EFFECT OF PROBIOTIC SUPPLEMENTATION ON THE PERFORMANCE OF WHITE PEKIN DUCKS

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DECLARATION

I hereby declare that this thesis entitled **"EFFECT OF PROBIOTIC SUPPLEMENTATION ON THE PERFORMANCE OF WHITE PEKIN DUCKS"**, is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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Certified that the thesis entitled **"EFFECT OF PROBIOTIC SUPPLEMENTATION ON THE PERFORMANCE OF WHITE PEKIN DUCKS"** is a record of research work done independently by K.Shibi Thomas, under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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K. Shibi Thomas

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Introduction

1. INTRODUCTION

In developing countries, livestock production constitutes a very important component of the agricultural economy. Bestowed with rich domestic animal diversity, Animal Husbandry plays a vital role in improving the socio-economic conditions of the rural masses. Among the various livestock enterprises poultry plays a vital role in poverty alleviation. The contribution of livestock sector to the GDP was 6.11 per cent in 1998-99. India ranked seventh in poultry population in the year 1992 (307.07 million) with an annual growth rate of 5.87 per cent (Anon, 2002).

Ducks being the second most important species of poultry in India, with a population of 24.48 million (Anon, 1994), forms about 8.5 per cent of the total poultry population. Although duck keeping is confined to coastal states, it still contributes significantly to the total GNP to the extent of Rs.40 million per annum.

Although, India is considered as the homeland of ducks, the breeds with excellent egg and meat producing qualities were developed in Europe and America. More than 92 per cent of the ducks reared in India are indigenous varieties. In most parts of the globe, ducks are being reared for meat production. On the other hand in few countries, like India ducks are more popular for egg production. Currently, the duck meat in our country is met from surplus drakes and spent ducks.

Kerala has an indigenous duck population of 11.8 lakh contributing 3.6 per cent of the duck population in the country (Anon, 2001). The long coastal stretch of 580 kilometre and the availability of vast riverbeds and large areas of water bodies serve as huge potential for duck production in Kerala.

A study on duck farming system in Kerala revealed that about 0.6 million ducklings of indigenous variety are hatched in the state annually (Leo *et al.*, 2003). Farmers keep only three to five drakes for every 100 ducks and the surplus

males are sold for meat purpose. The males attain market weight during April and December and these months coincide with the Easter and Christmas seasons.

As there is demand for duck meat, broiler duck production is gaining popularity in Kerala. Improved breeding techniques have made it possible to produce broiler ducks like White Pekin, which attain high body weight with superior feed efficiency. Duck meat is tasty and has been attributed medicinal value by people belonging to different strata. There is a preference for broiler duck in and around cities in Kerala and high quality duck meat fetches more price than broiler chicken meat.

Duck producers are constantly adopting measures to maximise efficiency, by optimising birds performance and minimizing feed cost. The major objectives of researchers in poultry nutrition are to make improvements in the production performance, efficiency of gain and quality of the products. Since 70% of the expenditure in poultry production is for feeding, even a small improvement in feed efficiency is considered to be vital and economically important.

It has been proved that incorporation of additives into the diet not only improves overall performance of the birds but also lowers feed cost. The concept of using microbial preparations like probiotics in poultry production has become an area of great interest because continued use of sub-therapeutic levels of antibiotics in poultry feeds may result in the deposition of residues in the body tissues. Due to increasing concerns over drug residues in animal products and resistance build up against antibiotics, the use of probiotics has received renewed emphasis in chicken production. Probiotics have been reported to be effective in counteracting the stress by its beneficial effects in live weight, feed intake, feed conversion efficiency and meat quality.

Eventhough, the beneficial effects of probiotics in chicken production is well documented its application in duck nutrition is not much emphasised. Basic research in duck nutrition and meat quality in our country is scanty.

The Poultry Farm of Kerala Agricultural University is supplying day-old White Pekin ducklings to farmers for broiler production. Hence, measures to improve the efficiency of meat production will be of economic advantage to farmers. Therefore, an experiment was planned to evaluate the effect of supplementation of probiotic on the growth and meat yield of Vigova variety of White Pekin ducks.

Review of Literature

2. REVIEW OF LITERATURE

The introduction of commercial broiler ducks like White Pekin has gained popularity in and around cities and has opened a new avenue for the production of duck meat as an alternative to chicken production in India. The supplementation of feed additives especially *Lactobacilli* based probiotics had improved the performance of broilers (Kadari, 2001; Senani *et al.*, 2000). Similarly, Kumararaj *et al.* (1997) and Kumari *et al.* (2001) observed that supplementation of probiotics had resulted in better production performance in Japanese quails. Many research works have been done on probiotics in chicken, but there is relatively little information available in the literature concerning the supplementation of Lactobacillus based probiotic in ducks. In this chapter an attempt has been made to review the available literature on the influence of probiotics on body weight and related characteristics of meat type ducks.

2.1 BODY WEIGHT AND BODY WEIGHT GAIN

Broadbent and Bean (1952) studied the yield of edible meat from turkeys, ducks and different market classes of chickens. White Pekin ducklings recorded an average live weight of 2.7 kg at nine weeks of age.

