%	4.8	6.7	4.7	4.8	4.4	5.8
Tannin content	0.03	0.017	0.018	0.03	0.017	0.024

CHAPTER FOUR

Results

4.1. Experiment 1

4.1.1. Performance of experimental birds fed graded levels of pigeon pea during the period (0 to 28 days) table 1.

The effect of feeding graded levels of pigeon pea to broiler chicks in period (0 to 28) days was shown in Table (1). Results indicated that 30% inclusion of pigeon pea significantly ($P<0.05$) reduced body weight gain and increased feed conversion ratio respectively, compared to 0.0 or 15% inclusion rates. On the other hand no difference in body weight gain and feed conversion ratio was observed in birds fed the control and the 15% pigeon pea diets.

As regarding body weight at 28 days and feed intake, results indicated no difference between treatments.

4.1.2 Performance of experimental birds fed graded levels of pigeon pea from day 28-45 (Table 2).

The effect of feeding graded levels of pigeon pea tothe broiler chicks in period (28-45 days) was shown in Table (2). The results showed that the inclusion of pigeon pea had no effect on body weight gain and body weight at 45 days.

The results also showed that 30% inclusion of pigeon pea significantly increased feed intake compared to 0.0 or 15% levels, while no difference was seen between the control and 15% levels. Feed conversion ratio was increased in the group given 30% pigeon pea compared to 15% level. However no difference in feed conversion ratio was observed between the control and the other two levels.

Production performance of broilers fed diets containing varying levels of cow pea in period (0-28 days) was presented in Table (3). Results showed that 15% inclusion of cow pea in broiler diets had no effect on the measured parameters. On the other hand 30% inclusion of cow pea significantly ($P<0.05$) reduced body weight gain, body weight at 28 days and feed intake and significantly raised feed conversion ratio as compared to the other two levels.

4.2.2 Performance of the experimental birds during the period (28-45 days). Table (4).

The effects of feeding graded levels of cow pea to broiler chicks in period (28-45 days) was shown in Table (4). Results showed that inclusion of cow pea had no effect on body weight gain (28-45 days) and feed conversion ratio. While inclusion of 30% cow pea significantly ($P<0.05$) reduced body weight at 45 days and feed intake compared to 0.0 and 15% inclusion of cow pea.

4.3 Histopathological examination:-

Examination of small intestine slides under a light microscope showed that no histopathological changes between the control and chicks given cow pea and/or pigeon pea. (Figs. 2a, 2b, 2c for experiment 1 and Fig. 3a, 3b, 3c for experiment 2).

4. 4 Immunological examination:-

Immunological examination by ELISA technique to the serum and mucous samples revealed that there was no significant difference between the control and chicks given cow pea and/or pigeon pea (Fig. 1).

4.5. Covariance analysis of pancreas and spleen:

Revealed that pancreas weight insignificantly increases by the increase of level of legume (pigeon pea or cow pea) in the diet.

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Revealed that pancreas weight insignificantly increases by the increase of level of legume (pigeon pea or cow pea) in the diet.

Table (1)

Production performance of broilers fed diets containing varying level of pigeon pea (0 to 28 days)1.

Item	Level of pigeon pea in the diet		
	0%	15%	30%
Body weight gain (0-28 days) g	822.72^{a}	796.35^{a}	692.5^{b}
Body weight at 28 days (g)	877.5	851.04	782.62
Feed intake (g/bird)	1405.23	1402.46	1441.93
Feed conversion ratio	1.71^{a}	1.76^{a}	2.08^{b}

1- Value are means of 3 replicates of 8 birds each.

a b = means on the same row not showing common superscripts are significantly different at 0.05% level.

Table (2)

Production performance of broilers fed diets containing varying levels of pigeon pea (28-45 days)1

Item	Level of pigeon pea in the diet		
	0%	15%	30%
Body wt. gain (28-45 days (g)	665.1	836.05	758.96
Body weight at 45 days (g)	1566.67	1687.09	1506.25
Feed intake (g/bird)	1798.82^{a}	1917.09^{a}	2153.99^{b}
Feed conversion ratio	2.75^{ab}	2.29^{b}	2.87^{a}
Weight of spleen (g)	0.92	1.39	1.01
Weight of pancreas (g)	2.98	3.00	4.1

1 = values are means of 3 replicates of 8 birds each.

a b = means on the same row not showing common superscripts significantly different at 0.05% level.

Production performance of broilers fed diets containing varying levels cow pea (0-28 days)1

Item	Levels of cow pea in the diet		
	0%	15%	30%
Body weight gain (0-28 days) (g)	822.72[a]	764,97[a]	581.67[b]
Body weight at 28 days (g)	877.5[a]	816.97[a]	646.67[b]
Feed intake (g/bird)	1405.23[a]	1343.07[a]	1123.15[b]
Feed conversion ratio	1.71[a]	1.76[a]	1.9[b]

1- values are means of 3 replicates of 8 birds each.

a b = means on the same row not showing common superscripts are significantly different at 0.05% level.

