NUTRITIONAL VALUE OF SAMAI (*Panicum miliare*) FOR POULTRY

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CERTIFICATE

This is to certify that the thesis entitled "**NUTRITIONAL VALUE OF SAMAI (Panicum miliare) FOR POULTRY**" submitted in part fulfilment of the requirements for the degree of **Doctor of Philosophy in Animal Nutrition** to the **Tamil Nadu Veterinary and Animal Sciences University, Madras** is a record of bonafide research work carried out by **Thiru M.R. PURUSHOTHAMAN** under my supervision and guidance and that no part of this thesis has been submitted for the award of any other degree, diploma, fellowship or other similar titles or prizes and that the work has not been published in part or full in any scientific or popular journal or magazine.

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ABSTRACT

NUTRITIONAL VALUE OF SAMAI (*PANICUM MILLIARE*) FOR POULTRY

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The nutritive value of Samai (*Panicum miliare*) for poultry was evaluated by chemical analysis and biological experiments.

Samai contained, 9.69% crude protein and 2882 Kcal/Kg of metabolisable energy.

The results of the first experiment, showed that the samai grains could be incorporated upto 30% of broiler diets replacing maize, without any adverse effect on weight gain, feed consumption and efficiency; however, inclusion at 40% level resulted in a significant reduction in body weight gain by 16.7% and in feed consumption by 18.3%.

In the second broiler experiment, it was observed that autoclaving did not exert any beneficial effect. Addition of enzyme (Ventri Gold-50g/100kg) or yeast culture (Yea Sacc 100g/100kg) improved the utility of samai even at 40% level as

evidenced by improved weight gain (3.5-28.2%), feed efficiency (4.7-23.9%) and feed consumption. Enzyme significantly improved ($P < 0.05$) the retention of calcium and phosphorus whereas yeast culture improved phosphorus only.

Inclusion of samai upto 30% level (75% replacement of maize) in egg-type grower diet gave similar performance as that of basal diet. Enzyme or yeast addition enhanced the inclusion level of samai to 40% (100% replacement of maize) of the diets. In layer diets, samai upto 20% level (50% replacement of maize) produced comparable performance as that of the control. At higher levels viz. 30% and 40%, delayed maturity (7.3 and 8.8%) decreased egg production (18 and 23.6%), poor feed consumption (3.6 and 6.1%) and feed efficiency (14.3 and 20.6%) were observed. Addition of enzyme or yeast culture did not improve the laying performance as well as the qualities of eggs.

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INTRODUCTION

1. INTRODUCTION

The Indian poultry industry has registered a phenomenal growth during the past two decades raising its population from 57 million in 1971 to 271 million in 1988. (Annual report of the Department of Agricultural and cooperation, Government of India, 1988-89). Parallel to this 4.5 million tonnes of poultry diet has been produced as on 1988. It has been estimated that by the year 2000 AD, there will be a demand for 9.5 million tonnes of feed to sustain an estimated population of 145 million hybrid layers and 750 million broilers (Saxena, 1990). Consequent to the change in the socio economic status of the society, and due to better awareness about the importance of poultry meat and eggs, the demand for the same is also likely to increase in the coming years. Such a situation imposes a greater demand for increased poultry production, which in turn requires more poultry feed.

In general, the various poultry diets contain about 40 to 50 per cent of cereal grains as source of energy, of which, maize is the most extensively used ingredient followed by jowar. Apart as feed, a substantial quantity of maize is being diverted for extraction of starch on commercial basis. Other grains viz. bajra, prosomillet, kodomillet etc are being used to very limited extent based on availability. The major problem of the feed industries, even in current situation, is the shortage of maize and its consequent high cost.

In this context, the precise task of nutrition research is to identify and establish host of alternative and substitutable feed raw materials, positively at cheaper cost. Several unconventional feed grains, like foxtail millet, kodo millet, barnyard millet etc have been identified and their utility as feed is being exploited. Generally, the utility of these unconventional feed ingredients is impaired due to presence of either antinutritional factor (ANF) or high non-starch polysaccharides (NSP) or both. However, the adverse effects of these factors could be ameliorated or eliminated completely/partly by advocating certain simple processings so as to achieve the desirable improvement in the nutritive value.

Samai *(Panicum miliare)* is one such millet available to an extent of 0.1 million tonnes annually in Tamilnadu (Season and Crop report, Government of Tamilnadu, 1988-89). It contains about 9 per cent crude protein and 70 per cent available carbohydrate. During the past, samai grains were used as food particularly by tribals and people of economically weaker sections; however, as a result of socio-economical changes, these people of late have switched over to the use of conventional food grains - rice or wheat, thus sparing the availability of samai which alternatively could be used as livestock feed for economic consideration as well as to mitigate the existing shortage of animal feed resources; only very limited work is available on its utility as livestock feed. Its use as a source of energy feed for poultry has not been exploited.

Hence, an attempt has been made to investigate its usefulness as a feed ingredient for poultry by assessing the following criteria.

1. Estimation of nutrient density, including calorific value

2. Determination of the optimum level of inclusion of samai replacing maize in broiler and layer diets.

3. Studying the effects of processing/supplementation to improve the nutritive value of samai and

4. Studying the economics of feed cost.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

In India, millets such as bajra, foxtail millet, jowar, barnyard, proso millet, samai etc., are commonly available but used as food for human beings to a limited extent. The nutritive value of these millets is similar to that of maize except for its higher crude fibre owing to the presence of hulls.

Samai *(Panicum miliare)* is a drought resistant crop, capable of yielding 650 kg/hectare. The grains are highly immune to pests and weevils during storage (Aiyear, 1980). This grain has many synonym - Samai in Tamil; Same in Malayalam and Kannada, Samalu in Telugu and Mutki in Hindi. The literature available on nutrient density of samai is very limited; however, its nutrient concentration and feeding value are reviewed here in comparison to other millets/cereal grains.

2.1 CHEMICAL ANALYSIS

a) Proximate principles:

The content of proximate principles of samai in comparison to other millets as reported in literature is presented in table 1. The value of crude protein (CP) in samai ranged from 7.5 to 10.1 with a mean of 8.76 per cent. This was found to be lesser as compared to that of other millets but comparable to that of maize. The contents of ether extract (EE) and crude fibre (CF) in samai were higher whereas the nitrogen free extractive (NFE) value was lesser in comparison to that of other millets. In respect of total ash, though variations were observed among the samples of samai, the mean value (4.58 per cent) was found to be higher.

TABLE 1. PERCENT PROXIMATE PRINCIPLES OF SAMAI AS COMPARED TO OTHER MILLETS (ON DRY MATTER)

Millets	Dry matter	Crude protein	Ether extract	Crude fibre	Nitrogen free extract	Total ash	Reference
Samai	88.5	8.7	5.3	8.6	72.0	5.4	Patwardhan and Renganathan (1962)
Samai	89.8	10.1	4.0	5.1	76.9	3.9	Aiyear (1980)
Samai	92.1	7.5	4.5	5.0	73.3	6.7	Aiyear (1980)
Samai	88.5	8.7	5.3	8.6	75.7	1.7	Gopalan et al. (1982)
Samai	86.3	8.8	5.4	7.7	72.9	5.2	Kathaperumal (1985)
Maize	89.5	9.2	3.9	2.4	82.8	1.7	I.S.I. (1980)
Jowar	88.1	11.8	2.2	1.8	82.4	1.8	Gopalan et al. (1982)
Bajra	87.6	13.2	5.7	1.4	77.1	2.6	
Foxtail	90.5	11.1	3.7	9.7	71.9	3.6	
Kodo	87.2	9.5	1.6	10.3	75.6	3.0	
Proso	88.1	14.2	1.2	2.5	79.9	2.2	

b) Fibre fractions:

The values for different constituents of CF reported, are given in table 2. Kathaperumal (1985) reported the value of NDF and ADF in samai as 15.02 and 8.09 while Reddy (1992) recorded as 40.58 and 12.46 in foxtail millet and 28.25 and 4.02 per cent for maize respectively. The value of fibre fractions viz hemicellulose, (28.12 vs 24.23) cellulose (9.82 vs 3.69) and lignin (2.14 vs 0.13) were higher in foxtail millet when compared to maize.

Geervani and Eggum (1989) reported that samai contained higher insoluble dietary fibre (29.48 per cent) when compared to other millets (17.8 to 26.04 per cent).

c) Available carbohydrate and energy content:

The available carbohydrate in terms of starch and glucose, the gross and metabolisable energy of different minor millets along with the value of maize are presented in table 3.

The starch content varied from 72.07 to 79.32 per cent, in most of the millets. Sugar content of foxtail millet was much higher (4.38 per cent) as compared to other millets most of which had less than 1 per cent (Geervani and Eggum, 1989). The gross energy (GE) and metabolisable energy (ME) value ranged from 4112 to 4571 and from 2642 to 2950 Kcal/kg respectively for various millets. The value of maize in respect of the above nutrients - starch, sugar and ME was found to be higher when compared to millets. The ratio of ME/GE in maize was higher (0.86) when compared to millets (0.64 to 0.72).

TABLE 2. PERCENT FIBRE FRACTIONS OF MILLETS AND MAIZE (ON DRY MATTER)

Fractions	Samai*	Fox tail** millet	Maize**
NDF	15.02	40.58	28.25
ADF	8.09	12.46	4.02
Hemicellulose	6.93	28.12	24.23
Cellulose	-	9.82	3.69
Lignin	-	2.14	0.13

* Kathaperumal (1985)
** Reddy (1992)

TABLE 3. PERCENT AVAILABLE CARBOHYDRATE AND ENERGY CONTENT (Kcal/kg) OF MILLETS AND MAIZE (ON DRY MATTER)

Millet	Available carbohydrate		GE	ME	ME/GE
	Glucose[a]	Starch[a]			
Samai	0.97	75.71	4571	-	
Foxtail	4.38	72.07	4112	2950[e]	0.72
Barynard	1.27	73.21	4496	-	
Proso	0.92	74.65	4515	2892[b]	0.64
Kodo	0.66	79.32	4421	2842[d]	0.64
Bajra			3755[g]	2642[c]	0.70
Sorghum			4027[g]	2645[c]	0.66
Maize	6.20[e]	53.54[e]	3812[f]	3309[c]	0.86

a - Geervani and Eggum (1989)
b - NRC - Poultry 1984
c - ISI (1980)
d - Baghel and Nekte (1989)
e - Reddy 1992 et. al
f - Devegowda (1989)
g - Crampton and Harris (1968)

Choct and Annison (1990) found a highly significant negative correlation between the energy metabolizability (ME/GE) of cereals and their non-starch polysaccharides (NSP) in young chickens.

d) Amino acids profile:

Data on the amino acids composition of samai grains in comparison with maize are presented in table 4. These values revealed that the samai was lower in lysine but richer in methionine. The value of other amino acids - arginine, leucine, phenylalanine, cysteine, tryptophan and threonine were more or less similar and comparable to that of maize.

Geervani and Eggum (1989) studied the protein quality of various minor millets in rats in terms of digestibility, biological value (BV) and net protein utilization (NPU). The digestibility of protein was very high ranging from 95.28 to 99.29 per cent, however, the BV ranged from 48.37 to 56.51 per cent, whereas the NPU ranged from 46.34 to 54.52 per cent.

e) Mineral Composition:

The concentration of various minerals both major and minor of samai and maize as reported in literature is presented in table 5. The concentration (mg/100g) of calcium (19), iron (5.2), sodium (8.1 to 90) and copper (0.42 to 2.6) were found to be higher in samai whereas phosphorus (210), magnesium (50) and chlorine (13) were lower than maize.

TABLE 4. ESSENTIAL AMINO ACIDS COMPOSITION (g/16 g N), TOTAL PROTEIN DIGESTIBILITY AND PROTEIN QUALITY OF SAMAI AND MAIZE (ON DRY MATTER)

Amino acids	Samai*	Samai**	Maize***
Alanine	-	9.61	-
Arginine	4.00	3.14	4.69
Glycine	-	1.81	-
Histidine	1.92	2.01	2.56
Isoleucine	5.92	4.91	-
Leucine	11.16	11.41	11.52
Lysine	1.76	1.09	3.20
Methionine	2.88	3.07	1.92
Phenylalanine	5.28	5.94	4.64
Tryptophan	0.96	0.69	0.64
Tyrosine	-	4.37	3.84
Cysteine	1.44	1.46	1.60
Threonine	3.04	3.55	4.48

Protein quality			
Protein digestibility (%)	-	97.71	-
Biological value (%)	-	53.00	-
Net protein utilisation	-	51.83	-

* Gopalan et al. (1982)
** Geervani and Eggum (1989)
*** NRC 1984.

TABLE 5. MINERAL COMPOSITION (mg/100g) OF SAMAI IN COMPARISON WITH MAIZE (ON DRY MATTER)

Mineral	Samai*	Samai**	Maize**
Calcium	20.0	17.0	10.0
Phosphorus	210.0	220.0	348.0
Iron	5.3	5.2	2.0
Zinc	3.0	-	-
Magnesium	40.0	60.0	144.0
Sodium	90.0	8.1	15.9
Potassium	-	129.0	286.0
Copper	2.6	0.42	0.19
Sulphur	-	149.0	114.0
Chlorine	-	13.0	33.0

* Kathaperumal (1985)
** Gopalan et al. (1982)

TABLE 6. TANNIC ACID (g/100g) OF WHOLE AND DEHUSKED GRAIN OF VARIOUS MILLETS* (ON DRY MATTER)

Millet	Whole grain	Dehusked grain
Samai	0.36	0.07
Foxtail millet	0.20	0.10
Proso millet	0.21	0.06
Barnyard millet	0.28	0.07
Kodo grain	0.87	0.15

* Geervani and Eggum (1989)

f) **Tannic acid:**

The content on total tannic acid present in millets as determined by Eggum and Christensen (1975) are shown in table 6. Tannin was present in whole grains at appreciable level and it ranged from 0.20 to 0.87 per cent whereas the value in dehusked grains was between 0.067 and 0.15 per cent. This indicates that most of the tannin present is in the husk rather than the grains.