Schubert *et al.* (1981) conducted a trial with 630 male Muscovy ducklings with 21 days starter feed and till 70 or 77 days finishing feed as meal, alone or with 7.5 or 15 per cent Rosenthaler (torula) yeast. The final body weight (BW) was about the same with 7.5 per cent yeast and control feed. But BW was reduced by three to five per cent, with 15 per cent yeast. To economize on imported protein feeds, 5.0 per cent of the yeast was the recommended maximum amount for starting and finishing rations for Muscovy ducks.

Leeson *et al.* (1982) conducted an experiment with Pekin ducks and recorded the body weight for males and females for each week from first to seventh week as follows:

Age in weeks	Body Weight (g)	
	Males	Females
1	273	286
2	800	807
3	1400	1381
4	1925	1931
5	2459	2449
6	2946	2845
7	3279	3113

Bentz *et al.* (1983) replaced fish meal and soyabean oil meal with or without mineral oil distillate fodder yeast 'Fermosin' 7.5 and 15 per cent in Muscovy ducklings for a period of 77 days. The live weight at 21 days of age was 493, 474 and 489 g and final live weight was 2984, 2847 and 2562 g, respectively indicating the possibility of using 15 per cent 'Fermosin' in starter feeds.

Campbell *et al.* (1985) conducted an experiment to study the influence of feed intake and sex on the growth and carcass composition of Pekin ducks and recorded the body weight as 2.15 kg in male and 2.14 kg in female in *ad libitum* system of feeding at eight weeks of age. The daily gain in body weight was 41.9 g in male and 40.7 g in female and recorded a significant difference between sexes.

Broiler ducks from 21 to 49 days old were given diets with 5 and 10 per cent yeast protein concentrate 'Vitex' and the live weights at seven weeks old duckling was 2.6-2.7 kg, giving no significant differences between the 'Vitex' supplemented groups and the reference group (Hudsky *et al.*, 1988).

Peethambaran (1991) studied the dietary protein and energy requirements of White Pekin ducks for growth. The body weight at eighth week of age averaged from 1335.81 g to 1555.00 g due to the various levels of energy protein ratio during the experimental period.

Commercial crossbred ducks were given isoenergetic sorghum diets with calculated phosphorus of 4.4, 5.2, 5.7, 5.0 and 5.7 g/kg without or with microbial phytase (from *Aspergillus niger*) at the rate of 825 units for 17 days in an experiment conducted by Farrel and Martin (1992). Ca: P ratio was constant at 1.3:1 and diets with 4.4, 5.2 and 5.7 g/kg phosphorus were supplemented with soyabean meal at 300, 400 and 500 g/kg. There was a significant increase in growth and feed intake in diets with 4.4 and 5.2 g/kg phosphorus only by increasing soyabean meal inclusion, with or without enzymes.

A Midwest feed manufacturer evaluated the benefit of adding two per cent Diamond V Yeast Culture (DVYC) to diets of speciality ducks like Rouen ducklings by conducting a controlled field study. The treatments consisted of three commercially available poultry feeds (each from a different manufacturer) with or without the direct addition of two per cent DVYC. The ducklings were fed for 34 days and the individual weights were recorded on 1, 6, 13, 25 and 34 days of age. The addition of yeast culture resulted in significant increase in growth rate in the ducklings starting at day 13. The results indicated that ducklings receiving two per cent DVYC gained 12.9 per cent more weight than the control diet during this 34 day study (White, 1992).

Aydin *et al.* (1994) fed Pekin ducks on a basal diet containing fish meal, or that diet with 2, 4, 6 or 8 per cent dried brewers' yeast instead of fish meal. During the first and second four weeks, the diet contained 19 and 16 per cent CP, respectively with a constant ME content of 3000 kcal/kg. Body weight at eight weeks of age was 1774.8, 1651.1, 1694.4, 1661.2 and 1580.0 g, with groups respectively.

The National Research Council (1994) has given the approximate body weights of White Pekin ducks at eight weeks of age as 3.61 kg in male and 3.29 kg in female with 2,900 ME/kg and 22 per cent crude protein upto two weeks and 3,000 ME/kg and 16 per cent crude protein during two to seven weeks of age.

Parova *et al.* (1994) studied the effect of application of probiotics based on Bacillus C.I.P 5832 on utility and economical parameters in fattening of ducks.

Ducklings were initially fed on a feed mixture with an inactive probiotic preparation or 0.05 per cent Paciflor (5x105 Bacillus C.I.P 5832/g) and later without or with Paciflor. Body weight at seven weeks of age was 3265 and 3369 g for the diets without or with Paciflor, respectively.

Male Muscovy ducks were given barley-based diets supplemented with glycosidases containing enzyme supplements in a growth trial of 77 days (Jeroch *et al.*, 1995). They observed that the addition of enzymes improved live weight gain in the starter phase by 3 to 16 per cent which declined to 0 to 5 per cent after 77 days and they attributed that higher growth rates were due to increased feed intake.