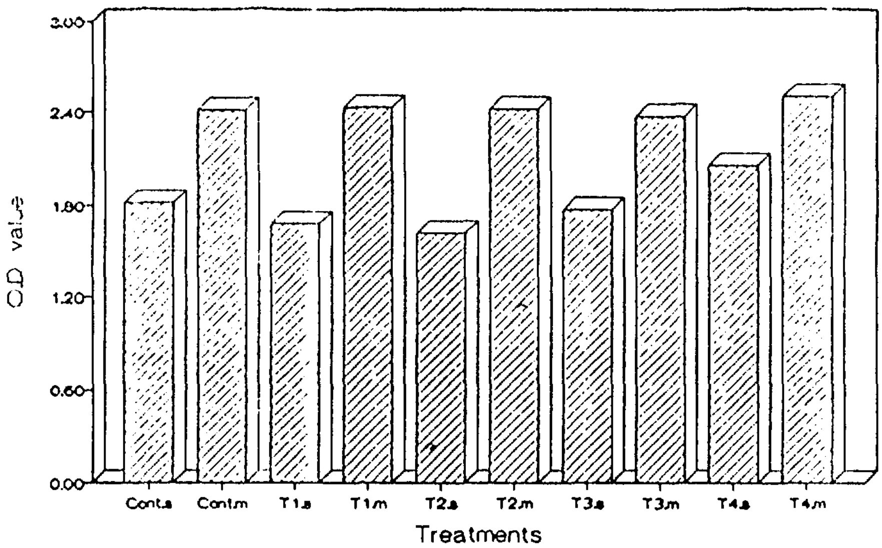
Table 4: Production performance of broilers fed diets containing varying levels of cow pea (28 to 45 days).

Item	Level of cow pea in the diet		
	0%	15%	30%
Body weight gain (28-45 days) (g)	665.21	695.69	610.9
Body weight at 45 days (g)	1566.67[a]	1512.65[a]	1257.44[b]
Feed intake (g/bird)	1798.82[a]	1638.4	1558.35[b]
Feed conversion ratio	2.75	2.37	2.58
Weight of spleen (g)	0.92	1.06	1.24
Weight of pancreas (g)	2.98	2.95	3.61

1= values are means of 3 replicates of 8 birds each.

a b = means on the same row not showing common superscripts significantly different at 0.05% level.

Fig. 1 Chicken immunoglobulin titer to infectious bronchitis.



Cont s = Control serum.
Cont M = Control mucous.
T = treatment
S = serum.
M = mucous.

O.D value= optical density value.

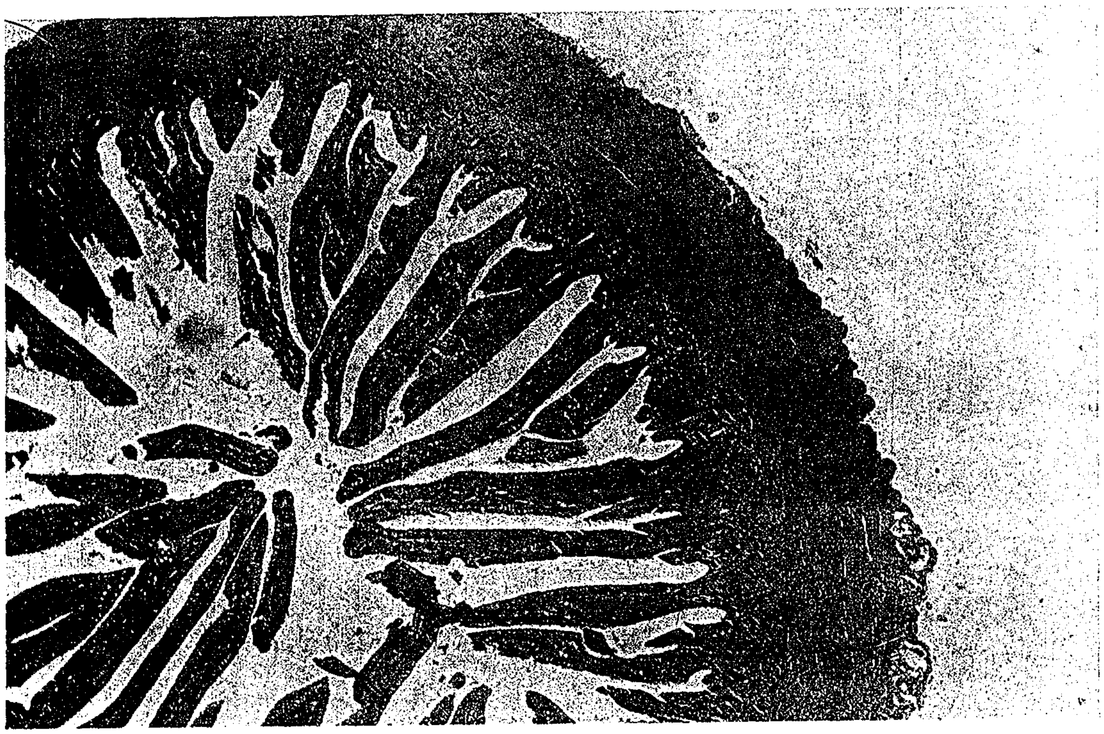


Fig 2a : Transverse section of small intestine of chick fed control diet, showing normal histological structure (H & E x 40).