2.2 FEEDING VALUE OF MILLETS

2.2.1 Broilers

Attempts to replace maize with various millets for broilers have been made but the results are inconsistent.

a) **Weight gain:**

Singh and Barsaul (1976) reported that bajra could totally replace the maize (40 per cent) in the reference diet without affecting the growth rate of birds. Similar result was also obtained by Reddy et al. (1987), Smith et al. (1989) and Thanabalan (1992). Rajini et al. (1986) observed improved growth when 37.5 per cent maize was replaced by bajra. However, Qureshi (1967) and Mohamedian et al. (1986) reported depressed growth when bajra was incorporated in the diets replacing 50 or 100 per cent of maize.

Baghel and Nekte (1982) observed that inclusion of foxtail millet at 61 per cent of the diet replacing maize resulted in similar growth. Such an observation also was confirmed by Reddy (1992) at 40% level of inclusion.

Azcona and Bonino (1985) reviewed the literature on the utilization of sorghum grains and concluded that sorghum grain poor in tannin (< 1 per cent) could replace maize without any adverse effect on growth. Lucbert and Castaing (1986), Rajini et al. (1986), Smith et al. (1989) and Douglas et al. (1990) also made similar observation when sorghum replaced maize totally in broiler diets. Gaffer et al. (1987) and Paik et al. (1989) recorded better growth rate in broiler chicks fed diet containing sorghum and maize in the proportion of 50:50, than the diet having either sorghum or maize alone. Contradictory to the above finding, Sinha et al. (1980) recorded depressed growth (26%) at 100 per cent replacement of maize.

Abate and Gomez (1984) found comparable growth in broilers on substitution of maize with finger millet at 60 per cent level of diets.

b) Feed consumption:

Comparable feed consumption was recorded when bajra replaced maize even at the highest level of 60 per cent (Yeong and Syed Ali, 1976; Rajini et al., 1986; Thanabalan, 1992). However, Reddy et al. (1987) noticed an increased feed consumption over that of birds fed basal feed, whereas Mohamedian et al. (1986) and Reddy et al (1991) observed a lower intake.

Baghel and Nekte (1982) and Reddy (1992) on feeding the broilers with the diet containing foxtail millet (60 per cent) observed comparable feed consumption. Similar observation of feed consumption was found when sorghum replaced maize (Smith et al., 1989).

c) **Feed efficiency:**

Complete replacement of maize with bajra in broiler diets had no significant difference on feed efficiency (Qureshi, 1967; Rajini et al., 1986; Reddy et al., 1987; Smith et al., 1989; Thanabalan 1992). However, favourable feed efficiency (11-15.9%) was observed by Singh and Barsaul (1976) and Sinha et al. (1980). Mohamedian et al. (1986) reported lower feed efficiency in bajra based diet.

Replacement of maize with foxtail millet did not show any variation on feed efficiency in broilers (Baghel and Nekte, 1982; Reddy, 1992) but substitution of finger millet resulted in lowered efficiency by 7.8% (Abate and Gomez, 1984); however, Rajini et al. (1986) recorded the same efficiency as that of basal diet.

d) **Blood picture:**

Ganapathy and Chitre (1961) observed in rat that inclusion of foxtail millet resulted in reduction of the mean haemoglobin (8.43 g/100 ml) and protein (2.98 g/100 ml plasma) level; however, addition of lysine increased to 13.54 and 4.78 g/100 ml respectively, but not to the extent observed as in those rats fed casein.

In broiler fed foxtail millet, Rao (1991) and Reddy (1992) observed no influence on the haemoglobin (9.25 and 9.1 g/100 ml) and serum protein levels (3.45 and 3.69 g/100 ml).

e) Carcass Qualities:

Suitability of unconventional feeds (energy or protein source) in broiler ration has been assessed in term of carcass yield and qualities by various authors.

In an attempt to include sunflower seed meal upto 40% in broiler (Salih and Taha, 1989), rice bran upto 20% (Carrion and Lopez, 1989; Purushothaman et al., 1990) rapeseed meal upto 15% (Chrappa, 1990) cassava peel upto 15% (Osei, 1992) no influence on carcass yield, weight of blood, viscera and liver was observed. However, feeding of cassava root meal (Babiker et al., 1991) at 75% replacement of sorghum was reported to reduce carcass yield, but increase liver and abdominal fat.

Use of millet-- foxtail millet upto 62% level in broiler ration did not have any influence on eviscerated, giblet and ready to cook yield (Rao, 1991; Reddy, 1992). Similar observation of comparable eviscerated weight and ready to cook yield was reported by Thanabalan (1992) when pearl millet totally replaced maize.

2.2.2 Layer

a) Weight gain:

Baghel and Nekte (1982) observed no difference in growth rate of white leghorn chicks fed diet containing 61 per cent of foxtail millet with ground nut cake and fish meal as source of protein, whereas at 56 per cent level in the diet having soyabean meal, the same authors found improved weight gain by 14% in chicks. In similar studies, Kapoor et al. (1987) while assessing the feeding value of kodo millet, at 60.5 per cent level with different sources of protein did not find any difference in the growth rate of egg chicken.

b) Feed consumption:

Incorporation of foxtail millet at 24 or 36 per cent level replacing wheat in layer diet, no significant difference was found in quantum of feed consumption (Trenchi, 1985), whereas the same millet at 40 per cent level replacing maize increased the feed consumption (Rao et al., 1991). Similarly, graded levels of foxtail millet on replacement of maize at 40 per cent in layer diets caused increased feed consumption (Reddy, 1992).

Again inclusion of bajra at 30 or 60 per cent levels substituting maize weight by weight showed no variation in feed consumption while the same levels in an isocaloric and isonitrogenous diet reduced feed consumption (Kumar et al., 1991). Contradictory to above observations, either kodo millet at 47 per cent or proso millet at 27.5 or 55 per cent of the diet caused an increased feed consumption by 4 to 7.4% (Baghel and Nekte, 1989; Korane et al., 1991).

Layer diet containing 60 per cent sorghum for maize did not influence the feed consumption (Castro et al., 1984; Park et al., 1985).

c) Egg production:

The birds fed diet having foxtail millet either at 24 per cent (Trenchi, 1985) or 40 per cent level (Rao ., 1991; Reddy, 1992) showed the same production performance as that of the birds fed control diet, during the period from 23rd to 46th week of age. Similarly inclusion/substitution of maize either with pearl millet upto 60 per cent (Kumar et al., 1991) or kodo millet upto 47 per cent (Baghel and Nekte, 1989) did not affect the egg production. However, inclusion of sorghum at 60 per cent (Park et al., 1985) or proso millet even at 27.5 percent (Korane et al., 1991) in the layer diets reduced egg production significantly by 5.2 and 16.7 per cent respectively.

d) Feed efficiency:

Use of foxtail millet at 40 per cent level in layer diet caused a poor feed efficiency (1.83 vs 1.79 kg of feed/dozen of eggs) compared to basal diet (Reddy, 1992). Similar to this, Korane et al. (1991) in their studies of proso millet, noticed a reduction of 56 per cent in feed efficiency. Contradictory to the early observations, Park et al. (1985) and Kumar et al. (1991) obtained comparable feed efficiency while incorporating either sorghum or pearl millet upto 60 per cent of the layer diets.

e) Egg qualities:

Use of kodo millet ranging from 12 to 47 per cent in layer diets did not affect the various egg qualities, except the visual yolk colour which significantly reduced progressively as the level of the millet increased in the diets (Baghel and Nekte, 1989). Similar reduction in visual yolk score was observed by Reddy (1992) and Korane et al. (1992) as the result of inclusion of foxtail (10%) or proso millet (55%) in layer diet.

2.3 EFFECTS OF PROCESSING

Substitution of millets (unconventional feed ingredient) for conventional cereal-maize in poultry diets has been shown to decrease growth and feed efficiency (McNab and Shannon, 1975; Patel and McGinnins, 1976). Generally grains are subjected to various processings like heat treatment, pelleting, soaking, chemical treatment etc. to ensure the increased bio-availability of nutrients.

2.3.1 Autoclaving:

Kratzer et al. (1974) observed similar growth rate in broilers fed diet containing 60 per cent autoclaved deoiled rice bran (DORB) as that of reference diet. However, Kratzer and Payne (1977) reported that inclusion of boiled water treated DORB had resulted in improvement of growth by 20 per cent over that of untreated. Incorporation of autoclaved DORB at 20 per cent in broiler diet did not influence the performance or nutrient digestibility but the balance of phosphorus was improved over the untreated DORB (Purushothaman et al., 1990).

On heat treatment of maize cobs (Umuna et al., 1985) and rice bran (Rathee and Lohan, 1986) reduced NDF and ADF were observed. Autoclaving of DORB had reduced the NDF (27 per cent) and ADF (3 per cent) but increased the glucose and starch by 1.4 and 1.55 per cent respectively (Purushothaman et al., 1990).

Czarnecki et al. (1984) found that when cereal grains - barley, wheat, maize, triticale etc were treated at 100°C to 130°C under 10 to 30 per cent moisture, the degree of gelatinisation got increased.

Inspite of certain favourable changes obtained by heating, Herstad and Mc Nab (1975) observed decreased dry matter digestibility of barley autoclaved at 120°C for 30 minutes.

2.3.2 Enzymes supplementation:

Recent studies have shown that addition of suitable crude enzymes to diets of poultry could lead to improvements in weight gain and feed efficiency by increasing the bioavailability of nutrients (Chesson, 1987; Broz, 1987; Rotter et al., 1989; Petterson, 1991; Friesen et al., 1992). Collier and Hardy (1986) observed a better feed efficiency (6 to 16%) on addition of varied levels of enzymes particularly in low digestible diets.

a) Broilers:

Application of pectinase (1000 ppm) in rye-based broiler diet improved the weight gain by 10-30 per cent and feed efficiency by 9-14 per cent (Patel et al., 1980; Grammer et al., 1982). Similarly Broz (1987) reported that pectinase preparation of Aspergillus niger (1000 ppm) significantly increased weight gain (9.9 per cent) and improved feed efficiency (7 per cent). The same author on addition of Trichoderma viridae cellulase complex (200 ppm) also noticed a significant improvement in weight gain (10.9 per cent) and feed conversion (8.5 per cent).

Cellulase at 100-500 ppm in the chick diets based on barley, oats or rye improved the weight gain (4-26 per cent) and feed conversion (2-8 per cent) whereas, less improvement was noticed (2 per cent) in chicks, fed diets containing maize or wheat (Broz and Frigg, 1986 a).

Supplementation of barley-based diets with purified beta-glucanase (500 ppm) significantly increased weight gain of chicks (6.4 to 10.5 per cent) as well as feed conversion (3.4 to 4.5 per cent). However, when added to a diet based on maize, beta-glucanase did not improve the chick performance significantly (Broz and Frigg, 1986b).

Bhatt et al. (1991) found that addition of Novoenzyme SP-243 containing cellulase and hemicellulase at 20 g/kg to the conventional broiler diets caused a significant gain in weight and improved feed efficiency. However, incorporation of multienzyme (protease, beta-glucanase, amylase, cellulase, xylanase, peptinase) at the rate of 500 ppm to broiler diets containing 50 per cent maize, or 25 per cent cumbu plus 25 per cent maize or 50 per cent cumbu no improvement in weight gain and feed conversion was observed (Thanabalan, 1992).

The addition of amylolytic enzyme preparation to grain based feeds other than barley and oats also had been reported to improve feed utilization but the results of various feeding trial were not wholly consistent. For example, the weight gain and feed efficiency in maize-soyabean based diets of layers (Gleaves and Dewan, 1970) and broilers (Parkany Gyarfos and Toth, 1978) were found to be substantially enhanced by the addition of amylase preparation, while in contrast, no significant increase was observed (Moss et al., 1978).

b) Layers:

Supplementation of pectinase (1g/kg feed) in rye based diets (Patel and McGinnins, 1976) improved egg production by 10-20 per cent. Similar encouraging result was obtained even in the absence of animal protein with low energy (Kvitkin and Tishenkova, 1979). Recent workers Hijikuro et al. (1989) and Nasi (1990) however reported a contradictory finding on the addition of cellulase.

Beta-glucanase (1g/kg) added to the layer diets having either barley, or wheat or oat failed to exert favourable response on egg production, whereas multienzyme preparation containing cellulase, beta glucanase and proteases not only helped to increase egg production but also utilisation of protein. The improved performance was attributed due to degradation of cell wall and readily availability of nutrients both acting synergistically (Nasi, 1990). Similar favourable egg production (17.2 per cent) and egg mass was reported by Adams (1989) as a result of multienzyme. Supplementation of Polar S (Chymotrypsin, Polysaccharidase) had no beneficial effect in maize-soyabean diet. (Wetscherek and Zollitsch, 1991).