An enzyme preparation (MEK-GPL), containing beta-glucanase, amylase and lysozyme activity was fed to crossbred 'Temp' ducklings, at seven days of age and they were floor-reared for 19 weeks with dietary treatments containing 0.1, 0.3 or 0.5 per cent MEK-GPL premix (Dadashko and Sirvidis, 1996). Ducks given the premix were heavier than controls, 2956 to 3123 g for males and 2979 to 2989 g for females and they concluded that the difference between controls and test groups were significant.

Cowan and Hastrup (1997) carried out studies with a multi-component microbial enzyme preparation containing both endoxylanase and betaglucanase in male Muscovy ducks. Enzyme supplementation at the rate of 500 g/tonne feed resulted in a significantly higher body weight than the control birds both at seventh and eleventh week of the study.

According to Ningguo and Zhengkang (1997) supplementation of a crude enzyme preparation in barley-based diet with Cherry Valley ducks increased the live weight gain and reached its peak at five weeks, while the relative growth rate decreased with time.

Two experiments were conducted to determine the role of the microbiotic preparations, Lactiferm L-400 and L-50, in protecting ducks against Salmonella infection. Lactiferm L-400 was used in the form of spray applied to egg surface

and on ducklings, while Lactiferm L-50 was added to drinking water for the first seven days. Any form of Lactiferm application resulted in increase in liveweight. At 35 days of age, there was significant difference in liveweight between control and trial groups, with 1347 g for control and 1363.7 to 1489.5 g, among trial groups respectively (Weis et al, 1997).

Farrell and Martin (1998) concluded that non-starch polysaccharides were not a significant factor in suppressing the nutritive value of rice bran and therefore the use of enzyme preparations was unlikely to be beneficial with regard to growth rate.

A study was carried out by Jin *et al.* (2000) to study the effect of adherent Lactobacillus cultures in broiler chickens. The trial groups were treated with 0.1 per cent dried culture of *Lactobacillus acidophilus* and another group with 12 Lactobacillus strains along with control. The treated groups contained a significantly higher body weight gain for a period of 40 days.

Shome *et al.* (2000) used a combination of *Lactobacillus acidophilus* and *Lactobacillus salivarius* as probiotic in native chicken of Andaman for a period of four weeks and reported that there was no significant difference between control and experimental group with regard to body weight gain. The difference between the two groups was only 8.45 g.

Banday and Risam (2001) conducted an experiment with Biospur, a probiotic with commercial broiler chicks in the ration at the rate of 0, 25, 50 and 75 g per 100 kg upto six weeks of age. The body weight gain was significantly higher in the groups fed with 50 and 75 g probiotic. This indicated that the body weight gain was significantly higher in the treated group.

Ehrmann *et al.* (2002) studied a total of 112 strains of Lactic acid bacteria of duck origin for their use as a probiotic feed supplement. Among all the isolates, two strains (*Lactobacillus animalis* TMW 1.972 and *Lactobacillus salivarius* TMW 1.992) were selected for a survival test. After a single feed administration, both microorganisms were shown to persist in the crop and

caecum of ducks for a period of 18 and 22 days, respectively. Within the autochtoneous micro flora of ducks, two strains of Lactobacilli exhibited strong potential as probiotic adjuncts. The results indicated that the natural gut microflora of poultry serves as an excellent source for optimal strains.

Hong *et al.* (2002) investigated the growth performance and nutrient utilization responses of White Pekin ducks to a commercial enzyme preparation, containing 4000 units amylase, 12000 units protease and 1600 units xylanase per gram. The diets contained the enzyme mixture at 0, 0.375 or 0.5 g/kg in a growth study for 42 days and showed a six to eight per cent increase in body weight gain for birds fed diets containing the enzyme.

Hruby (2002) has quoted that a trial conducted at the Roslin Research Institute with an enzyme complex added to the ration of Pekin ducks (1 kg/tonne) resulted in increased body weight uniformity. The percentage of birds within average body weight (± 15 per cent) at 42 days of age increased from 91 per cent in the control diet to 93 per cent in the enzyme-supplemented diets.

While comparing the meat variety of Pekin ducks with other poultry species, Khan (2002) has suggested the optimum age at slaughter as seven weeks of age and the average live weight at slaughter as 3.18 kg.

Punnagai *et al.* (2002) conducted a biological trial for a period of five weeks to study the effect of graded levels of *Lactobacillus acidophilus* on the performance of Japanese quails. The quails were fed with graded levels (0, 0.1, 0.2 and 0.3 per cent) of *Lactobacillus acidophilus* from day one to five weeks of age. The *Lactobacillus acidophilus* supplemented groups recorded body weight of 132.4, 133.0, 137.1 g and was significantly higher than the control group (126.2 g).

Roy (2002) observed that White Pekin ducks attained body weight of 2.2 to 2.5 kg at seven weeks of age.