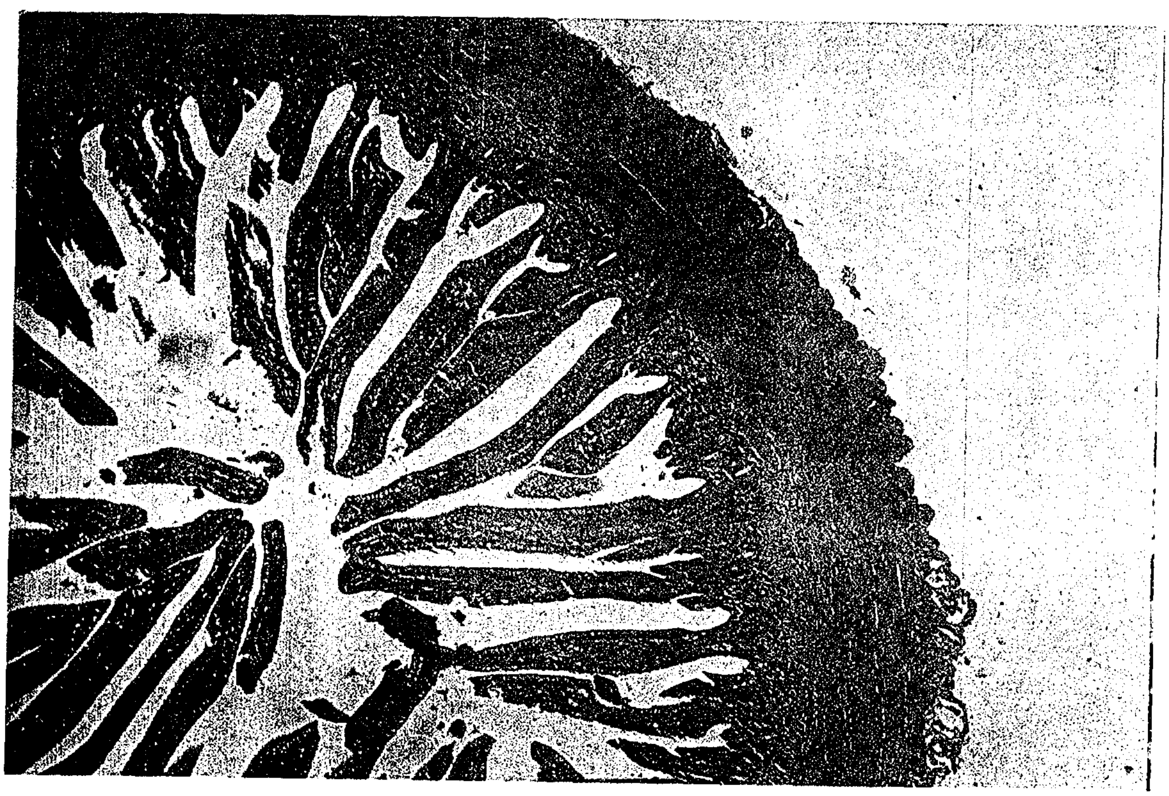


Fig 2b : Transverse section of small intestine of chick fed diet containing 15% pigeon pea showing no histological alteration as compared to the control (H & E x 40).

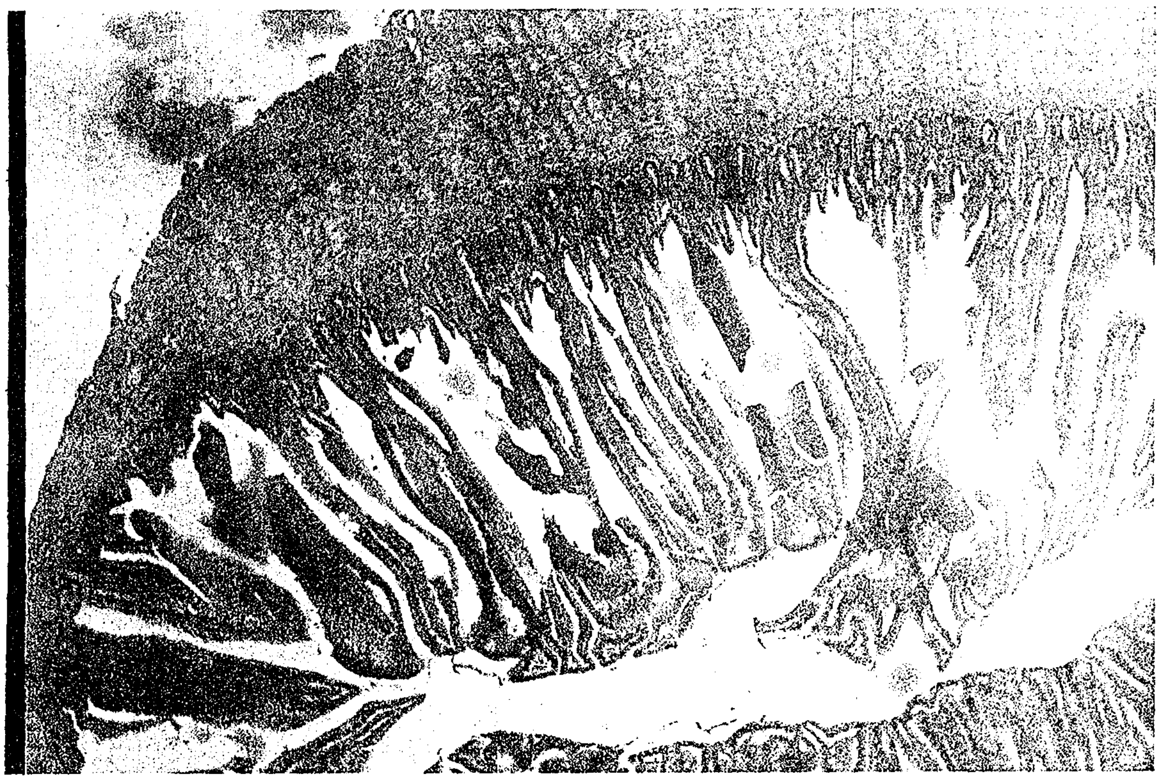


Fig 2c : Transverse section of small intestine of chick fed diet containing 30% pigeon pea showing no histological alteration as compared to the control (H & E x 40).