Benabdeljellil (1991) observed no significant difference in egg qualities on enzyme supplementation of layer diet. While Petterson (1991) recorded greater percentage of broken egg with increased shell weight.

c) **Nutrient digestibility:**

The addition of beta-glucanase to a barley based broiler diet resulted in improvement of apparent digestibility of dry matter, organic matter and ether extract (Broz and Frigg, 1986b). Broz (1987) reported that cellulase complex containing multiple enzyme (cellulase 200 ppm) resulted in a significant improvement in dry matter digestion and nitrogen retention. This may be probably due to improved utilisation of non-starch polysaccharides. Similarly, Broz and Frigg (1990) observed that enzyme supplementation in oats based diet significantly increased retention of dry and organic matter whereas the nitrogen retention was not affected.

Bhatt et al. (1991) while studying the effect of enzyme supplementation recorded an increased digestibility in dry matter, CP, EE, CF and NFE. This improvement could be possibly due to the release of protein and storage polysachharides which are otherwise protected by intact cell walls. Similar finding of improved nutrients digestibility was observed by Friesen et al. (1992) while studying the effect of enzyme on different cereals.

d) Metabolisable energy:

Similar to other nutrients, addition of beta-glucanase significantly increased the ME of the diet by 187 KJ/kg (Broz, 1986b). Supplementation of pectinase to rye based diet did not bring any improvement but cellulase complex caused a significant increase by 7.5 per cent in ME (Broz, 1987). Similar improvement (3.7 per cent) in ME value was obtained in broiler diets based on oats (Broz and Frigg, 1990; Rotter et al., 1990; Friesen et al., 1992).

2.3.3 Yeast culture:

Yeast culture is found to enhance the palatability of the ration due to flavouring property of the high content of nucleic acid and glutamic acid (Peppler 1982) and improved weight gain and feed efficiency in meat producing animals (Philips and Von Tungeln, 1985, Fallon and Harte, 1987).

a) Poultry:

Supplementation of live yeast culture had resulted in increased utilization of minerals (Thayer et al., 1978) nitrogen and ME of sorghum hulls (Wenk, 1990).

Gaynor Mc Daniel (1990) on studying the effect of yeast (1g/kg) observed early maturity, increased semen production with high concentration of sperm in male birds whereas in female birds improved egg mass, shell quality and hatchability. Contrary to the above finding, Brake (1991) on inclusion of Yea Sacc at 0.5% level as well as Vogt and Mathews (1991) at 0.1% observed no beneficial effects on weight gain and feed intake.

b) Swine:

Rizvanov and Dragnov (1987) observed greater weight gain and lowered feed efficiency in swine on supplementation of yeast (25g/100 kg). The low concentration of serum alanine and aspartic transferase and increased activity of alkaline phosphatase due to yeast addition was suggestive of more intensive amino acid metabolism.

Wenk (1990) reported that yeast culture increased NDF digestibility by 8-15% and digestible energy by 0.8 to 1.2%.

c) Horse:

Addition of Yea Sacc (20g/day) in the diets of nursing and weaning foal had improved the weight gain and feed efficiency by 8% which could be attributed to better amino acid balance and nitrogen retention. (Glade and Sist, 1990).

Glade (1990) had reported that yeast in horse ration increased the digestibility of dry matter (4.8%), energy (15%), NDF (9%), hemicellulose (14.7%), cellulose (18.2%) crude protein (11-14%) and phosphorus availability (28%). Similarly, Godbre

(1983) achieved increased digestibility of crude fibre as the result of yeast, probably due to higher activity of cellulolytic bacteria in caecum. Pagan (1990) observed better balance of calcium and phosphorus by 12.7 and 22.3% respectively.

d) pH and microbial count:

Rose (1980) reported that the presence of live yeast cells and its replicate would lower the oxygen concentration of the gut which could favour the growth of strictly anaerobic bacteria. In ruminants, yeast culture increased total bacteria count - 11 folds (Dawson and Hopkins, 1992) the concentration of cellulolytic bacteria (89%) and lactate utilizers - 3 folds (Edward, 1991). However, in poultry the species and count of intestinal bacteria were not influenced by yeast (Vogt and Mathews, 1991)

MATERIALS AND METHODS

3. MATERIALS AND METHODS

The sufficient quantity of fully matured grains-Samai *(Panicum miliare)* was obtained from, The Regional Research Station, Tamilnadu Agricultural University, Paiyur, for chemical and biological experiments of this study. These grains were sun-dried, freed from exterhious material and ground. Apart from this, nine samples of samai of unknown variety were collected randomly from different parts of Tamilnadu for analysis.

With an objective of improving the nutritive value of samai, two commercial additives viz. Ventri Gold (hemicellulase, cellulase, glucanase, xylanase, pectinase, amylase, protease, lipase) and Yea Sacc[1026] *(Saccoharomyces cerevisiae)* were used in the biological experiment of this study.

A number of chemical analysis and a series of biological experiments in broilers and layers were carried out following the standard procedures in the Department of Animal Nutrition, Veterinary College and Research Institute, Namakkal, to assess the feeding value of samai for poultry.

3.1 CHEMICAL ANALYSIS

a) Proximate principles:

Nine random samples and test sample of samai were analysed for the total dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF) and total ash (TA) as per the methods of AOAC (1980). Nitrogen free extractive (NFE) was calculated. All values were calculated and expressed on per cent dry matter basis.

b) Fibre fractions:

Samples of samai - raw as well as autoclaved and maize were subjected to analysis of neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) as per the method of Goering and Van Soest (1970) using Fibretec. In addition, cellulose, hemicellulose and lignin also were estimated and the values are expressed as per cent of feed material on dry matter.

c) Available carbohydrate and Metabolisable energy:

All the 10 samples were analysed for the content of starch and soluble sugars using anthrone method of Clegg (1956). The concentration of starch and sugar was calculated by comparing the reading with standard glucose solution.

Based on per cent CP, EE, and available carbohydrate, the metabolisable energy value (ME) was calculated for each sample using the formula of Carpenter and Clegg (1956).

M.E.(Kcal/kg) = 53 + 38 (% CP + 2.25 x % EE + 1.1 x % starch + % glucose).

d) Mineral profile:

Sample of samai was analysed for certain major minerals viz. calcium and phosphorus and a few minor minerals viz, copper, zinc, iron, cobalt and manganese using Atomic absorption spectrophotometer as per the procedure given in Cook Manual (1982).

e) Tannic acid:

Tannin from three samples of different area were extracted using methanol. The estimation of tannin was carried out using spectrophotometer as per the method of Slinkard and Singleton (1977). The results were calculated as tannic acid based on standard curve.

3.2. BIOLOGICAL EXPERIMENTS

3.2.1 Determination of metabolisable energy:

The metabolisable energy of the test sample both ground and unground was estimated in roosters as per the methods of Farrell (1978).

Eight roosters were starved for a period of 24 hours, fed 35g of unground samai and maintained in individual cages for a day. A plastic sheet was fastened under each cage for collection of excreta. Water was provided *ad libitum* during 24h experimental period at the end of which excreta were collected quantitatively for further analysis. The excreta of each bird were made into homogenous mass and dried at 80°C to find out the dry matter content. After an interval of 7 days the same procedure was adopted for estimation of metabolisable energy in ground samai.

The calorific value of feed sample as well as the excreta were assayed by adiabatic bomb calorimeter and the values were used to arrive at the metabolisable energy of samples using the formula of Sibbald (1976).

$$ME\ (K\ Cal/g) = \frac{(GE_f \times X) - Y_{ef}}{X}$$

Where GE_f = is the gross energy of the feeding stuff (Kcal/g)

Y_{ef} = is the energy voided as excreta by the fed bird

X = is the weight of feedstuff fed (g)

3.2.2 Effect of feeding samai on broiler performances:

The optimum level of inclusion of raw samai in broiler diets was examined in this experiment. Samai was incorporated at 0, 10, 20, 30 or 40 per cent in the rations replacing maize. The level of various ingredients was adjusted so as to have the isocaloric and isonitrogenous diets. The ingredients and proximate composition of the rations used in the experiment are given in the tables 7 and 8 respectively.

One hundred and fifty day-old broiler Vencob chicks received from Tamilnadu Poultry Development Corporation, Namakkal, were used in this experiment. The chicks were weighed individually, wing-banded and distributed on basis of body weight into 5 treatment groups with 3 replicates in each according to a randomized plan.

All the birds were housed in litter pens and reared for 56 days following standard management practices uniformally for all the treatments except the diets.

A record of weekly weight gain and feed consumption was maintained. At the end of 8 weeks of age, 6 birds from each experimental group were slaughtered to assess the carcass qualities. Simultaneously blood was collected from 6 birds in each

EXPERIMENT - 1

TABLE 7. INGREDIENT COMPOSITION (%) OF BROILER DIETS

Ingredients (kg)	Level of Samai				
	0	10	20	30	40
Maize	40.0	30.0	20.0	10.0	0.0
Samai	0.0	10.0	20.0	30.0	40.0
Deoiled rice bran	26.0	19.5	13.0	6.5	0.0
Broken wheat	0.0	6.5	13.0	19.5	26.0
Groundnut cake	22.0	22.0	22.0	22.0	22.0
Fish meal	10.0	10.0	10.0	10.0	10.0
Mineral mixture[1]	2.0	2.0	2.0	2.0	2.0
Vitamin and mineral premix[2]	+	+	+	+	+
Coccidiostat[3]	+	+	+	+	+
Antibiotics[4]	+	+	+	+	+

1. Mineral mixture at level added supplied calcium 0.64, phosphorus 0.12%.
2. Vitamin and mineral premix 250/100 kg, at the level added supplied vitamin A, 7,50,000 I.U; Vit D_3, 75,000 I.U; Vit. B_1, 0.3 g; B_2, 0.5 g; B_6, 0.2 g; B_{12}, 1 mg; Vit E., 125 units; K_3, 0.1g; Folic acid, 50 mg; Niacin, 2g; Calcium panthothenate 1g; choline chloride 20g; Ca, 55 g; Cu, 0.3g; I, 0.08; Fe, 4.6g; Mn, 5.5g; P, 20.8g; Zn, 6g per 100 kg diet.
3. Coccidiostat (D.O.T) - 50 g/100 kg.
4. Antibiotics (Colidox) 50 g/100 kg.

\+ Supplemented.

EXPERIMENT - 1

TABLE 8. CHEMICAL COMPOSITION (% DM) OF THE BROILER DIETS

Nutrient	Level of Samai %				
	0	10	20	30	40
Dry matter	89.89	90.11	89.17	89.78	88.99
Crude protein	21.91	21.82	22.31	21.85	22.13
Crude fibre	6.65	6.64	6.40	6.15	5.99
Ether extract	3.78	3.12	3.20	3.26	3.34
Ash	10.40	10.53	10.42	9.38	10.57
Nitrogen-free extract	57.26	57.89	57.67	59.36	57.97
Acid insoluble ash	3.34	3.40	3.20	3.12	2.90
Lysine*	0.87	0.85	0.82	0.80	0.77
Methionine*	0.33	0.34	0.35	0.36	0.37
ME* Kcal/Kg	2744	2743	2742	2740	2739

* Calculated values.

experiment group for estimation of PCV, ESR, RBC and haemoglobin. The estimation of haemoglobin was done by cyanomethaemoglobin method (Dacie and Lewis, 1968; and I.C.S.H., 1978) using Drankin solution.

3.2.3 Effect of feeding processed samai - autoclaving and supplementation (enzyme or yeast culture) on broiler performance:

This experiment was designed to find out whether autoclaving or addition of multienzyme or yeast culture would improve the nutritive value of samai either by inactivating or destruction of any antinutritive factor or increasing the bioavailability of nutrients.

- Autoclaving

Autoclaving of samai was done at 120°C, at a pressure 15 lbs/inch^2 for 30 minutes. The sample was then removed, air-dried and stored for subsequent use.

- Supplementation

The Ventri Gold containing multienzyme was incorporated to the experimental diets at the rate of 50 g/100 kg. Similarly, Yea Sacc[1026] containing yeast culture was added at the rate of 100 g/100 kg in the experimental diets.

In this experiment, either raw or autoclaved samai was incorporated at 30 per cent or 40 per cent levels; in addition, the control and diets containing 30 per cent and 40 per cent raw samai were supplemented with enzyme or yeast, so as to have

11 treatments. The ingredients and proximate composition of the rations are presented in tables 9 and 10.

Two hundred and thirty one, day-old broiler chicks of same strain were allotted randomly to 33 groups of seven chicks in each after weighing and wing banding. The duration of the experiment, criteria studied and management practices followed were similar as in the previous experiment.

At the end of the experiment, a metabolic trial for a period of three days using three birds from each treatment was conducted. Daily feed intake and excreta were quantified for the birds individually for estimation of digestion coefficients of various nutrients, balance of nitrogen, calcium and phosphorus and metabolisable energy of the experimental diets.

3.2.4 Effect of feeding samai and supplementation (enzyme or yeast culture) on layer performance:

A growth cum layer trial of 25 weeks was conducted with 210 Babcock BV 300 birds of 16 weeks age. The pullets were weighed, wing banded and distributed randomly into 21 groups of 10 birds each with least difference in weight. Each group of birds was randomly housed in deep litter pens.