2.2 FEED CONSUMPTION

The cumulative feed intake by Pekin ducks, for a period of seven weeks was 8432 and 8657 g for male and female, respectively and the week wise feed consumption was as follows (Leeson *et al.*, 1982)

Age in weeks	Feed consumption (g)	
	Males	Females
1	273	250
2	854	796
3	1240	1264
4	1284	1399
5	1510	1615
6	1603	1719
7	1694	1615

The feed intake in g/day was 136.9 g in male and 137.3 g in female between 14 and 56 days in Pekin ducks (Campbell *et al.*, 1985).

The feed consumption ranged from 115.09 to 179.52 g per bird per day during the period of sixth week in an experiment conducted by Peethambaran (1991) to study the optimum energy/ protein ratio for White Pekin ducks during the growth phase. During the eighth week of the experiment the feed consumption averaged 127.54 to 170.18 g.

In commercial crossbred ducks, Farrell and Martin (1992) found a significant increase in feed intake with increasing soyabean meal inclusion in diets with calculated phosphorus levels of 4.4 and 5.2 g/kg with or without enzymes. They also reported that enzyme supplementation has no significant effect on feed consumption in ducks.

The National Research Council (1994) has given the approximate feed consumption of White Pekin ducks at eighth week of age as 1.68 kg in male and 1.63 kg in female and the cumulative feed consumption as 9.86 kg and 9.61 kg in male and female, respectively.

In an experiment to test the efficacy of enzyme preparations targeting the non-starch polysaccharides (NSPs) in rice bran Farrell and Martin (1998) reported that NSPs were not a significant factor in suppressing the nutritive value of rice bran and therefore the use of enzyme preparations were unlikely to be beneficial with regard to feed intake.

Biospur, a probiotic was added to the diet of commercial broiler chicks in the ration at the rate of 0, 25, 50 and 75 g per 100 kg upto six weeks of age to study the growth performance and carcass characteristics (Banday and Risam, 2001). At the end of 28 days the birds fed with higher level of Biospur consumed significantly higher feed but at the end of the experiment the groups fed probiotic consumed lesser amount of feed than control.

Khan (2002) reported the feed consumption of Pekin ducks as 8.63 kg for a period of seven weeks.

Punnagai *et al.* (2002) supplemented *Lactobacillus acidophilus* in various levels viz., 0, 0.1, 0.2 and 0.3 per cent in Japanese quails from day one to five weeks of age to study the effect of *Lactobacillus acidophilus* on the weekly feed consumption. The feed intake recorded for the above groups upto five weeks of age, were 405.1, 396.5, 390.3 and 398.7 g, respectively indicating that *Lactobacillus acidophilus* supplementation had resulted in moderate reduction in feed intake.

2.3 FEED CONVERSION RATIO

Bonomi *et al.* (1980) studied the use of live yeast feeding for meat type ducks. Day old Muscovy ducklings were given one of four diets with crude protein 19 per cent to 30 days and 17 per cent to 60 days of age, based on vegetable meals with eight per cent animal meals or with 50, 75 or 100 per cent of the animal meals replaced by vegetable meals and with or without 0.15 per cent Zimoyeast, a preparation of the living yeasts *Saccharomyces cerevisiae* and

Kluyveromyces fragilis. The feed intake/kg gain was 4.07 per cent less in the group given Zimoyeast but results were inferior to the control group given eight per cent animal meals without Zimoyeast.

In a study to measure the production and carcass characteristics of the Pekin ducks by Leeson *et al.* (1982) the cumulative feed efficiency was 2.62 and 2.83 in male and female, respectively and the week wise feed efficiency was as follows:

Age in weeks	Feed Efficiency	
	Males	Females
1	1.12	1.09
2	1.62	1.58
3	2.07	2.17
4	2.40	2.55
5	2.83	3.12
6	3.29	4.39
7	5.10	6.19

Bentz *et al.* (1983) assessed the supplementation of mineral oil distillate fodder yeast 'Fermosin' at 7.5 or 15 per cent in Muscovy ducks for a period of 77 days and reported that there was no effect on intakes per kg gained.

The feed:gain ratio was 3.28 and 3.31 in male and female, respectively between 14 and 56 days of age by *ad libitum* feeding in Pekin ducks (Campbell *et al.*, 1985).

Hudsky *et al.* (1988) reported that the feed conversion efficiency was 3.1 to 3.3 by the addition of five to ten per cent yeast protein concentrate 'Vitex' in broiler ducks from 21 to 49 days.

The cumulative feed efficiency upto sixth and eighth week as reported by Peethambaran (1991) ranged from 3.24 to 3.35 and 3.92 to 4.33, respectively.

Biostrong 500, a herbal growth promoter, when added in starter and finisher diets for table ducks at 0.5, 1.0 and 1.5 g/kg in a series of trials by Kiss *et al.* (1992) gave favourable results in feed conversion efficiency.

Non-significant difference in feed: gain ratio was reported in table ducks fed with basal diet containing fish meal and the diet containing 2, 4, 6 or 8 per cent dried brewers' yeast instead of fish meal. The feed: gain ratio was 4.60, 4.67, 4.97, 4.31 and 4.95, respectively (Aydin *et al.*, 1994).