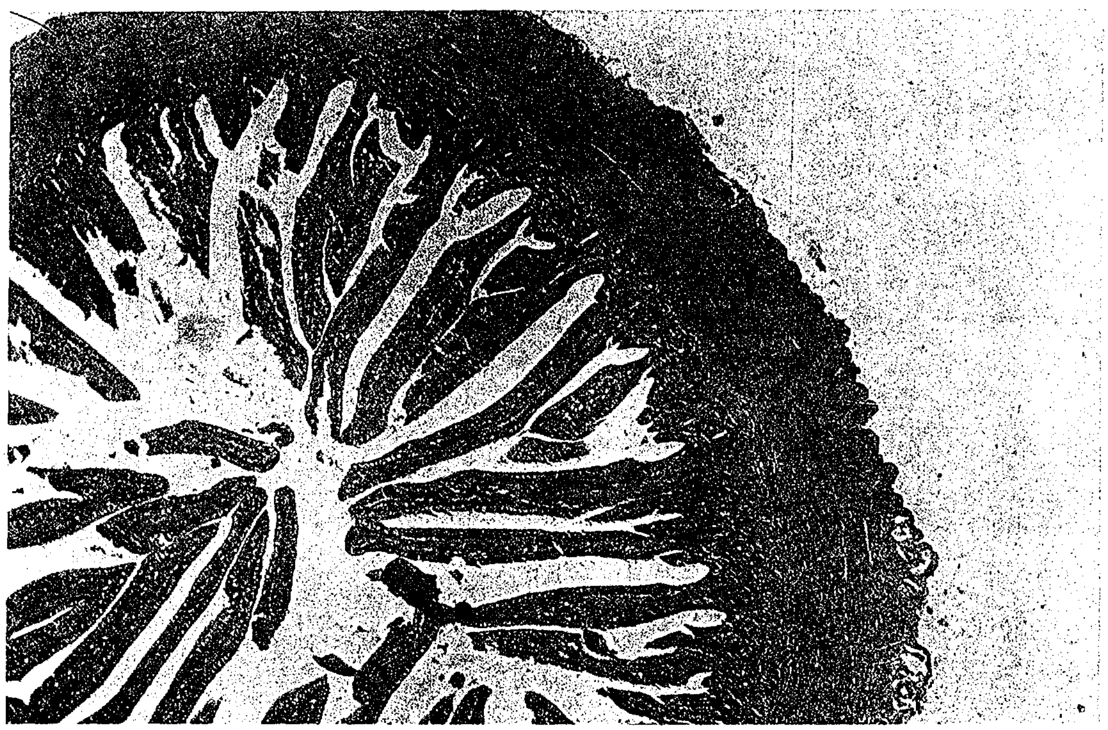


Fig 3a : Transverse section of small intestine of chick fed control diet, showing normal histological structure (H & E x 40).

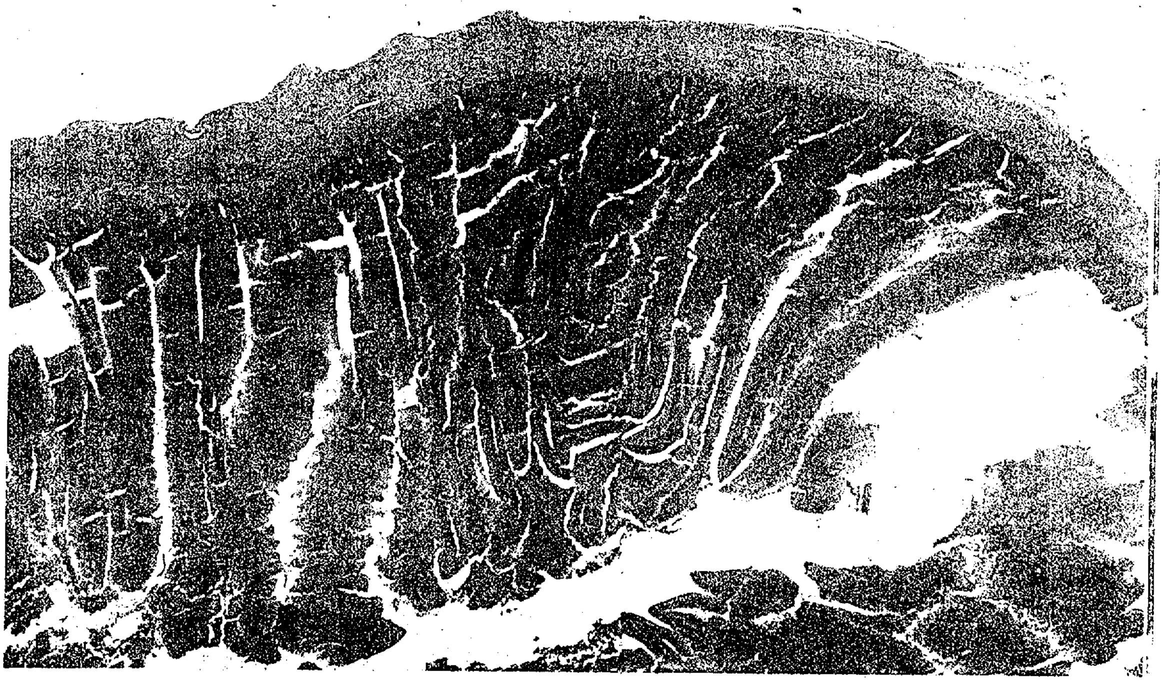


Fig 3b : Transverse section of small intestine of chick fed 15% cow pea with no histological alteration as compared to control (H & E x 40).