Seven experimental grower and layer diets were formulated incorporating samai at 0, 10, 20, 30 and 40 per cent level, further the diet containing 40 per cent samai was supplemented with enzyme or yeast. The ingredient and proximate composition of the grower and layer experimental diets are shown in tables 11, 12, 13 and 14 respectively. The pullets were fed grower diets upto the end of 20 weeks of

TABLE 9. INGREDIENT COMPOSITION (%) OF BROILER DIETS HAVING AUTOCLAVED SAMAI OR SUPPLEMENTS

Ingredient	Levels of Samai %										
	Raw samai			Autoclaved samai		Enzyme			Yeast		
	0	30	40	30	40	0	30	40	0	30	40
Maize	40.0	10.0	0.0	10.0	0.0	40.0	10.0	0.0	40.0	10.0	0.0
Samai	0.0	30.0	40.0	30.0	40.0	0.0	30.0	40.0	0.0	30.0	40.0
Deoiled Rice bran	26.0	6.5	0.0	6.5	0.0	26.0	6.5	0.0	26.0	6.5	0.0
Broken wheat	0.0	19.5	26.0	19.5	26.0	0.0	19.5	26.0	0.0	19.5	26.0
Groundnut cake	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
Fish meal	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Mineral mixture[1]	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Enzyme[2] 50g/100g	-	-	-	-	-	+	+	+	-	-	-
Yeast culture[3] 100g/100kg	-	-	-	-	-	-	-	-	+	+	+

Vitamin and mineral premix[1] 250g/100kg; Coccidiostat[1] - 50g/100kg; Antibiotics[1] - 50g/100kg used in all experimental diet.

[1]Same as table 7. [2]Ventri Gold. [3]Yea sacc[1026]

TABLE 10. CHEMICAL COMPOSITION (% DM) OF THE BROILER DIETS HAVING AUTOCLAVED SAMAI AND SUPPLEMENTS

Nutrient	Level of Samai %										
	Raw samai			Autoclaved samai		Enzyme			Yeast		
	0	30	40	30	40	0	30	40	0	30	40
Dry matter	93.15	92.64	91.93	94.62	94.24	95.14	96.23	94.02	93.28	92.28	94.54
Crude protein	21.94	21.86	22.13	22.14	21.88	22.06	22.11	22.05	21.56	22.03	21.87
Crude fibre	6.17	6.41	6.23	6.16	6.22	6.41	6.45	6.13	6.41	6.21	6.15
Ether extract	3.24	3.07	3.14	3.16	3.04	3.30	3.12	3.14	3.35	3.14	3.06
Ash	9.59	11.34	10.03	10.30	10.06	9.81	9.75	9.96	10.35	10.03	10.04
Nitrogen free extract	59.06	57.32	58.47	58.24	58.80	58.42	58.57	58.72	58.33	58.59	58.88
Lysine*	0.87	0.80	0.77	0.80	0.77	0.87	0.80	0.77	0.87	0.80	0.77
Methionine*	0.33	0.36	0.37	0.36	0.37	0.33	0.36	0.37	0.33	0.36	0.37
ME* (kcal/kg)	2744	2740	2739	2740	2739	2744	2740	2739	2744	2740	2739

* Calculated values.

TABLE 11. INGREDIENT COMPOSITION (%) OF GROWER DIETS

Ingredient	Level of Samai %						
	0	10	20	30	40	40 + enzyme	40 + yeast culture
Maize	40.0	30.0	20.0	10.0	0.0	0.0	0.0
Samai	0.0	10.0	20.0	30.0	40.0	40.0	40.0
Broken wheat	5.6	10.8	16.0	21.2	26.5	26.5	26.5
Deoiled rice bran	30.3	24.4	18.4	12.5	6.4	6.4	6.4
Groundnut cake	14.1	14.8	15.6	16.3	17.1	17.1	17.1
Fish meal	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Mineral mixture[1]	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Vitamin and mineral premix[1] 250g/100kg	+	+	+	+	+	+	+
Enzymes[2] 50g/100 kg	-	-	-	-	-	+	-
Yeast culture[3] 100g/100kg	-	-	-	-	-	-	+

Coccidiostat[1] - 50g/100kg; Antibiotics[1] - 50g/100kg used in all experimental diets.

[1]Same as table 7 [2]Vetri Gold [3]Yea Sacc[1026] +Supplemented

TABLE 12. CHEMICAL COMPOSITION (% DM) OF THE GROWER DIETS

Ingredient	Level of Samai %						
	0	10	20	30	40	40 + enzyme	40 + yeast culture
Dry matter	94.53	94.73	94.79	94.18	94.84	94.68	94.83
Crude protein	18.04	17.98	18.00	17.96	18.02	17.91	17.98
Crude fibre	6.70	6.56	6.51	6.49	6.58	6.61	6.51
Ether extract	4.21	4.51	4.12	4.41	4.07	4.18	4.21
NFE	60.55	60.25	61.70	61.05	60.52	61.01	60.74
Total ash	10.50	10.70	9.67	10.09	10.81	10.29	10.56
Acid insoluble ash	4.21	4.34	4.12	4.45	4.30	4.66	4.97
Calcium	1.20	1.15	1.24	1.25	1.19	1.24	1.14
Phosphorus	0.70	0.72	0.69	0.67	0.68	0.73	0.67
Lysine*	0.87	0.86	0.84	0.83	0.81	0.81	0.81
Methionine*	0.34	0.35	0.36	0.37	0.38	0.38	0.38
ME* (Kcal/Kg)	2645	2653	2661	2669	2677	2677	2677

TABLE 13. INGREDIENT COMPOSITION (%) OF THE LAYER DIETS

Ingredient	Level of Samai %						
	0	10	20	30	40	40 + enzyme	40 + yeast culture
Maize	40	30	20	10	0	0	0
Samai	0	10	20	30	40	40	40
Deoiled rice bran	24	18	12	6	0	0	0
Broken wheat	0	5	10	16	21	21	21
Groundnut cake	20	21	22	22	23	23	23
Fish meal	8	8	8	8	8	8	8
Shell grit	6	6	6	6	6	6	6
Mineral mixture[1]	2	2	2	2	2	2	2
Vitamin and mineral premix[1] 250g/100kg	+	+	+	+	+	+	+
Enzymes[2] 50g/100 kg	-	-	-	-	-	+	-
Yeast culture[3] 100g/100kg	-	-	-	-	-	-	+

TABLE 14. CHEMICAL COMPOSITION (% DM) OF THE LAYER DIETS

Nutrient	Level of Samai %						
	0	10	20	30	40	40 + enzyme	40 + yeast culture
Dry matter	95.57	95.33	95.63	94.12	94.18	95.95	94.0
Crude protein	18.05	17.99	18.0	17.98	17.96	17.97	17.99
Ether extract	3.90	3.84	3.95	3.64	3.77	3.79	3.69
Crude fibre	6.19	6.05	5.98	5.96	5.92	5.82	5.93
NFE	56.87	55.51	56.75	54.87	55.39	56.03	58.82
Total ash	14.99	16.61	15.32	17.55	16.96	16.39	13.57
Acid insoluble ash	4.73	4.81	5.21	5.85	5.28	5.00	4.79
Calcium	3.24	3.20	3.29	3.19	3.32	3.30	3.20
Phosphorus	0.79	0.73	0.78	0.78	0.81	0.82	0.80
Lysine*	0.90	0.89	0.88	0.87	0.85	0.85	0.80
Methionine*	0.34	0.35	0.36	0.37	0.38	0.38	0.38
ME* (Kcal/Kg)	2500	2509	2518	2527	2537	2537	2537

* Calculated value

age. The feed intake and weight during the above period were recorded to reckon the feed efficiency.

These pullets were fed layer diets, from 21st week of age to the end of 40th week . As weak birds noticed in few groups, the total number of birds in each group was reduced to 9 equally. Standard management practices were followed throughout the experimental period. The criteria studied were (i) age at first egg, (ii) age at 50 per cent production, (iii) egg production (hen-day), (iv) feed consumption and feed efficiency and (v) egg quality.

Feed consumption, egg production, egg quality and feed efficiency were recorded at each interval of 28 days period.

- Egg Qualities

For egg quality studies, 2 eggs at random from each group on the last day of each period was taken. The following egg qualities were studied.

Egg weight : Each egg was weighed in a monopan balance to the nearest 0.1 g and recorded.

Shape index : The length and width of the egg were measured upto one-tenth of a mm with vernier calipers. The length was measured as the distance between the poles, and the width as the distance at the maximum circumference of egg. The shape index was calculated by the formula given below.

$$\text{Shape index} = \frac{\text{Greatest width}}{\text{Greatest length}} \times 100$$

Albumin index : The eggs were broken on a clean glass plate. The albumin height was measured with the Ames tripod micrometer. The long and short axis of the apparent thick white were measured with vernier calipers and they were averaged to get a mean width measurement. The albumin index was calculated by dividing the albumin height by the mean width of the thick white.

Yolk index : The mean width and the maximum height of yolk were measured by vernier calipers and Ames tripod micrometer respectively and the index was calculated as follows:

$$\text{Yolk index} = \frac{\text{Maximum height}}{\text{Maximum width}}$$

Yolk colour : The colour of the yolk was visually compared to the serially dilution of potassium dichromate solution as per the procedure of Bornstein and Bartov (1965).

Haugh unit : Haugh unit was calculated taking into account of weight and height of albumin of egg using USDA Egg Quality Slide Rule.

Shell thickness : Measurements were taken at three points, namely equatorial region, narrow and broad ends. The average of these three measurements was taken as mean shell thickness. Screw gauge was used and measured to the nearest 0.01 mm.

- Carcass studies

At the end of 40 weeks age, 6 birds from each treatment were slaughtered to study the dressing percentage, giblet and liver weight.

- pH and Bacterial count

The effect of yeast on pH and intestinal microbial load, was studied in 6 birds fed diet containing 0, 40 per cent samai and 40 per cent samai + yeast.

The pH of the intestine was found out at six different area viz proventriculus, gizzard, duodenum, jejunum, ileum and caecum in each bird.

The total bacterial count, presumptive coliform and E. coli were done as viable counts as per the method suggested by Collins and Lyne (1985).

A known quantity (5-10 g) of the intestinal content was dissolved in 90 ml of saline, which was again serially diluted upto 10^{-7} (for total count) and 10^{-6} (for presumptive coliform and E. coli). One ml of each dilution was pipetted out into the centre of a petridish to which 15 ml of melt trypticase soya agar (for total bacterial count) or Mac Conkey agar (for Presumptive coliform) was added, mixed gently and maintained at 45°C. After setting the media the dishes were incubated at 37°C for 24 hours. Colonies were counted with the help of a simple colony counter. The viable count per g DM was calculated by multiplying the average number of colonies per plate by the reciprocal of the dilution.

Confirmatory E. coli counts were obtained by subjecting the coliform bacteria to indole, methyl red, Voges Proskaner and citrates utilisation tests (Carter and Cole 1990).

3.3 STATISTICAL ANALYSIS

The data collected on various parameters were statistically analysed as per the methods of Snedecor and Cochran (1967) and Duncan (1965) however, the data on slaughter parameter and hen-day egg production were transformed to arcsine angle and subjected to the analysis.

3.4 FEED COST EFFECTIVENESS

The relative economy of raising broilers upto 8 weeks and layers between 20 to 40 weeks of age without and with samai at varying levels and supplementation of enzyme or yeast culture was calculated based on the actual feed cost, live weight, livability and prevailing market rate of broilers and 80 paise per egg. The values are expressed in percentage, assuming that of control as zero per cent.

RESULTS AND DISCUSSION

4. RESULTS AND DISCUSSION

The results of various chemical analysis and biological experiments carried out to study the nutritional value of samai for poultry are presented and their significance discussed, in this chapter.

4.1 CHEMICAL ANALYSIS

a) Proximate principles:

The proximate composition of ten unknown variety of samai samples collected from different localities in Tamilnadu are reported in table 15 in comparison with that of maize. The samai grains contained (as per cent dry matter) crude protein - 9.69, ether extract - 5.45, crude fibre - 5.54, total ash - 5.83 and nitrogen-free extract - 73.49. The variation in composition of these ten samples in general is very minimal.

The mean crude protein, ether extract and nitrogen free extract were found to be agreeable with the values of earlier workers (Patwardhan and Ranganathan, 1982; Aiyear, 1980; Gopalan et al., 1982; Kathaperumal, 1985), while the value of crude fibre agreed with that of Aiyear (1980). Similarly the total ash content was agreeable with those of Patwardhan and Ranganathan (1962) and Kathaperumal (1985) but differed with that of other workers.

While comparing the composition of samai with that of various other millets (Table-1), the crude protein value of samai was found to be lower whereas other nutrients in general were higher; however, the crude fibre content of kodo and foxtail alone was higher.