In an experiment conducted by Parova *et al.* (1994), meat type ducklings were initially fed on a feed mixture containing an inactive probiotic preparation or 0.05 per cent Paciflor (5x105 Bacillus C.I.P 5832/g) and later without or with Paciflor. The feed: gain ratio was 3.36 and 3.29 without or with Paciflor.

Jeroch *et al.* (1995) supplemented a glycosidase containing enzyme to barley-based diets in Muscovy ducks for a period of 77 days and found 4 to 13 per cent increase in feed intake during starter period and one to seven per cent increase during whole period, therefore advantages in feed conversion efficiency were observed during the starter phase only.

Microbial enzyme supplementation containing endoxylanase and betaglucanase in male Muscovy ducks numerically decreased the feed conversion ratio both at seventh and eleventh week of the study (Cowan and Hastrup, 1997).

The administration of microbiotic preparation like Lactiferm-400 in the form of spray to egg surfaces and the application of Lactiferm-50 to drinking water for the first seven days to ducklings to study their effect against Salmonella infection by Weis *et al.* (1997) resulted in a slightly better feed conversion of 3.14 and 3.20 in the trial groups, respectively against 3.35 in the control.

Feeding of an enzyme preparation (4,000 units amylase, 12,000 units protease, and 1,600 units xylanase per gram) in White Pekin ducks led to an improvement in feed efficiency over the 42-day study (Hong *et al.*, 2002).

Khan (2002) reported a feed conversion ratio of 2.7 for Pekin ducks for a period of seven weeks.

Dietary supplementation of *Lactobacillus acidophilus* in Japanese quails at levels 0, 0.1, 0.2 and 0.3 per cent for a period of five weeks by Punnagai *et al.* (2002) resulted in non-significant improvement in feed efficiency of 2.85 against 3.21.

2.4 BIOCHEMICAL PARAMETERS

Landauer et al. (1941) reported the total cholesterol levels in plasma for male Pekin ducks as 450-500 mg/100 ml and the total cholesterol levels in plasma for Mallard as 730 mg/100ml.

Defalco (1942) stated that the total serum protein for duck (*Anas platyrhyncus*) was 3.50 g/100ml when conducting a serological study of some avian relationships.

Werner (1944) found total serum proteins of 6.44 g/100 ml in ducks (*Anas platyrhyncus*) of both sexes.

While studying the dietary protein and energy requirements of White Pekin ducks for growth, Peethambaran (1991) has reported that the serum protein levels ranged from 3.68 to 4.32 g/100ml at eighth week of age.

Joy and Samuel (1997) conducted an experiment in which probiotics like *Lactobacillus sporogenes* were administered to broiler chicken of either sex at 0, 50 and 100 million organisms per chick per day orally from day 1 to 42. Probiotic did not influence the total plasma protein levels during the entire period, but the serum cholesterol levels had a significant difference between treatments at fourth, fifth and sixth week of age.

Kadari (2001) supplemented 'Lactosacc' a probiotic containing live yeast culture, *Lactobacillus acidophilus* and *Streptococcus faecium* in broiler chicks for a period of eight weeks. The biochemical parameters like serum cholesterol and serum protein were estimated at the end of the experiment. The serum cholesterol levels were significantly reduced in both the probiotic supplemented groups

(0.025 per cent and 0.05 per cent), when compared to the control. While the serum protein levels were not affected by probiotic supplementation.

2.5 PROCESSING YIELDS

White Pekin ducks were grown using standard management procedures and 10 ducklings were processed and frozen at 28, 35, 41, 46, 48, 50, 53, 55, 57, 63 and 68 days of age. The percentage of breast meat increased from 4.79 per cent at 28 days of age to 15.93 per cent at 63 days of age. Leg meat decreased from 17.97 per cent to 12.28 per cent from 28 days to 63 days (Stadelman and Meinert, 1977).

The organ proportions and the yield and commercial cuts of male and female Pekin ducks at seventh week of age were as follows (Leeson *et al.*, 1982)

Organs (g)	Male	Female
1. Abdominal Fat	2.0	2.2
2. Liver	2.2	2.3
3. Heart	0.7	0.7
4. Gizzard & Proventriculus	3.9	3.4
Cut up parts (per cent)		
5. Neck	7.8	9.4
6. Drumsticks	19.6	16.2
7. Thighs	19.2	20.8
8. Wings	10.4	8.6
9. Back	28.0	31.9
10. Breast	7.7	6.3

Ahmed *et al.* (1984) conducted a study on certain quantitative characters of Khaki Campbell duck meat and found that the giblet yield in per cent was significantly higher in females (7.03) than in males (5.7), whereas per cent ready-to-cook yield in per cent was significantly higher in males (72.94) than in females

(68.40). The per cent yield of cut-up-parts of duck carcass in fresh sample was as follows:

Parts	Male	Female
Breast	34.60	32.30
Back	30.33	30.41
Wing	14.62	15.52
Drumsticks	11.98	11.89
Thigh	8.24	9.44

The eviscerated carcass weight was recorded as 1.34 kg in both male and female Pekin ducks at 56 days of age in an experiment conducted by Campbell *et al.* (1985)

The dressing percentage was 70-72 per cent in groups given 'Vitex' (5 and 10 per cent yeast protein concentrate) in broiler ducks at 49 days of age (Hudsky *et al.*, 1988).