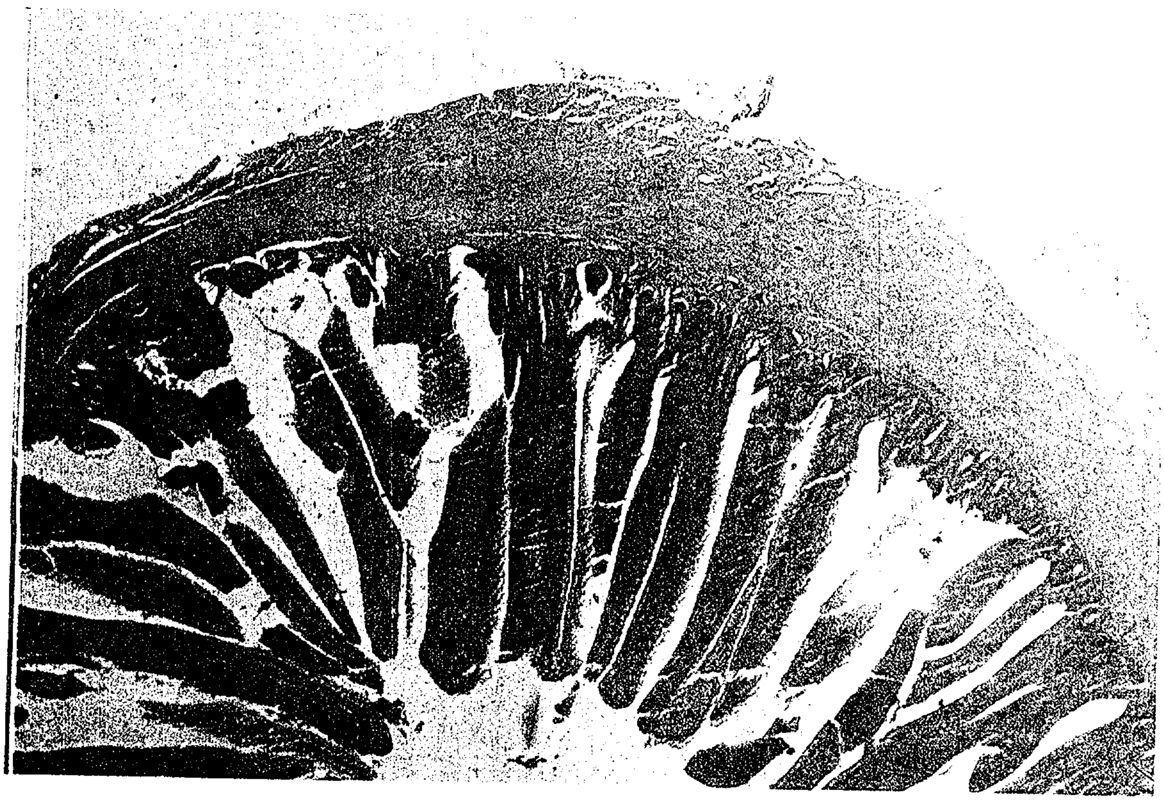


Fig 3c : Transverse section of small intestine of chick fed 30% cow pea with no histological alteration as compared to control (H & E x 40).

CHAPTER FIVE

Discussion

Experiment I

The insignificance difference in body weight, feed conversion ratio and feed intake when 15% pigeon pea was included in broiler diet from hatching to 28 days could be due to the fact that antinutritional factors present in pigeon pea are not sufficient enough to cause a significant difference. However increasing the inclusion rate of pigeon pea to 30% reduced body weight. This may be due to the increase in antinutritional factors present in pigeon pea.

The significant increase in feed intake observed when broiler fed pigeon pea from 28 to 45 days confirmed the assumption that birds were adapted to the diet and therefore tolerate the effects of antinutritional factors by increasing feed intake. This result is consistent with findings of Tangtaweewipat and Elliot (1988, 1989). The results also are in line with that of Boonlom and Tangtaweewipat (1989).

Experiment II

The similarity in performance of chicks fed 15% cow pea from hatching to 28 days and chicks fed the control diet could be due to small inclusion rate of the cow pea in the diet. The observed reduction in feed intake when inclusion rate of cow pea was elevated to 30% may be due to unpalatability of the diet. This reduction in feed intake resulted in a significant reduction in the body weight. The fact that cow pea is unpalatable was confirmed with the significance reduction in feed intake when chicks fed 30% cow pea from 28 to 45 days.

Available literature lacks information related to the use of cow pea in poultry diet. So the findings of this experiment as compared with results of other experiments that used other types of legumes are in line with findings of Ologhobo *et al* (1993) who used jack bean and jack bean fractions in their experiments. Also the results seem to agree with findings of Rubio *et al* (1989) who used faba bean. But the results is in conflict with the findings of Johnson and Eason (1990) who used field pea, lupin and chick pea, this may be due to different legumes used.

The increase in pancreas mass with increasing levels of pigeon pea or cow pea in the diet may be due to presence of protease inhibitors (Visitpanich *et al* 1985). This could be a compensatory effect of the pancreas which by secreting more proteolytic enzymes counteracts the amount inactivated by the protease inhibitors (Schneeman *et al* 1977). This result agrees withthe findings of Boonlom and Tangtaweewpat (1989).

As far as the histopathological examinations of the intestine is concerned, the results suggested no difference between those collected from the birds fed the control diet and those fed on pigeon or cow pea diets. This result may be due to the fact that the toxic factors present in pigeon pea and cow pea are not high enough to cause a difference from the control diet. These results disagree with results of Rubio *et al* (1989) who found that faba bean causes shortening of the villi of the small intestine. The disagreement may be due to different legume content of toxic factors e.g. cyanide contents of cow pea and pigeon pea were 2.1, 0.5 mg/100g while that of field peas was 2.3 mg/100g (FAO 1982).

Immunological tests revealed no significant difference between the chicks fed the experimental diets (pigeon pea and cow pea) and those fed the control diet. This could be due the to small quantity of toxic factors present in cow pea and pigeon pea).