TABLE 15. PERCENT PROXIMATE COMPOSITION OF SAMAI COLLECTED FROM DIFFERENT LOCATIONS OF TAMIL NADU (ON DM BASIS)

Source	Dry matter	Crude protein	Crude fibre	Ether extract	Total ash	Nitrogen free extract
Kovilpatti	94.72	9.91	5.15	5.99	6.12	72.83
Dharmapuri	93.55	9.99	5.16	5.68	5.67	73.50
Theni	95.48	9.51	5.37	5.20	5.46	74.46
Papanasam	94.25	9.48	5.69	4.72	6.14	73.97
Trichy	92.20	9.47	5.77	5.24	5.47	74.05
Lee Bazaar	92.49	8.75	5.48	5.69	5.71	74.37
Krishnagiri	93.25	9.76	5.84	5.49	5.91	73.00
Kolli Hills	95.64	9.31	5.60	5.86	6.21	73.02
Madurai	94.28	9.57	6.22	4.84	6.30	73.07
Paiyur (Test Sample)	92.35	11.10	5.11	5.75	5.34	72.70
Mean ± S.E.	93.82 ± 0.38	9.69 ± 0.18	5.54 ± 0.11	5.45 ± 0.13	5.83 ± 0.10	73.49 ± 0.30
Maize	93.47	9.82	2.79	2.80	3.03	81.50

The data suggest that samai grains seem to be a potential feed for poultry being comparable in crude protein, higher in ether extract, crude fibre and total ash but lower in nitrogen-free extract when compared to maize.

b) Fibre fractions:

The fibre fractions of raw, autoclaved samai and maize are presented in table 16. The NDF (34.23 vs 27.62%) and ADF (11.09 vs 3.93%) of raw samai were higher than the reference cereal maize. The increased NDF and ADF value in samai were due to higher amount of lignin and cellulose and not to the hemicellulose. Contradictory to this present study, Kathaperumal (1985) reported lower NDF (15.02%) and ADF (8.09%) for samai.

The process of autoclaving did not influence the different fibre fractions. However, in general, heating of maize cobs (Umuna et al., 1985) rice bran (Rathee and Lohan, 1986) or deoiled rice bran (Purushothaman et al., 1990) had reduced the NDF and ADF contents.

c) Available carbohydrate and metabolisable energy:

The available carbohydrate content in terms of glucose and starch and metabolisable energy calculated for various samai samples are presented in table 17.

The mean value for glucose was 2.57% with a very little variation among samples whereas the value of starch was 51.14% with a wider range from 44.88 to 60.51%. Available carbohydrate with mean value of 53.81% showed the same trend as that of starch.

TABLE 16. PERCENT FIBRE FRACTIONS OF SAMAI (RAW AND AUTOCLAVED) AND MAIZE (ON DM BASIS)

Fibre fractions	% of various fraction		
	Raw samai	Autoclaved samai	Maize
NDF	34.23	33.33	27.62
ADF	11.09	10.26	3.93
Cell contents	65.77	66.67	72.38
Hemicellulose	23.14	23.06	23.69
Cellulose	5.61	4.98	3.37
Lignin	5.73	5.57	0.74

TABLE 17. PERCENT AVAILABLE CARBOHYDRATE AND CALCULATED METABOLISABLE ENERGY OF SAMAI (ON DM BASIS)

Source	Glucose[1]	Starch[1]	Available Carbohydrate	M.E[2] (Kcal/Kg)
Kovilpatti	3.28	46.62	49.90	3015
Dharmapuri	2.54	60.51	63.05	3544
Theni	2.41	56.72	59.13	3321
Papanasam	2.12	47.30	49.42	2875
Trichy	2.23	47.13	49.36	2916
Lee Bazaan	2.48	55.35	58.83	3280
Krishnagiri	2.99	47.88	50.87	3008
Kolli Hills	2.37	44.88	47.25	2874
Madurai	3.06	50.09	53.15	3041
Paiyur (Test Sample)	2.22	54.90	57.12	3346
Mean ± S.E.	2.57 ± 01	51.14 ± 1.59	53.81 ± 1.60	3122 ± 007
Maize	2.18	62.98	65.16	3381

1. Clegg (1956)
2. Carpenter and Clegg (1956)

The values of glucose observed here were higher but starch lower, when compared to the values of the most of the millets (Table-3) including samai (Geervani and Eggum, 1989). The variation could be attributed either to the difference in the strain/variety or degree of maturity/process of removal of the hull.

The glucose content of samai was more or less similar (2.57 vs 2.18%) but the value of starch was lesser (51.14 vs 62.98%) when compared to maize.

The mean metabolisable energy of samai calculated in the study was 3122 kcal/kg which was comparable with that of maize 3309 kcal/kg (ISI - 1980).

d) Mineral profile:

The mineral composition of samai analysed in this study is presented in table 18 and the same is compared with the published value of maize.

The levels of calcium and phosphorus were 20 and 460 mg/100g respectively. The value of calcium was similar but phosphorus was higher as compared to reported value (Table-5) of Gopalan et al. (1982) and Kathaperumal (1985). Among the few trace elements estimated viz iron, copper, zinc, manganese and cobalt, the value of iron only was in agreement with that of the above workers.

e) Tannic acid:

The tannin content of whole samai grain was 0.17% which significantly differed from that (0.36%) of Geervani and Eggum (1989). However, this value was comparable more or less with the value of foxtail (0.20%) and prosomillet (0.21%) but

TABLE 18. MINERAL PROFILE (mg/100g) OF SAMAI AND MAIZE (ON DM BASIS)

Minerals	Samai	Maize*
Calcium	20.0	33.7
Phosphorus	460.0	303.0
Copper	1.60	0.34
Zinc	0.65	0.35
Iron	4.09	1.91
Manganese	2.90	1.91
Cobalt	0.03	0.002

* Values of NRC (1984)

found to be markedly lower than that of kodo millet (0.87%). The level of tannic acid in samai was well below the level of tolerance (0.3 - 0.5%) as reported by Jansman et al. (1989).

4.2 BIOLOGICAL TRIAL

4.2.1 Metabolisable energy of samai:

The estimated ME value of whole and ground samai is presented in table 19. The ME values of whole and ground grains were 2071 and 2882 Kcal/kg respectively. The lesser ME value of whole grain might be due to high indigestible fibrous husk as this was appreciated by the appearance of whole grains in the droppings.

The ME value of ground samai grain (2882 kcal/kg) was highly comparable with that of similar millets - foxtail - 2950 Kcal/kg (Reddy, 1992) proso millet - 2892 Kcal/kg (NRC 1984) and kodo millet - 2842 Kcal/kg (Baghel and Nekte 1989) but lesser than that of maize by 23%. The ME estimated of samai was found to be lesser than the calculated ME by 240 Kcal/kg which could probably be due to poor digestibility and/or utility of nutrients in the system. The poor ratio of ME/GE (0.64) of samai suggests the higher proportion of non-starch polysaccharide in the endosperm as reported by Choct and Annison (1990) in various grains.

4.2.2 Feeding value of samai:

4.2.2.1 Effect of feeding samai on broiler performances:

The effects of feeding raw samai grains at 0, 10, 20, 30 or 40% level of diets on broiler performance measured in terms of weight gain, feed consumption and feed efficiency are shown in table 20.

TABLE 19. METABOLISABLE ENERGY (Kcal/Kg) OF WHOLE AND GROUND SAMAI (ON DM BASIS)

Method	Whole grain	Ground grain	Maize
Estimates apparent Metabolisable energy*	2632	2908	
	2642	3209	
	2131	2712	
	1682	2932	
	1887	2909	
	2003	2409	
	1887	2833	
	1946	3143	
Mean ± S.E.	2071 ±125	2882 ± 82	3350**
Calculated M.E.		3122 ± 7	3380
Gross energy		4494	4785
ME/GE		0.64	0.79

* Sibbald (1976)

** NRC (1984)

TABLE 20. EFFECT OF FEEDING SAMAI ON WEIGHT GAIN, FEED CONSUMPTION AND FEED EFFICIENCY IN BROILER CHICKS AT 0-8 WEEKS OF AGE

Diets	Weight gain (g)	Feed consumption (g)	Feed efficiency
Control	$1184.0^{a} \pm 92.3$	$3309^{a} \pm 56$	2.81 ± 0.15
10% samai	$1204.8^{a} \pm 103.6$	$3402^{a} \pm 164$	2.86 ± 0.25
20% samai	$1209.8^{a} \pm 83.8$	$3515^{a} \pm 68$	2.91 ± 0.17
30% samai	$1110.8^{ab} \pm 73.6$	$3010^{ab} \pm 182$	2.74 ± 0.20
40% samai	$985.8^{b} \pm 87.2$	$2705^{b} \pm 94$	2.74 ± 0.05

Each value of body weight gain is a mean of 30 observations.

Each value of feed consumption and feed efficiency is a mean of 3 observations.

Mean values with atleast one common superscript in a column are not significant at ($P < 0.05$)

a) Weight gain:

The mean weight gain of chicks fed diets containing 0, 10, 20, 30 and 40% raw samai were 1184.0, 1204.8, 1209.8, 1110.8 and 985.8 g respectively. The chicks receiving 40% samai in the diet showed significantly ($P < 0.05$) poor growth among the treatments.

Such a growth depression in starter chicks was reported by Sinha et al. (1980) when sorghum (52.2%) was included in the rations replacing maize. Mohamedian et al. (1986) also reported such depressed growth when bajra replaced maize totally.

Contradictory to the present observation, 100 per cent replacement of maize with bajra (Rajini et al., 1986; Reddy et al., 1987; Thakur and Prasad, 1990) resulted in highest body weight.

The poor rate of growth noticed in this study might be due to lower feed consumption which in turn could be attributed to poor palatability at 40% level of samai. However, the weight gain among the other four treatments, though did not differ significantly, showed numerical difference marginally. Further, it was also observed that the weight gain during the first 4 weeks of the experimental period showed no significant difference among the treatments.

b) Feed consumption :

The cumulative feed consumption among birds in various treatments upto 8 weeks of age revealed, a significant ($P< 0.05$) difference between the control, 10% and 20% samai diet and diet containing 40% samai. There was a progressive increased consumption of feed upto 20% level of samai but a marked reduction was seen in diet containing 30 and 40% samai. The reduced feed consumption in 40% samai diet was appreciated from 1st week onwards. Probably the poor feed consumption might have been due to higher proportion of non-starch polysaccharides. Similar observation of lower feed intake was observed when bajra replaced maize (Sinha et al., 1980; Mohamedian et al., 1986; Reddy, 1991). Contrary to this observation, higher feed consumption was noticed when bajra (Reddy et al., 1987; Thanabalan, 1992) or foxtail millet (Reddy, 1992) replaced maize. Comparable feed consumption was recorded when finger millet (Yeong and Syed Ali 1976, Rajini et al., 1986), foxtail millet (Baghel and Nekte, 1982) bajra (Rajini et al., 1986, Smith et al., 1989) or Kodo millet (Kapoor et al., 1987) replaced maize.

c) Feed efficiency:

The least feed consumption naturally resulted in poor weight gain but did not adversely affect the feed utilisation. The feed efficiency, at different weeks *per se* was not affected due to change in the level of samai of the diet. Similar comparable feed efficiency was reported on inclusion of various millets (Qureshi, 1967; Yeong and Syed Ali, 1976; Abate and Gomez, 1984; Rajini et al., 1986; Kapoor et al., 1987, Reddy et al., 1987; Douglas et al., 1990; Reddy, 1992). On the contrary poor feed efficiency was observed by inclusion of finger millet (Baghel and Nekte 1982) or bajra (Mohamedian et al., 1986; Thanabalan, 1992) or sorghum (Paik et al., 1989) in broiler ration replacing maize. However, better feed efficiency was noticed by earlier workers when bajra was incorporated (Singh and Barsaul, 1976 and Sinha et al., 1980).

d) Haematology:

The PCV, Hb,RBC and ESR values of birds fed diets containing different levels of samai are presented in table 21. These values did not show any variation between control and other treatment groups. This is in agreement with the findings of Rao (1991) and Reddy (1992) while feeding the broilers with foxtail millet. But Ganapathy and Chitre (1961) observed a reduction in mean haemoglobin value in rats fed diet containing foxtail millet. The present observations indicate that the samai grains probably have no deleterious substances that affect the blood picture.

e) Carcass studies:

The weight of carcass, liver and trimmable fat as percent body weight is given in table 22.

Inclusion of samai at 40% level in the diet resulted in increased dressing percentage whereas no variation was noticed in respect of liver and trimmable fat. Similar results were recorded on feeding foxtail millet to broilers by Rao (1991) and Reddy (1992).

The data of this experiment suggest that the samai grains could be incorporated upto 30% in the broiler diets, without affecting the weight gain and feed efficiency.

TABLE 21. EFFECT OF FEEDING SAMAI ON BLOOD PARAMETER IN BROILERS AT 8 WEEKS OF AGE

Diet	PCV %	Hb/dl	RBC $10^6/mm^3$	ESR mm^2
Control	27.67 ± 0.30	6.51 ± 0.21	3.61 ± 0.07	6.33 ± 0.30
10% Samai	26.67 ± 1.07	6.80 ± 0.20	3.70 ± 0.04	6.17 ± 0.28
20% Samai	26.17 ± 0.28	6.12 ± 0.24	3.57 ± 0.05	5.33 ± 0.19
30% Samai	29.33 ± 4.01	5.60 ± 0.36	3.46 ± 0.10	6.00 ± 0.85
40% Samai	24.50 ± 0.61	5.93 ± 0.42	3.50 ± 0.12	6.83 ± 1.17

Each value is a mean of 6 observations.

Mean values in a column are not significant at $P < 0.05$.

Hb : analysis were done by Cyanmethaemoglobulin method.