The ready-to-cook yield in White Pekin ducks at eighth week of age ranged from 65.75 to 72.30 per cent while the giblet yield varied from 6.33 to 7.61 per cent (Peethambaran, 1991).

Aydin *et al.* (1994) found that diet had no significant effect on carcass weight, but significantly influenced the weight of pancreas, liver, gizzard and carcass fat by the administration of 2, 4, 6 or 8 per cent dried brewers' yeast instead of fish meal in Pekin ducks.

Ducklings of meat origin were initially fed on a feed mixture with an inactive probiotic preparation or 0.05 per cent Paciflor (5x105 Bacillus C.I.P 5832/g) and later without or with Paciflor. The carcass yield was 72.84 and 72.87 per cent without or with Paciflor (Parova *et al.*, 1994).

Carcass quality variables were not consistently influenced but there was a tendency for an increased percentage of breast meat in enzyme-supplemented ducks containing glycosidase in male Muscovy ducks for a period of 77 days

(Jeroch *et al.,* 1995). They also indicated that carcasses of ducks given the enzyme supplement contained more adipose tissue.

Cowan and Hastrup (1997) stated that microbial enzyme supplementation containing endoxylanase and betaglucanase in male Muscovy ducks at 500 g/ tonne of feed numerically increased the carcass yield.

Results from a 16 week experiment on Muscovy ducks showed that effective micro-organism added in the feed and or in the drinking water had no significant effect on production performance but significantly increased breast meat yield percentage, significantly reduced breast ash content and tended to increase protein content of breast meat and polyunsaturated fatty acid content in duck oil (Chantsavang *et al.*, 1999).

Punnagai *et al.* (2002) concluded that carcass yields were not significantly influenced by *Lactobacillus acidophilus* supplementation at levels 0, 0.1, 0.2 and 0.3 per cent in Japanese quails at fifth week of age.

The processing yields and losses in male Kuttanad ducks were studied at 20 weeks of age (Anon, 2003). The average ready-to-cook yield was 68.36 per cent, eviscerated yield without giblets was 62.09 per cent, giblet yield comprising of heart, liver and gizzard was 6.27 per cent and the average yield of breast, drumsticks, thigh, back, wings + shank and neck + skin were 25.79, 12.61, 10.80, 20.96, 17.27 and 12.57 per cent, respectively.

2.6 LIVABILITY

Gippert and Bodrogi (1992) studied with a probiotic Lacto-Sacc (*Streptococcus faecium*, *Lactobacillus acidophilus*, proteinase, cellulase, amylase and yeast culture) at 1 kg/tonne for 45 days in starter, grower and finisher diets in ducks and found that the supplement had no effect on mortality.

Weis *et al.* (1997) conducted two experiments to study the role of microbiotic preparations, in protecting against Salmonella infection in ducks.

Lactiferm L-400 was used in the form of spray applied to egg surface and Lactiferm L-50 was added to drinking water for the first seven days against control. The latter showed lower mortality of four to seven per cent compared to the control which was 10 per cent.

Shome *et al.* (2000) used a combination of *Lactobacillus acidophilus* and *Lactobacillus salivarius* as probiotic in native chicken of Andaman for a period of four weeks and reported 100 per cent survivability in the treated groups.

Livability was not significantly influenced by *Lactobacillus acidophilus* supplementation in Japanese quails when fed for a period of five weeks as reported by Punnagai *et al.* (2002).

2.7 ECONOMICS

The cost of feeding ducklings for a period of eight weeks as studied by Peethambaran (1991) ranged from Rs.18.95 to Rs. 25.25.

Meat type ducklings were initially fed on a feed mixture with an inactive probiotic preparation or 0.05 per cent Paciflor (5x105 Bacillus C.I.P 5832/g) and was later given without or with Paciflor. Parova *et al.* (1994) worked out the financial profit as 27.18 and 27.93 kcs / kg finished duck without or with Paciflor.

Punnagai *et al.* (2002) concluded that supplementation of 0.1 to 0.2 per cent level *Lactobacillus acidophilus* in broiler quail diet will improve the body weight gain and feed efficiency and thereby increase the profit margin to the farming community.

Materials and Methods

3. MATERIALS AND METHODS

An experiment was conducted in the Department of Poultry Science, College of Veterinary and Animal Sciences, Mannuthy, for a period of eight weeks from September to October 2002 to evaluate the effect of probiotic supplementation on the performance of Vigova variety of White Pekin ducks.

3.1 EXPERIMENTAL MATERIALS

3.1.1 Experimental Birds

One hundred and forty four (144) day-old straight run White Pekin (Vigova variety) ducklings procured from the Kerala Agricultural University Poultry Farm (UPF), Mannuthy formed the experimental material.