It can be concluded that pigeon pea can be used as a plant protein source in the broiler diet up to 30% without affecting chick performance.

Cow pea can be used in broiler diet to the level of 15%, but above this level it has an adverse effects on chick performance.

References:

Abdel Halim R. Ahmed and Abdel Azim A. M. Nour (1990). Protein Quality of Common Sudanese Leguminous Seeds. Lbenson-wiss - U-Technol., volume (23) page 301-304 (1990).

Abdalla, M.I., (1997). Factors affecting protein extraction from cow pea. M,Sc. Thesis. U. of K.

Aletor, V.A. and Aladetimi, O.O. (1989). Compositional evaluation of some cow pea varieties and some under utilize edible legumes in Nigeria - Die Nahrung 33: 999-1007. British Poultry Science (1993) 34: 323-337.

Aletor V.A. (1987). Nutritional studies in the rat fed lima bean (Phaseolous lenatus). Haemoagglutinins extract. Journal of animal physiology and animal nutrition, 57: 32-41.

Aletor, V.A. & Fetuga, B.I. (1984). Influence of raw and cooked lima beans on some liver enzyme activity in the rat. Nutrition reports International 29: 565-570.

Anderson, Haffermann, J.C., Zhang, Y. and Parson, C.M. (1992). Effect of heating on nutritional quality of Conventional and Kunitz trypsin inhibitor-free Soya beans. Poultry Science, 71: 1700-1709.

Apata, D.F. (1989). Biochemical, Nutritional and Toxicological assessment of some tropical legume seeds. Ph. D. Thesis, University of London. British Poultry Science (1993), 34: 323-337.

Association of Official Analytical Chemist (AOAC 1975). Official methods of analysis, 12th edn., AOAC Washington, D.C.

Aykrod, W.R. and Doughty, J. (1964). Legumes in human nutrition. P.A.C. Nutritional studies No. 19. FAO, Rome.
Cited in Nutritional improvement of food legumes by Breeding, edited by PAC (1973). P. 28 in international workshop on grain legumes edited by ICRISAT (1975) P. 189. Sudan Journal of food Science and Technology (1980), 12: 35-43.

Begbie, R. and Pusztai, A (1989). The resistance to proteolytic breakdown of some plant (seed) proteins and their effects on nutrient utilization and gut metabolism in: Friedmann, M. (Ed.) Absorption and

Utilization of amino acids. Volume III. CRC Press Boca Raton, Fl 244-263.Cited in In Vitro Digestion for Pigs and Poultry Edited by M.F. Fuller. The Rowett Research Institute. Greenburn Road, Bucksburn. Aberdeen AB2 95B Scotland - First printed 1992 - reprinted 1993.

Bliss, P.A (1975). Cow pea in Nigeria In: Milner.
M. (Ed.) Nutritional improvement of food legumes by breeding.
John Willey, New York PP 230. Lbenson-wiss -U-Technol- Volume (23) 301-304 (1990).

Boonlom Cheva - Isarkul and Suchon Tangtaweewipat (1989). Pigeon pea as protein source in poultry diets. Uses of tropical grain legumes proceedings of Consultant Meeting 27-30 March 1989. ICRISAT Centre India.

Bressani, R. and Elias, L.C. (1980). Nutritional value of legume crops for humans and animals in: R.J. Summerfield and A.H. Bunting (Eds) Advances in legume science (1989) 30:101-114.

Bressani, R. Brenes, R.G., Garcia, A. and Elias, L.G. (1987). Chemical composition, amino acid content and protein quality of Canavalia sp seeds. Journal of Science of food and Agriculture 40:17-23.

Chemick, S.S., Lepkovsky, S. and Chaikoff, I.L. (1948). Dietary factors regulating the enzyme content of pancreas by the ingestion of raw soy beans meal. American Journal of Physiology 155:33-41.

Culling, C.F.A. (1974). Histopathological and Histochemical techniques, third edition. Butterworth & Co. London.

Davies, R.L (1980). Advances in grain legumes utilization for pig production. In recent advances in animal nutrition in Australia PP (123-130).(D.J. Farrel editor). Armidale, NSW: UNE. British Journal of Nutrition (1995), 74: 671-679.

D'Mellow, J.P.F., Acamovic, T. and Wulker, A. B. (1985). Nutritive value of Jackbeans (Canavalia ensiformis) for young chicks - Tropical Agriculture (Trinidad) 62: 145-150).

Duke, A., James, A. (1983) In: Handbook of Legumes of World Economic Importance. 2nd printing A. Division of Plenum Publishing Corporation New York PP 298.

Elhardalou S. B., Eltinary A.H. and Nour A.A.M. (1980). Chemical characteristics of some legumes grown in the Sudan. Journal of food Science and Technology 12: 35-42).

Elias, L.G., Fernadez, D.G., and Bressani, R. (1979). Possible effects of seed coat polyphenolics on the nutritional quality of bean protein. Journal of food science 44:525-528.

Falvey, J.L. and Visitpanich T., (1980a) Nutrition of high land Swine. 3. Grain legume supplementation and growth potential. Thai J. Agric. Sci. 13:109-118. Animal feed Science and Technology 25 (1989) 123-135.

Food and Agriculture Organization (1989). Quarterly protein of statistics. Vol. 2. No. 4. PP 51-53 Rome. Food and Agriculture Organization.

Food and Agriculture Organization (1982). Legumes in human nutrition P. 37.

Gatel, F. (1994). Protein quality of legume seeds for non-ruminant animals. A literature review. Animal feed Science and Technology, 45:317-348.