EXPERIMENT - 1

TABLE 22. EFFECT OF FEEDING SAMAI ON CARCASS WEIGHT LIVER AND TRIMMABLE FAT AS PER CENT BODY WEIGHT IN BROILERS AT 8 WEEKS OF AGE

Diets	Carcass weight	Liver	Trimmable fat
Control	$70.28^{a} \pm 1.39$	2.85 ± 0.20	1.73 ± 0.27
10% samai	$70.02^{a} \pm 1.82$	2.84 ± 0.24	1.61 ± 0.13
20% samai	$69.93^{a} \pm 1.07$	2.89 ± 0.16	1.05 ± 0.15
30% samai	$68.94^{a} \pm 3.58$	2.88 ± 0.08	1.23 ± 0.24
40% samai	$77.89^{b} \pm 0.94$	3.52 ± 0.06	1.47 ± 0.24

Each value is the mean of 6 observations.

Mean values with same superscript are not significant at ($P < 0.05$)

Values were subjected to arc sine angle and analysed for statistical significance.

4.2.2.2 Effect of feeding processed samai - autoclaving and supplementation (enzyme or yeast culture) on broiler performance:

The data on body weight gain, feed consumption and feed efficiency, digestibility and balance of nutrients of different dietary treatments are presented in tables 23, 24 and 25 respectively.

a) Weight gain:

The mean body weight gain (998 g) of chicks fed diet containing 40% samai significantly differed ($P < 0.05$) from that of the birds fed diet having 30% samai and control. However, no significant difference was observed in weight gain between the chicks fed diet containing 30% samai and control. The trend of the weight gain observed in this experiment is more or less similar to the finding of the earlier one.

Inclusion of autoclaved samai at 30% level did not improve the weight over that of either 30% raw samai or control diet. Similar observation of comparable growth was observed when autoclaved barley (Herstad and McNab, 1975), rice bran (Majun and Payne, 1977) or deoiled rice bran (Purushothaman et al., 1990) was included in broiler diets. On the contrary, Kratzer et al. (1974) noticed improved weight gain on autoclaved rice bran whereas Ward et al. (1987) found depressed growth on rye diets.

Addition of commercial multienzyme to all the three diets manifested a better growth rate as compared to the respective unsupplemented groups. This significant improvement ($P < 0.05$) in growth rate was appreciated from 4 weeks onwards, in

TABLE 23. EFFECT OF FEEDING AUTOCLAVED SAMAI, SUPPLEMENTATION OF ENZYMES OR YEAST CULTURE IN SAMAI DIET ON WEIGHT GAIN, FEED CONSUMPTION AND FEED EFFICIENCY IN BROILERS AT 0-8 WEEKS OF AGE

Diets	Weight gain (g)	Feed consumption (g)	Feed efficiency
Control	$1369.8^{bc} \pm 58.8$	$3261^{ab} \pm 117$	$2.41^{bc} \pm 0.11$
30% raw samai	$1341.0^{bc} \pm 67.6$	$3026^{bc} \pm 88$	$2.33^{cd} \pm 0.13$
40% raw samai	$998.1^{d} \pm 64.8$	$2667^{d} \pm 77$	$2.72^{a} \pm 0.12$
30% autoclaved samai	$1327.9^{c} \pm 47.7$	$2921^{bcd} \pm 47$	$2.20^{cde} \pm 0.05$
40% autoclaved samai	$1119.1^{d} \pm 50.1$	$2998^{bc} \pm 66$	$2.69^{ab} \pm 0.10$
Control + enzyme	$1574.1^{a} \pm 37.9$	$3194^{ab} \pm 109$	$2.03^{de} \pm 0.04$
30% samai + enzyme	$1479.2^{ab} \pm 48.5$	$3005^{bc} \pm 34$	$2.02^{e} \pm 0.07$
40% samai + enzyme	$1261.0^{cd} \pm 49.5$	$3041^{bc} \pm 18$	$2.42^{abc} \pm 0.06$
Control + Yeast culture	$1625.0^{a} \pm 28.6$	$3417^{a} \pm 101$	$2.10^{de} \pm 0.03$
30% samai + Yeast culture	$1388.6^{bc} \pm 64.9$	$3058^{bc} \pm 85$	$2.22^{cde} \pm 0.07$
40% samai + Yeast culture	$1279.8^{c} \pm 55.5$	$2864^{cd} \pm 75$	$2.07^{de} \pm 0.06$

Each values of body weight gain was a mean of 21 observations.

Each value of feed consumption and feed efficiency is a mean of 3 observations.

Mean values with atleast one common superscript in a column are not significant ($P < 0.05$).

all groups. Enzyme supplementation in 30 per cent samai diet improved weight gain and the same was comparable with that of control diet having enzyme. Enzyme in diet having 40% samai resulted in weight gain comparable statistically to that of the control, however, the growth depression noticed between control and 40% raw samai dietary groups (371 g) was not completely alleviated by the addition of enzymes.

The improved performance of chicks fed basal as well as experimental diets as the result of enzyme supplementation is in agreement with the finding of various workers (Parkany Gyarfos, 1975; Gohl, 1978; Suga et al., 1978; Hesselman and Aman 1986; Broz, 1987; Petterson and Aman, 1988).

Supplementation of yeast culture significantly ($P < 0.05$) improved the weight gain of chicks fed the control and 40% samai diets, whereas only marginal increase in 30% samai diet, over that of respective unsupplemented group was noticed. Addition of yeast culture to the diet containing 40% samai resulted in improved weight gain over that of the unsupplemented one; such improved performance was comparable to that of control.

However contradictory to this, Velasco et al (1989) and Vogt and Mathews (1991) observed no favourable effect on weight gain in broilers. While Rizvanov and Dragnev (1987) in Swine and Glade and Sist (1990) in horse recorded better weight gain as a result of yeast culture.

b) Feed consumption:

Inclusion of 40% samai in the diet resulted in reduction of feed consumption by 11.9 and 18% as compared to the diets having 30% samai and control diet. This observation concurs with the previous experiment.

The process of autoclaving improved the feed consumption by 12.4% in 40% samai fed chicks, but not in 30% level of samai diet when compared to respective raw samai diets. Similar to this, Majun and Payne (1977) observed improved feed consumption due to autoclaving of rice bran. On the contrary, Deolankar et al. (1979) and Ward and Marquardt (1987) recorded a decreased feed consumption due to autoclaving of rice bran or rye respectively.

Enzyme supplementation in the control and diet having 30% samai did not influence the feed consumption in comparison with respective unsupplemented groups. Similar comparable feed consumption was reported by Broz and Frigg (1986b, 1990) and Broz (1987, 1993). Enzyme in diet containing 40% samai improved feed consumption by 14% over the respective unsupplemented group. Similar observation of increased feed consumption was reported due to addition of various enzymes in different cereals based diets (Broz and Frigg 1986a; Madaesi et al., 1988; Rotter et al., 1989; Jeroch et al., 1990; Petterson et al., 1991; Richter et al., 1990 and Wetscherek et al., 1991).

The addition of yeast culture had no influence on feed consumption in all the three diets. As in the present study, Velasco et al. (1989) and Vogt and Mathews (1991) also observed no increase in feed consumption. However, it helped the diet containing 40% samai to improve the feed intake to that of the diet containing 30% samai but not to the level of the control. Similar to this Peppler (1982) claimed improved feed consumption as the result of better palatability due to flavour of the yeast culture.

On analysis of data, it is inferred that autoclaving as well as supplementation of enzymes or yeast resulted in an increased feed consumption only at higher level (40%) of samai diets. Among the three treatments, enzymes improved the intake to the maximum (14%).

c) **Feed efficiency:**

The feed efficiency in chicks fed 30% samai diet was comparable as that of control, whereas that of the birds fed 40% samai diet was poor. In contrary to this experiment, comparable feed efficiency was recorded in the previous experiment even upto 40% level of samai incorporation in the broiler diet.

Autoclaving of samai had no beneficial effect at 30% level as observed on inclusion of autoclaved deoiled rice bran (Purushothaman et al., 1990). Whereas inclusion of autoclaved samai at 40% had improved feed efficiency, which concurred the finding of Kratzer et al. (1974) and Kratzer and Payne (1977), on the use of autoclaved rice bran.

The efficiency of feed utilization was improved by enzyme supplementation in all the three diets over unsupplemented diets from the second week onwards. Addition of enzyme in 30 per cent samai diet had better feed efficiency, than the control but comparable to that of control with enzyme. But 40% samai plus enzyme did not show any significant improvement over the unsupplemented diet but resulted in marginal improvement which is comparable with that of control. Better feed efficiency by enzyme addition (unienzyme or multienzyme) was reported in literature by various workers with different diets (Broz and Frigg, 1986b; Broz, 1987, 1993; Rotter et al., 1989; Petterson et al., 1991; Bhatt et al., 1991; Friesen et al., 1992)

Supplementation of yeast to the diet having 40% samai resulted in significant improvement in feed efficiency as compared to unsupplemented 40% samai and control diets. As above yeast in swine (Rigvanov and Dragnev, 1987) and equine ration (Glade and Sist, 1990) resulted in improved feed efficiency.

The data on feed efficiency suggest that autoclaving failed to exert any beneficial effect; whereas enzyme or yeast showed a significant ($P < 0.05$) improvement in most of the diets.

d) Nutrient digestibility :

The digestion coefficients of various nutrients, ME values and balance of nutrients in various experimental diets are presented in tables 24 and 25 respectively. The value of digestion coefficient of various nutrients ranged from DM: 58.86 - 72.38; OM: 59.05 - 71.39; EE : 74.58 - 78.78 and CF: 23.68 - 25.42%. The ME value of the experimental diets ranged from 2696 to 2828 Kcal/kg.

On comparison of the digestion coefficient of nutrients, no significant difference was observed among the experimental diets irrespective of the levels of samai or processing or supplementation.

TABLE 24. EFFECT OF FEEDING AUTOCLAVED SAMAI, SUPPLEMENTATION OF ENZYMES OR YEAST CULTURE IN SAMAI DIET ON METABOLISABLE ENERGY (Kcal/Kg) AND DIGESTION COEFFICIENT OF NUTRIENTS

Diet/Criteria	ME	Digestion Coefficient			
		DM	OM	EE	CF
Control	2753 ± 7	64.15 ± 2.39	64.20 ± 2.24	78.77 ± 2.15	25.00 ± 0.93
30% raw samai	2734 ± 3	72.38 ± 2.78	71.39 ± 2.60	78.78 ± 3.74	24.17 ± 0.74
40% raw samai	2739 ± 20	64.95 ± 2.08	64.77 ± 1.99	78.40 ± 1.86	23.68 ± 0.70
30% autoclaved samai	2696 ± 121	60.16 ± 3.80	61.49 ± 3.08	78.77 ± 2.43	24.27 ± 0.28
40% autoclaved samai	2728 ± 14	58.86 ± 2.16	59.05 ± 1.45	78.53 ± 2.03	24.38 ± 0.17
Control + enzyme	2809 ± 10	70.13 ± 1.41	69.13 ± 2.17	77.47 ± 2.75	25.79 ± 0.17
30% samai + enzyme	2783 ± 29	67.17 ± 1.60	66.17 ± 2.25	77.38 ± 1.32	24.89 ± 0.85
40% samai + enzyme	2785 ± 36	65.20 ± 2.88	65.12 ± 2.73	77.29 ± 1.32	24.89 ± 0.85
40% samai + enzyme	2785 ± 36	65.20 ± 2.88	65.12 ± 2.73	77.29 ± 3.73	25.42 ± 0.65
Control + Yeast culture	2852 ± 52	70.52 ± 2.99	69.97 ± 2.89	74.58 ± 1.05	24.54 ± 0.59
30% samai + Yeast culture	2789 ± 29	69.65 ± 3.88	69.41 ± 3.82	77.29 ± 1.97	24.84 ± 0.97
40% samai + Yeast culture	2828 ± 26	67.19 ± 2.23	65.62 ± 2.31	75.62 ± 2.83	24.87 ± 0.84

Mean Values in a column are not significant at $P < 0.05$

Similar observation of comparable digestion coefficient of nutrients between autoclaved and raw deoiled rice bran was reported by Purushothaman et al. (1990). Nevertheless, Herstad and Mc Nab (1975) found decreased nutrient digestibility when barley was autoclaved. Whereas Czarnecki et al. (1984) noticed an increase in starch and protein digestibility and Kratzer and Payne (1977) in ME due to autoclaving of deoiled rice bran.

Similar to this experiment, Jeroch et al. (1990) reported no effect on the digestibility of nutrients when wheat based diet was supplemented with enzymes. Contrary to this, other workers noticed improved nutrient digestibility and ME value (Broz, 1987, 1993; Marek et al., 1989; Rotter et al., 1989; Broz and Frigg, 1990; Friesen et.al 1990, Rotter et al., 1990).

Addition of yeast culture to poultry diets improved the ME and nitrogen utilisation (Wenk, 1990). Such a trend in horse and swine was (Glade, 1990; Pagan, 1990; Wenk, 1990) observed in CF digestibility. The increased digestibility could be attributed to the stimulation of cellulolytic bacteria in the caecum and colon (Godbre, 1983).

The balance study showed no influence in respect of nitrogen due to either autocalving or supplementation of enzyme or yeast culture. In contrary to the present result, increased nitrogen balance was reported (Marek et al., 1989 and Broz, 1993) due to enzymes.

Autoclaving increased the retention of phosphorus but not the calcium, whereas enzymes resulted in better retention of both.