3.1.2 Experimental Rations

The Bureau of Indian Standards had not prescribed any standards on the nutrient requirements of ducks. Therefore the present study was undertaken in White Pekin ducks fed with standard broiler ration formulated as per BIS specifications (1992). For the first six weeks, the ducklings were fed broiler starter mash containing 23 per cent crude protein and 2800 kcal per kg metabolizable energy as the duck starter ration. From seventh week onwards broiler finisher mash containing 20 per cent crude protein and 2900 kcal per kg metabolizable energy content was fed as the duck finisher ration and was continued till the end of eight weeks of age. The feed ingredients used for the formulation of the ration were yellow maize, soyabean meal, gingelly oil cake, unsalted dried fish, rice polish, dicalcium phosphate, mineral mixture and salt. The per cent ingredient composition of the feed is presented in Table 1. The proximate composition of the ration was determined according to the procedures described in AOAC (1990) and is presented in Table 2.

Table 1. Per cent composition of feed ingredients in the duck starter and finisher rations fed to the experimental ducks

Sl. No.	Ingredients	Inclusion level	
		Starter (%)	Finisher (%)
1.	Yellow maize	45.00	56.50
2.	Rice polish	8.50	11.00
3.	Soyabean meal	33.50	23.00
4.	Gingelly oil cake	2.75	-
5.	Dried Unsalted fish	8.00	7.00
6.	Dicalcium phosphate	0.75	1.00
7.	Mineral mixture*	1.25	1.25
8.	Salt	0.25	0.25

To every 100 kg of the feed added

** Indomix $A+B_2+D_3$ 15 g

*** Indomix BE 15 g

* Keyes mineral mixture without salt (KSE Ltd., Irinjalakuda)

Ingredients: Calcium – 24.0%, Phosphorus – 12.0%, Magnesium – 6.5%, Sulphur – 0.5%, Iron – 0.5%, Zinc – 0.38%, Manganese – 0.15%, Copper – 0.5% Iodine – 0.03%, Cobalt – 0.02%, Fluorine (max) – 0.04%, Acid insoluble ash (max) – 2% and moisture – 4%

** Indomix $A+B_2+D_3$ (Nicholas Piramal India Ltd., Mumbai)

Composition per gram: Vitamin A – 40,000 IU, Vitamin B_2 – 20 mg, Vitamin D_3 – 5000 IU

*** Indomix BE (Nicholas Piramal India Ltd., Mumbai)

Composition per gram: Vitamin B_1 – 4 mg, Vitamin B_6 – 8 mg, Vitamin B_{12}– 40 mcg, Niacin – 60 mg, Calcium pantothenate – 40 mg, Vitamin E – 40 mg.

Table 2. Chemical composition of duck starter and finisher rations on dry matter basis, per cent

Nutrients	Starter (%)	Finisher (%)
Moisture	9.65	9.25
Crude protein	23.11	20.42
Ether extract	5.84	5.97
Crude fibre	5.81	5.92
Total ash	11.04	11.73
Acid insoluble ash	2.45	2.35
Calcium	1.30	1.27
Phosphorus	0.53	0.57
Metabolizable energy (kcal/kg) (Calculated value)	2801	2900

3.1.3 Probiotic

The probiotic used in this study was "Livesac", a product from Zeus Biotech Limited, Mysore. Each kilogram Livesac contains Lactic acid bacteria 120000 million CFU/kg, live yeast cells 5000 billion CFU/kg and traces of enzymes viz., Xylanase, Glucanase, Pectinase, Amylase, Cellulase, Protease, Phytase and Galactosidases.

3.2 EXPERIMENTAL METHODS

3.2.1 Housing of Ducklings

Day-old ducklings were weighed individually, wing banded and housed in a shed with individual pens for each replicate with a floor space of 2356 cm^2 per bird. The house, feeders, waterers and other equipment were cleaned thoroughly and disinfected prior to housing of ducklings.

3.2.2 Experimental Design

Day old ducklings were randomly divided into 12 lots of 12 ducklings in each pen. These groups were allotted randomly into three dietary treatments T_1, T_2 and T_3 each with four replications containing 12 ducklings each as per the details presented in Table 3.

T_1 – standard broiler ration (control)

T_2 – control + 250g Livesac / tonne of feed (0.025%)

T_3 - control + 500g Livesac / tonne of feed (0.05%)

3.2.3 Management

The ducklings were reared on litter floor and were provided with optimum conditions of brooding and management. Feed and water were provided *ad libitum*

Table 3. Distribution of the different dietary treatments and layout of the experiment

Treatment	Replication	No. of ducks	Level of probiotic inclusion (g per tonne of feed)
T_1	R_1	12	-
	R_2	12	-
	R_3	12	-
	R_4	12	-
T_2	R_1	12	250
	R_2	12	250
	R_3	12	250
	R_4	12	250
T_3	R_1	12	500
	R_2	12	500
	R_3	12	500
	R_4	12	500

throughout the experimental period. Standard managemental practices were adopted identically to all treatments during the entire experimental period.