George, A.A. and Delumen, B.O. (1991). Anaval methionine rich protein in Soybean. J. Agric. Food Chemistry. 39: 224-226.

Gomez, A.A. and Gomez, K.A. (1984). Statistical procedures for agriculture research (2nd edn). Wilay and Sons, New York. Inc., USA, PP. 97-120.

Jain, K.C., Sherma, P., Gupta, S.C., Reddy, L. J. and Singh, U, (1980). Breeding for vegetable-type Pigeon peas In: proc. Int. workshop on pigeon peas (ICRISAT). Patachera, India, vol. 2. PP 165.

Johnson, A. V. and Lay, L.C. (1974). Genetic improvement of plant proteins. J. of Agric. Food Chemistry (1974), 22: 558-566.

Johnson, R. J. And Eason, P. J. (1990). Effect of dietary inclusion of field pea, lupin, Narbon beans and chick pea on the growth performance of broiler chickens. Proceeding of Australian Poultry Science Symposium 2: 96-99.

K.G. Wiryawan and J.G. Dingle (1995). Screening tests of protein quality of grain legumes for poultry production. British Journal of Nutrition (1995) 74: 671-679.

Khattab, A.A. and Khidir (1972). Amino acids composition of some legume seeds in Sudan. Sudan Agric. J. 7:45.

King, T.P., Begbie, R. and Cadenhead, A. (1983). Nutritional toxicity of raw kidney bean in pigs. Immunochemical & cytopathological studies on the gut and pancreas. Journal of the Science of Food and Agriculture, 34: 1404-1412.

King, T.P., Pustzai, A. and Clarke, E.M.W. (1982). Kidney bean (<u>phaseolous vulgaris</u>). Lectin-induced lesions in the rat small intestine - 3-Ultrastructional studies. Journal of Comparative Pathology, 92: 357-373.

King, T.P, Pusztai, A, Grant, G. and Slater, D. (1986). Immunogold localisation of ingested Kidney bean (<u>phaseolous Vulgaris</u>) lectins in epithelial cells of the rat small intestine. Histochemical Journal, 18: 413-420.

Layman, R. and Lepkovsky, S. (1957). The effect of raw soybean meal and trypsin inhibitor on pancreatic enzyme secretion in the rat. Journal of Nutrition 62: 269-284.

Liener, I.E. and Kakade, M.L. (1980). Protease inhibitors In: Linear, E.E. (ed.) Toxic Constituents of plant food stuffs 2nd edition. Academic Press. New York. Cited in In Vitro digestibility for pigs and poultry, P. 45-59.

Liener, I.E. (1994). Implications of antinutritional components of soybean foods. Critical reviews in food science and nutrition 34: 31-67.

Liener, I.E. (1962). Toxic factors in the edible legumes and their elimination. Animal J. Nutrition (1962) 2:281-298.

Liener, I.E. (1976). Legume Toxins in relation to protein digestibility. A review Journal of food science 41 :1076-1081.

Liener, I.E. (1976). Legume Toxins in relation to protein digestibility. A review Journal of food science 41 :1076-1081.

Lorenzsonn, V. and Olsen W.A. (1982). In vivo responses of small intestinal epithelium to intraluminal dietary lectins. Gastroentrology 82: 838-848.

Mader, Z., Gertler, A. and Brek, Y. (1979). The fate of the Bowman-Birk trypsin inhibitor from soybeans in the digestive tract of chicks. Comparative Biochemical & Physiology 62 A: 1057-1061.

Martin - Tangway, J., Vuillaume, J. and Kossu, A. Condensed tannin in horse bean seeds. Chemical structure & apparent effects on poultry. J. of Science of Food and Agriculture (1977), 28:757-765.

Ma Yu and Bliss, F.A. (1978). Tanin Content and inheritance in common beans.Crop Sci, 18:459-461.

Mitjavila, S., Lacombe, C., Carrera G & Derache, R.. (1977). Tanin acid and oxidized tannic acid on the functional state of rat intestinal epithelium. Journal of nutrition, 107: 2113-2121.

Monica Cheesbrough (1987). Medical lab manual for tropical countries. Volume II Microbiology EL.BS. English Language book society, tropical health technology. Butterworth pages 90-93.

Mustafa A.T. (1977). Protein enriched cereals for bakery production. Sud. J. of food science & Tech. (1977) 9:90.

National Research Council (1984). Nutrient requirement of poultry (8th edn) National Academy of Science, Washington, D.C.

Ologhobo A.D., Apata D.F and Oyejide A. (1993). Utilization of Raw Jackbean (Canavalia ensiformis) and Jack bean fractions in diets for broiler chicks. British Poultry Science (1993), 34: 323-337.

Parpia, H.A.B. (1973) Utilization problems in food legumes. In nutritional improvement of food legumes by breeding edited by PAG p. 281. Sud. J. Of Food Sci. Tech. (1980), 12:35-42.

Price, M.L., Hangerman, A.E. and Butler, L.G. (1980) Tanin content of cow peas, chick peas, pigeon peas and mung beans. Journal of Agriculture & food Chemistry (1980), 28:459-461.

Purseglove J.W. (1968) Tropical crops. Dicotyledons. Longmans Green and Co. Ltd. London & Harlow. Sud. J. Fd. Sci. Tech. (1980,12).

Pusztai, A. (1967). Trypsin inhibitor of plant origin, their chemistry & potential role in animal nutrition. Nutrition abstracts reviews 37: 1-9.

Pusztai, A. (1986). The biological effect of lectins in the diet of animals and man. In: Bog-Hansen T.C. and Van Driesche, E. (Eds) lectins Vol. 5. Walter de Gruyte, Berlin PP. 317-327. Cited in In Vitro digestion for pigs and poultry pages 45-60.