EXPERIMENT - 2

TABLE 25. EFFECT OF FEEDING AUTOCLAVED SAMAI, SUPPLEMENTATION OF ENZYME OR YEAST CULTURE IN SAMAI DIET ON BALANCE OF NUTRIENT (g/bird/day)

Diet	Balance of nutrient		
	Nitrogen	Calcium	Phosphorus
Control	1.569 ± 0.102	0.287^{ab} ± 0.006	0.278^{a} ± 0.006
30% raw samai	1.614 ± 0.055	0.285^{ab} ± 0.015	0.278^{a} ± 0.004
40% raw samai	1.490 ± 0.061	0.257^{a} ± 0.023	0.294^{ab} ± 0.005
30% autoclaved samai	1.580 ± 0.08	0.257^{a} ± 0.017	0.312^{bc} ± 0.003
40% autoclaved samai	1.526 ± 0.061	0.311^{abc} ± 0.018	0.304^{abc} ± 0.008
Control + enzyme	1.606 ± 0.008	0.297^{abc} ± 0.016	0.316^{bc} ± 0.002
30% samai + enzyme	1.454 ± 0.014	0.336^{bcd} ± 0.030	0.313^{bc} ± 0.002
40% samai + enzyme	1.621 ± 0.022	0.348^{cd} ± 0.008	0.311^{c} ± 0.002
Control + Yeast culture	1.575 ± 0.052	0.338^{bcd} ± 0.033	0.325^{c} ± 0.006
30% samai + Yeast culture	1.670 ± 0.029	0.384^{d} ± 0.034	0.326^{c} ± 0.005
40% samai + Yeast culture	1.642 ± 0.031	0.372^{a} ± 0.023	0.329^{c} ± 0.003

Each value is the mean of 3 observations.

Mean values with atleast one common superscript in a column are not significance. ($P < 0.05$)

Similar beneficial balance of phosphorus was also observed by Corley and Baker (1979), on heat treatment.

The better balance by enzyme addition might be due to the phytase activity on bound organic calcium and phosphorus as reported by Swick (1992).

In this study, yeast improved the balance of phosphorus as also recorded by earlier workers (Thayer et al., 1978; Glade, 1990; Pagan 1990), in all diets, while improvement of calcium was appreciated only in samai diets. Similar observation was made by Pagan (1990).

Inclusion of autoclaved samai at 40% level resulted in a marginal increase in growth and feed efficiency with a significant increase in feed consumption. Such an increased feed consumption might probably be due to better palatability as the result of the destruction of any thermolabile antinutritional factor(s). Such improved feed consumption was reported by Huisman and Tolman (1992) while using autoclaved legume seeds. Moreover, the marginal improvement in growth and feed efficiency could be attributed to increased availability of cell contents due to rupture of cell wall and exposure of cell contents by heat treatment, as reported by (Saunder et al., 1969).

The high concentration of non-starch polysaccharide in samai as indicated by poor ratio of ME/GE and high insoluble fibre (Geevani and Eggum, 1989) might have limited the higher inclusion of samai in broiler diet. However, this limitation had been overcome by addition of non starch polysaccharide degrading enzymes as observed by the early workers in barley (Chesson et al., 1987) and rye diet (Broz, 1987).

The improved performance in weight gain and feed efficiency by enzymes addition noticed in this study is suggestive of that the enzymes might have helped to facilitate better absorption of nutrients by avoiding the formation of viscous solution as the result of breakdown of pentosans and beta-glucans (De Silva et al., 1983).

Better beneficial effects obtained due to yeast might be due to intensive amino acid metabolism as observed in pigs by Rizvanov and Dragnev (1987), creation of anaerobic condition (Rose, 1980) which is unfavourable for the growth of pathogen organism but favourable for cellulolytic bacteria (Edwards, 1991) and decreased mould concentration in feed (Hoxha et al., 1989) which could have acted synergistically.

4.2.2.3 Effect of feeding samai and supplementation (enzyme or yeast culture) on layer performance:

The mean weight gain, feed consumption and feed efficiency of grower birds fed graded levels of samai (0, 10, 20, 30 40%, 40% + enzyme and 40% + yeast culture) for the period from 16 to 20 weeks are presented in table 26.

Inclusion of samai upto 30% level in grower diet did not affect the weight gain, whereas 40% caused a significant growth depression. However, this depression on growth rate was overcome by supplementation of either enzyme or yeast culture.

Similar results of comparable weight gain upto 30 per cent level in broiler diet and depressed growth on 40 per cent samai was observed in earlier experiments.

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EXPERIMENT - 2

TABLE 26. EFFECT OF FEEDING SAMAI AND SUPPLEMENTATION OF ENZYME OR YEAST CULTURE IN SAMAI DIET ON WEIGHT GAIN (g), FEED CONSUMPTION/BIRD (g) AND FEED EFFICIENCY RATIO FOR GROWERS (16-20 WEEKS)

Diet	Weight gain	Feed consumption	Feed efficiency ratio
Control	$294.0^{bc} \pm 8.4$	2542 ± 101	8.82 ± 0.10
10% samai	$302.0^{cd} \pm 8.9$	2625 ± 70	8.79 ± 0.16
20% samai	$318.0^{d} \pm 7.1$	2730 ± 85	8.76 ± 0.12
30% samai	$312.7^{cd} \pm 7.4$	2734 ± 33	8.81 ± 0.12
40% samai	$271.3^{a} \pm 12.4$	2368 ± 93	8.81 ± 0.12
40% samai + enzyme	$283.0^{ab} \pm 9.2$	2467 ± 115	8.76 ± 0.09
40% samai + yeast culture	$300.3^{bcd} \pm 10.8$	2625 ± 115	8.65 ± 0.13

Each value of body weight gain is a mean of 30 observations.

Each value of feed consumption and feed efficiency ratio is a mean of 3 observations.

Mean values with atleast one common superscript in a column are not significant. ($P < 0.05$)

The feed consumption and feed efficiency were not significantly affected by different diets except 40% samai diet which had lesser (174g) feed consumption as compared to control. Supplementation of enzyme or yeast culture improve feed consumption as observed in earlier experiment. The non significant difference in feed efficiency in this experiment followed the previous experiments.

Layer experiment

The data on weight gain, feed consumption, feed efficiency, age at first egg and 50% production, hen-day production and liveability of birds reared from 21 to 40 weeks of age and fed diet containing different levels of samai with and without supplements are presented in table 27.

The mean body weight gain of the birds recorded in control was 522.3g whereas the same ranged from 496.2 to 522.3g among other groups; as such no significant difference was noticed in adult birds as against the reduced weight gain in growers. This suggeststhat the adult birds could be capable of utilising high level of samai. Similar observation of non significant effect on body weight gain was recorded when bajra (Singh and Barsaul, 1976; Kumar et al., 1991) or foxtail millet (Reddy, 1992) replaced maize in layer diet. However use of kodo grain improved the weight gain (Baghel and Nekte, 1989).

Supplementation of enzyme or yeast culture in layer diet containing 40% samai had no effect on the weight gain, as noticed by (Albustany and Elwinger, 1988).

TABLE 27. EFFECT OF FEEDING SAMAI AND SUPPLEMENTATION OF ENZYME OR YEAST CULTURE IN SAMAI DIET ON THE PERFORMANCE OF LAYERS (21 - 40 WEEKS OF AGE)

Criteria/Diet	Level of Samai %						
	0	10	20	30	40	40% + enzyme	40% + yeast culture
Weight gain - 20-40 weeks (g)	522.3 ± 6.8	503.5 ± 12.8	522.3 ± 8.8	498.9 ± 18.7	496.2 ± 5.5	499.8 ± 12.7	503.5 ± 9.4
Age at first egg (day)	136.7^a ± 1.0	137.3^a ± 2.1	137.7^a ± 0.7	146.3^b ± 3.1	148.0^b ± 0.5	146.3^b ± 3.0	149.3^b ± 1.4
Age at 50% egg production (day)	157.7 ± 3.4	157.7 ± 6.4	156.3 ± 2.7	166.7 ± 2.6	165.3 ± 1.9	167.0 ± 2.4	165.3 ± 1.0
Hen day production (%)	68.65^a ± 1.65	68.57^a ± 1.01	67.57^a ± 0.61	57.33^b ± 0.37	52.43^c ± 1.11	57.04^b ± 0.59	57.33^b ± 0.77
Feed consumption (g/bird/day)	107.0^a ± 0.24	106.4^a ± 0.08	106.5^a ± 0.07	103.2^b ± 0.54	100.5^c ± 0.76	102.7^b ± 0.08	103.5^b ± 0.33
Feed efficiency (kg/dozen of egg)	1.89^a ± 0.04	1.86^a ± 0.03	1.89^a ± 0.02	2.16^b ± 0.01	2.28^b ± 0.06	2.16^b ± 0.02	2.16^b ± 0.02
Survived/Started	26/27	26/27	26/27	26/27	26/27	26/27	26/27

Mean values with atleast one common superscript in a row are not significant ($P < 0.05$)

a) **Age at 1st egg and 50% production:**

Inclusion of samai upto 20% level of the diet did not affect the age of maturity, whereas at 30 and 40% levels of samai significantly delayed the maturity. Even supplementation with enzyme or yeast culture did not bring any favourable response. Contrary to this, early maturity was observed in broiler male breeders (Gaynor Mc Daniel, 1990)

The age at 50 percent egg production in different treatments showed no significant difference. Either enzyme or yeast culture supplementation did exert any benefit.

b) **Egg production:**

The data on the percent hen-day egg production revealed that inclusion of samai upto 20 percent (50% replacement of maize) did not influence the egg production during the period under study. At 30 and 40 per cent levels of samai inclusion, significant reduction in egg production was observed. As the duration of feeding increased (from 3rd 28-day period onwards) the reduction in egg production in birds fed diet containing 40% was non-significant as compared to diet containing 30% samai.

Similar results of partial replacement of maize with other millets had been reported in literature without any effect on egg production; 75 per cent of sorghum could replace maize (Castro et al., 1984; Gowda et al., 1984; Park et al., 1985), 80% replacement of maize with kodo millet (Kapoor et al., 1987). Replacement of maize even at 50% with kodo millet (Korane et al., 1992) reduced the egg production.

However when foxtail millet totally replaced wheat (Trenchi, 1985) or maize (Reddy, 1992) or pearl millet totally replaced maize (Kumar et al., 1991) no change in hen-day egg production was observed.

Addition of enzyme or yeast culture in diet containing 40% samai was not effective in improving the egg production to the level of the control diet, but comparable to diet containing 30% samai. The improvement due to supplementation was mainly in later stage (from 3rd 28-day period onwards); use of enzyme in layer diet had also been reported to cause no improvement in egg production. (Hijikuro et al., 1989, Wetscherek and Zollistch 1991). On the contrary, more egg production was noticed by Morimoto et al. (1966), Patel et al. (1980) and Nasi (1990).

c) **Feed consumption:**

The data on the mean daily feed consumption of birds during 21-40 weeks of age showed that feed consumption significantly declined as the level of samai in layer diet increased to 30 and 40% levels. Supplementation of enzyme or yeast culture in diet containing 40% samai resulted in better feed consumption than unsupplemented diet and was comparable to that of 30% samai diet.

In broiler experiments I and II, similar observation of reduced feed consumption was recorded only in the 40% samai fed groups. Similar observation of reduced feed consumption was recorded by Kumar et al. (1991) when pearl millet replaced maize and also when kodo millet totally replaced maize (Baghel and Nekte, 1989). However, sorghum replacing 100 per cent maize (Park et al. (1985) did not influence the feed consumption, but foxtail millet on total replacement of maize

Trenchi (1985); Reddy (1992). Prosomillet replacing 50% maize also showed similar results (Korane et al., 1992).

As observed in this experiment, supplementation of enzyme or yeast culture in broiler ration (Experiment II) improved the feed consumption over the unsupplemented group.

d) **Feed efficiency:**

The feed efficiency (kg of feed/dozen of eggs) of different treatments during 21-40 weeks of age indicated that the feed efficiency was significantly reduced as the level of samai was increased to 30 per cent and above. Supplementation of enzyme or yeast did not influence the feed efficiency.

Similar trends of reduced feed efficiency (feed required/dozen of eggs) was observed by Korane et al. (1992) as the level of kodo millet increased. Comparable feed efficiency when sorghum (Park et al., 1985) or foxtail millet (Trenchi, 1985; Reddy, 1992) replaced maize but improved efficiency (Kumar et al., 1991) when pearl millet replaced maize was recorded.

e) **Mortality:**

Mortality rate in the layers was even (one) in each of the experimental groups and this was also found to be unassociated with the dietary samai inclusion.

f) Egg Qualities:

The data on the quality of eggs are presented in table 28. The quality of eggs in terms of weight, surface area, shape index, albumen index, haugh unit, yolk index and shell thickness did not differ due to different diets and between different periods except for the increase in egg weight and surface area which improved as the age of the birds increased. The intensity of yolk colour was significantly less as the level of samai was increased, probably due to lack of xanthophyll in samai.

The egg quality of this study confirms the earlier observation of Baghel and Nekte, (1989), Korane et al. (1992), Reddy (1992) on inclusion of different millets in layer diet.

Supplementation of enzyme or yeast culture in layer diet had no influence on egg quality. Benabdeljelil (1991) observed such effect on enzyme, whereas Gaynor McDaniel (1990) recorded an improved egg size and shell quality on yeast in broiler breeder stock.

g) Carcass Qualities:

The data on dressing percentage, giblet and liver (percentage body weight) of the birds fed, different levels of samai are presented in table 29 and the same did not differ. This result confirms the observation in the first broiler trial of this study and the early works with the use of sunflower seed meal (Salih and Taha, 1989) rice bran (Carrion and Lopez, 1989), foxtail millet (Reddy, 1992) and bajra (Thanabalan, 1992).

TABLE 28. EFFECT OF FEEDING SAMAI AND SUPPLEMENTATION OF ENZYME OR YEAST CULTURE ON EGG QUALITY

Diet/Criteria	Egg weight (g)	Surface area cm^2	Albumen index	Yolk index	Shape index	Shell thickness mm	Haugh Unit	Yolk colour
Control	49.53 ± 0.83	59.01 ± 0.59	0.585 ± 0.043	3.333 ± 0.119	73.37 ± 0.70	0.377 ± 0.006	69.60 ± 2.99	3.73^{a} ± 0.11
10% samai diet	48.76 ± 1.20	57.42 ± 1.46	0.612 ± 0.037	3.441 ± 0.120	77.45 ± 1.26	0.375 ± 0.004	68.67 ± 2.28	3.50^{a} ± 0.10
20% samai diet	48.71 ± 1.10	58.23 ± 0.74	0.490 ± 0.046	3.345 ± 0.132	74.71 ± 0.52	0.373 ± 0.006	66.97 ± 3.35	2.70^{b} ± 0.18
30% samai diet	49.87 ± 0.95	58.98 ± 0.60	0.518 ± 0.042	3.338 ± 0.139	74.21 ± 0.49	0.366 ± 0.007	63.67 ± 3.09	2.27^{c} ± 0.08
40% samai diet	49.48 ± 1.06	60.74 ± 1.15	0.513 ± 0.043	3.297 ± 0.138	76.58 ± 0.67	0.367 ± 0.007	65.03 ± 2.14	1.73^{d} ± 0.08
40% samai+enzyme	49.77 ± 0.85	57.97 ± 0.64	0.483 ± 0.030	3.126 ± 0.121	75.57 ± 0.33	0.383 ± 0.005	62.60 ± 2.16	1.90^{d} ± 0.07
40% samai+yeast culture	48.64 ± 1.09	57.87 ± 0.62	0.502 ± 0.041	3.318 ± 0.127	75.41 ± 0.67	0.371 ± 0.007	60.93 ± 3.10	1.83^{d} ± 0.07

Each value is a mean of 42 observations.

Mean values with atleast one common superscript in a column are not differ significant ($P < 0.05$).

TABLE 29. EFFECT OF FEEDING SAMAI AND SUPPLEMENTATION OF ENZYMES OR YEAST CULTURE ON SLAUGHTER PARAMETER OF LAYER BIRDS

Ration	Dressing %	Giblet %	Liver %
Control	67.73 ± 1.55	5.48 ± 0.35	2.63 ± 0.26
10% Samai	67.23 ± 1.12	5.98 ± 0.19	3.07 ± 0.17
20% Samai	66.89 ± 1.17	5.34 ± 0.24	2.88 ± 0.15
30% Samai	66.99 ± 0.45	5.66 ± 0.14	2.84 ± 0.17
40% Samai	67.09 ± 0.69	5.28 ± 0.16	2.70 ± 0.09
40% Samai + enzyme	66.98 ± 1.02	5.08 ± 0.30	2.61 ± 0.09
40% Samai + Yeast culture	64.43 ± 0.59	5.00 ± 0.29	2.95 ± 0.17

Each value is the mean of 6 observations.

Mean values in a column are not significant at $P < 0.05$.

h) pH of intestinal contents and Microbial count:

The data on the microbial load and pH at different points in the intestinal tract recorded are presented in table 30. The total microbial load did not differ significantly but numerical increase was noticed both in birds fed diets containing 40% samai and 40% samai plus yeast culture as compared to control. Contradictory to this, there was a reduction in respective of Presumptive Coliform and E.coli in the samai diets as compared to the control diet. The numerical increase in total count and reduction in aerobic organism - Presumptive Coliform and E.Coli in the supplemented diet might have been due to reduction in oxygen concentration as observed by Rose (1980) and the increase in total count might have been due to the raise in anaerobic population or specific increase in the cellulolytic organisms as observed by Edward (1991) and Dawson and Hopkins (1992) as a result of yeast addition.

The pH recorded at various point of intestinal tract of the birds fed basal and samai diets with yeast culture did not differ. Probably the increase in concentration of lactic acid as the result of yeast might have been utilised by the increased population of lactate utilizing bacteria which would have maintained the pH of the intestine as attributed by Edward (1991), Dawson and Hopkins (1992).

4.3 FEED COST EFFECTIVENESS

Influence of various dietary treatments on the feed cost over the returns in terms of relative (%) profit or loss as compared to the control is presented in table 31. In broiler diet, samai upto 30% level provided more profit (+2.69 to 5.92), autoclaving of samai improved the profit at 30% level of inclusion only. Addition of enzyme or

TABLE 30. EFFECT OF YEAST CULTURE SUPPLEMENTATION ON MICROBIAL LOAD OF INTESTINAL CONTENTS/g AND pH OF INTESTINE AT DIFFERENT POINTS

Ration	Total count x 10^7CFU	Presumptive coliform x 10^6CFU	E.coli x 10^6 CFU	pH					
				Proventriculus	Gizzard	Duodenum	Jejunum	Ileum	Caeca
Control	11.68 ± 2.85	18.77 ± 4.77	9.77 ± 2.40	5.99 ± 0.21	5.62 ± 0.19	5.07 ± 0.24	5.53 ± 0.18	5.72 ± 0.16	6.3 ± 0.19
40% Samai	15.91 ± 2.09	13.58 ± 4.48	6.94 ± 2.40	5.99 ± 0.09	6.02 ± 0.22	5.57 ± 0.18	5.71 ± 0.12	5.95 ± 0.09	6.19 ± 0.11
40% Samai + Yeast Culture	17.67 ± 2.10	6.42 ± 1.60	3.60 ± 1.00	5.82 ± 0.29	5.99 ± 0.17	5.51 ± 0.17	5.43 ± 0.27	5.89 ± 0.11	6.12 ± 0.11

Each value is a mean of 6 observations.

Mean values in a column are not significant at $P < 0.05$.

TABLE 31. RELATIVE FEED ECONOMY (%) OF DIFFERENT DIETS OVER THE CONTROL

Diet	Broiler Experiment I	Broiler Experiment II	Layer
Control	0.0	0.0	0.0
10% samai	+ 3.10		+ 9.55
20% samai	+ 3.45		+ 12.08
30% samai	+ 2.69	+ 5.90	- 29.50
40% samai	- 6.85	- 27.81	- 43.80
30% autoclaved samai	--	+ 3.86	--
40% autoclaved samai	--	- 21.25	--
Control + enzyme	--	+ 23.86	--
30% samai + enzyme	--	+ 22.41	--
40% samai + enzyme	--	- 4.0	- 32.80
Control + yeast culture	--	+ 20.96	--
30% samai + yeast culture	--	+ 5.45	--
40% samai + yeast culture	--	- 2.02	- 52.6

+ (or) - : Profit or loss in % over the control.

yeast culture increased the profitability (18% with enzymes and +15.3% with yeast culture) over the unsupplemented group. In layer, samai upto 20% level had resulted in more profit, at higher level the loss was directly related to the level, addition of enzyme or yeast culture did not help to reduce the margin of loss in 40% samai diet.

SUMMARY AND CONCLUSION

5. SUMMARY AND CONCLUSION

To assess the nutritive value of samai *Panicum miliare* a millet to be used as an energy feed for poultry, a series of chemical analysis and biological trials were carried out.

Ten samples of samai of unknown variety obtained from different sources were analysed for the proximate principles and available carbohydrates. Based on the above analysis the metabolisable energy (ME) was predicted.

The mean value (in percent) for the proximate principles was crude protein 9.69; ether extract - 5.45%, crude fibre - 5.54; total ash - 5.83 and nitrogen free extractive - 73.47, on dry matter basis. The mean value for available carbohydrate was 54.11% and ME - 3122 Kcal/kg. The sample either raw/autoclaved used for biological trials alone was subjected for fibre fractions and the results being NDF-34.23 and 33.33% and ADF - 11.09 and 10.26% respectively. Three samplesof samai and test samai were assayed for tannic acid and mineral contents.

A biological experiment using 8 adult cockerels was conducted to determine the ME for whole as well as ground samai grains, the value being 2107 and 2882 kcal/kg respectively.

A set of three biological trials to assess the feeding value of samai were conducted, two of which in broilers and one in layers.

In the first broiler experiment 150 Vencob day-old broiler chicks were randomised into five treatments each of which in triplicate. The treatment diets contained 0,10,20,30 and 40% level of samai replacing maize with equal protein and energy. Weekly body weight and feed consumption were recorded.

The results of 8 weeks study revealed that samai could be incorporated in broiler ration upto 30% level without affecting the body weight gain, feed consumption and feed efficiency. At 40% level of samai, depressed growth rate (985g) was noticed as compared to control diet (1184g). Also feed consumption was affected by 18.3%, but the feed efficiency was comparable.

The samai grains included at different levels did not influence the blood picture as well the carcass yield and quality.

In the second broiler experiment, 231 day-old Vencob broiler chicks were randomised into 11 treatments each in triplicate, with an objective of studying the effects of autoclaving or supplementation of enzyme or yeast culture, on the utility of samai grains. In addition to the growth trial for 8 weeks, a metabolism trial was conducted with three birds in each treatment to find out the nutrient digestibility, balance of nitrogen, calcium and phosphorus and ME.

The result showed that autoclaving did not influence the body weight gain, but it improved the feed consumption and feed efficiency only at 40% level and not in other treatments. Moreover, autoclaving did not improve digestibility of nutrients, balance of nitrogen and calcium except for the improved phosphorus availability.

Supplementation of enzyme exerted a beneficial effect on body weight gain in all the three diets, and feed consumption in 40% samai diet only. Enzyme addition did not significantly bring any desirable result on nutrient digestibility, except the balance of calcium and phosphorus.

Similarly supplementation of yeast culture also improved the weight gain and feed efficiency in all the three diets. Like enzyme addition, yeast also failed to exert any significant increase in nutrient digestibility or balance except for the phosphorus.

Based on the positive response of enzyme or yeast supplementation which permitted the higher level of samai inclusion, a layer trial was formulated. The layer trial was started with 210 pulletsof 16 weeks old. The pullets were randomised into 21 groups and 3 groups were allotted to each of the 7 treatments. There were seven treatment diets containing graded levels of samai of which the diet having 40% samai alone was supplemented either with enzyme or yeast culture. During the trial, from 15-20th week, grower diets were fed and from the beginning of the 21st week onwards layer diets were given until 40th week of age. Age at 1st egg and 50% production, egg production, feed consumption and egg qualities were studied. At the end of 40 weeks of age, 6 birds from each treatment were sacrificed to study the carcass yield. Intestinal pH and microbial count were done in birds fed the control, 40% samai and 40% samai + yeast.

During the grower phase (15-20 weeks) it was observed that inclusion of samai at 30% resulted in comparable performance but inclusion at 40% depressed the growth, which was nullified with enzyme or yeast addition, however, feed consumption and feed efficiency were not influenced either by level of samai or supplementation.

The age at 1st egg production was not affected upto 20% level of samai but beyond this the sexual maturity was delayed. Further supplementation also did not have any influence on maturity. The age at 50% production differed significantly among the treatments. The higher level of samai more than 20% of the diets depressed egg production, feed consumption and feed efficiency. The depression in 40% samai diet was significantly more than the 30% samai diet. Supplementation of enzyme or yeast culture in 40% samai diet was ineffective in all traits studied.

The quality of eggs in terms of weight, surface area, shape index, albumin index, haugh unit, yolk index and shell thickness did not differ among the diets and also between the periods except egg weight and surface area which improved as the age of the birds increased. The intensity of yolk colour was significantly less as the level of samai was increased. Supplementation of enzyme or yeast culture had no influence on egg qualities.

The dressing percent and other carcass traits showed no variations among the various treatments.

CONCLUSION

1. Samai (Panicum miliare) with crude protein - 9.69% and 2882 Kcal/kg of ME was a potential energy feedstuff for poultry. Samai grains were high in CF, NDF and ADF and low in total available carbohydrate when compared to maize.

2. The tannic acid content of samai grain was 0.17% which is well below the tolerance level for poultry.

3. Samai could be incorporated in broiler ration upto 30% replacing 75% of the maize in an isocaloric and isonitrogenous diet, without any adversity.

4. Incorporation of autoclaved samai improved the feed consumption in the diet containing 40% samai only. Autoclaving did not improve the energy content of the diet or digestibility or balance of nutrients except for phosphorus.

5. Addition of enzyme improved weight gain, feed efficiency, and balance of calcium and phosphorus.

6. Yeast in broiler diets improved the performance and balance of phosphorus.

7. In egg type pullets samai could be included upto 30% without any adversity. Addition of enzyme or yeast permitted the inclusion of samai at 40% level.

8. In layer diet, samai upto 20% produced comparable performance, addition of enzymes or yeast did not improve the performance. Samai even upto 40% level did not influence the carcass yield and egg qualities except for a reduction in intensity of yolk colour.

9. On the basis of experiments conducted in this study, samai could be included in broiler diet upto 30% and upto 20% in layers diet replacing maize in an isocaloric and isonitrogenous diet. Supplementation of multienzyme or yeast culture permits the inclusion of samai upto 40% level in broiler diets only.

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