Pusztai, A., Clarke, E.M.W. Glant, G & King, T.P. (1981). The toxicity of phaseol us vulgaris lectins Nitrogen balance and Immunochemical Studies. Journal of Science of Food & Agriculture. 32:1037-1046.

Pusztai, A. (1989) Lectins In: Cheeke, P.R. (ed.) Toxicants of plant origin Vol. III CRC Press, . Raton 29-71. Cited in In Vitro digestion for Pigs and Poultry.

Pusztai A., Ewen, S.W. B., Grant, G., Peumans, W.J., Van Damme, E.J.M., Rubio, L. and Bardocz, S. (1986). Relationship between survival and binding of plant lectins during small intestine passage and their effectiveness as growth factors. Digestion, 46: (Sppl 2) 308-316.

Ravindran, V., and Blair (1992). Feed resources for poultry production in Asia and the Pacific II, plant protection sources. World's Poultry Science Journal, 48:205-231.

Reddy, N.R., Person, M.D., Sathe, S.K., and Salunkhe D.K. (1985). Dry bean tannins: a review of nutritional implications. Journal of the American Oil Chemists Society, 62:651-549.

Roebuck, B.D. (1986) Enhancement of pancreatic carcinogensis of raw soya protein isolate, in Friedman, M (Ed.) Nutritional & Toxicological significance of enzyme inhibitors in food. pp. (1). (New York. Plenum. Press).

Rubio L.A., A. Brenes and M. Castano (1989). Histological alteration to the pancreas and Intestinal tract produced by raw faba bean diets in growing chicks. British Poultry Sci. 30:101-114.

Rouanet, J., Lafront, J., Chalem, M., Chofppy, A. and Besancan, P. (1985). Effect of dietary kidney bean (Phaseol us Vulgaris) lectins in growing rats. Nutrition report international, 31:237-244.

Santidrian, S., Reig. G and Miralles, M. (1988). Growth rate muscle protein composition, intestinal absorption of-D-galactose and L-leucine and Nitrogen balance in rats fed the raw legume (chamaecyatisus proliferous). Plant foods for human nutrition, 38:135-143.

Schneeman, B.O., Chang, L, Smith, L.B. and Layman, R.L., (1977) Effect of dietary amino acids, casein and soybean trypsin inhibitor on pancreatic protein secretion in rats. Journal of Nutrition, 107:281-288.

Singh U. (1984). The inhibitor of digestive enzymes by polyphenols of chick pea (Cicer Arietinum) and pigeon pea (Cajanus cajan L). Nutrition reports international, March, 1984. Volume 29 No. 3

Singh, U. and Eggum, B.O.(1984). Factors affecting the protein quality of pigeon pea (Cajanus cajan). Qual plant food. Human Nutrition 34: 273-283. Animal feed Science & Tech. (1989). 25: 123-135.

Singh, U. Jain, K.C., Jambunathan, R. and Faris, D.G., (1984). Nutritional quality of vegetable pigeon peas (Cajanus cajant L minor). Dry matter accumulation, Carbohydrates and protein. J. of food Science. 49:799-800.

Singh, U. Rao, P.V. Subrahmanyam, N. and Sexena, K. (1993) Cooking characteristics, chemical composition and protein quality of newly developed genotype of pigeon pea (Cajanus cajan L). Journal of Science of Food and Agriculture, 61:395-400.

Snedecor, G.W. and Cochran, W.G. (1980). Statistical methods. 7th ed. Ames, Iowa, The Iowa State University Press, U.S.A.

Springhall, J., Akinola, J.O. and Whiteman P.C. (1974). Evaluation of pigeon pea (Cajanus cajan) meal in chicken rations. Pages 117-119. In proceeding of Australian Poultry Science Convention. Sydney. Australia.

Tangtaweewipat S. and Elliot R.(1989). Nutritional value of pigeon pea (Cajanus cajan) meal in poultry diet. Animal feed science and Technology. (1989), 25: 123-135.

Tangtaweewipat, S. and Elliot, R. (1989) Utilization of pigeon pea (cajanus cajan) as a poultry feed III. Evaluation of pigeon pea as a protein energy source in layer ration. Journal of Agriculture. 5(1): 37-45.

Tangtaweewipat S. and R. Elliot, R. (1988). Utilization of pigeon pea (cajanus cajan) as a poultry feed. II. Evaluation of pigeon pea as protein/energy source in broiler diets. Pages 1-11 in proceedings of the 26th Annual Agricultural Conference. Animal Veterinary and Fishery Division, 3-5 Feb. 1988, Bangkok, Thailand: Kasetsart University.

Tothil, J.D. (1948). Agriculture in the Sud. London. Oxford University Press. Geoffrey Camborlge. Sud. J. FD. Sci. Tech. (1980, 12).

Van der Poel A.F.B. (1990). Effect of processing on antinutritional factors and protein nutritional value of drybeans (Phaseol us Vulgaris). A review of animal feed science and technology. 29: 179-208.

Venkat Rao, S. Leela, R., Sweminathan, M. and Parpia, H.A.B. (1964). The nutritive value of protein leguminous seeds J Nutr. and Dietetic, 1:304-321.

Visitpanich, T., Batterham, E.S. and Norton, B.W. (1985a). Nutritional value of chick pea (Cicer arietinum) and pigeon pea (cajanus cajan) meals for growing pigs and rats. I Energy content and protein quality. Aust. J. Agric. resources, 36:327-335.

Vohra, P., Kratzer, F. H and Joshyn M.A. (1966). The growth depression and toxic effects of tannin to chicks. Poultry science. 45:135-142.