3.2.4 Meteorological Observations

The maximum and minimum temperatures were recorded at 8 a.m daily and the wet and dry bulb thermometer readings were taken at 8 a.m and 2 p.m on all days throughout the experimental period. From these data, weekly mean maximum and minimum temperatures and percentage relative humidity were arrived at.

3.2.5 Body Weight

The individual body weight of ducklings was recorded biweekly from day old till the end of the experimental period to study the pattern of body weight gain under different treatment groups.

3.2.6 Feed Consumption

Feed intake of the ducklings was recorded replication wise at the end of each week. From these data the average daily feed intake per bird was calculated for various treatment groups.

3.2.7 Feed Conversion Ratio

Based on the data on body weight gain and feed intake, the feed conversion ratio was calculated.

$$\text{Feed conversion ratio} = \frac{\text{Feed consumed (kg)}}{\text{Body weight gain (kg)}}$$

3.2.8 Biochemical Parameters

Blood was collected at the end of eighth week of age, from four males and four females from each treatment. The serum was analysed for total protein using Biuret method and the total serum cholesterol was estimated using cholesterol oxidase peroxidase methodology using kits supplied by Agappe Diagnostics, India.

3.2.9 Processing Yields

At the end of the experiment, one male and one female from each replicate were randomly selected and were sacrificed to study the processing yields as per the procedure described by BIS (1973). Percentage of ready-to-cook yield including giblet yield was calculated from these data. The weight of liver, heart and gizzard were also taken.

The abdominal fat was separated and weighed as per the procedure described by Health *et al.* (1980) and the percentage of abdominal fat was derived from it.

Out of the 24 birds slaughtered 12 birds (two males and two females from each treatment) were taken to analyse the meat:bone ratio as per the procedure of Bajwa *et al.* (1999).

3.2.10 Livability

Mortality was recorded replicate-wise during the entire experimental period. Post-mortem examination of dead birds was conducted in each case to find out the cause of the death.

3.2.11 Economics

Cost benefit analysis was worked out using the data on the cost of feed and probiotic, live weight and quantity of feed consumed by ducks in each treatment group.

3.2.12 Statistical Analysis

Data collected on various parameters were statistically analysed as per the methods described by Snedecor and Cochran (1985).

Results

4. RESULTS

This chapter presents the results of the study on the effect of probiotic supplementation on the performance of Vigova variety of White Pekin ducks.

4.1 METEOROLOGICAL OBSERVATIONS

The meteorological data during the experimental period covering eight weeks commencing from 6th September to 31st October 2002 are presented in Table 4.

The mean weekly maximum temperature ranged from 30.6° to 35.0° C with an overall mean value of 32.65° C. The highest mean value for the minimum temperature was 26.4° C while the lowest mean value was 24.7° C with an overall mean value of 25.78° C.

The relative humidity (R.H) in the forenoon ranged from 61.3 to 78.3 per cent with an overall mean of 69.3 per cent while in the afternoon the R.H ranged from 31.7 to 49.3 per cent with an overall mean of 41.14 per cent.

4.2 BODY WEIGHT

The fortnightly mean body weight as influenced by different dietary treatments, viz., control ration (T_1), ration with 0.025 per cent probiotic (T_2) and ration with 0.05 per cent probiotic (T_3) are presented in Table 5 and Fig.1.

The mean body weight of day-old ducklings in the three dietary treatments viz., T_1, T_2 and T_3 were 41.00, 41.62 and 41.34 g respectively. It was evident that day-old body weight of ducklings in different treatment groups was comparatively uniform. Statistical analysis revealed that there was no significant difference between the treatment groups in the body weight of day-old ducklings at the beginning of the experiment.

Table 4. Mean weekly meteorological data during the experimental period

PERIOD (Weeks)	Temperature (°C)		Relative Humidity (%)	
	Maximum	Minimum	8 a.m.	2 p.m.
1	32.4	26.4	64.5	36.7
2	35.0	26.0	61.3	38.0
3	34.0	25.7	64.0	31.7
4	33.3	25.4	66.7	39.0
5	32.3	24.7	71.3	48.4
6	30.6	26.0	78.3	41.0
7	32.0	25.7	71.3	45.0
8	31.6	26.3	77.0	49.3
Mean	32.65	25.78	69.3	41.14
SE	0.49	0.19	2.20	2.14

The body weight of ducklings at the end of second week of age averaged 173.88, 182.07 and 184.48 g for the three dietary treatments T_1, T_2 and T_3 respectively. The difference in body weight between the treatments having the lowest and highest body weight was only 10.6 g. No statistical significance was observed in body weight between the treatments at the end of second week of age.

The fourth week body weight of ducklings offered diets supplemented with 0, 0.025 and 0.05 per cent probiotic were 867.77, 890.11 and 926.89 g respectively. This indicated that the body weight was the highest in the ducklings fed the ration supplemented with 0.05 per cent probiotic (926.89 g), whereas the control group registered the lowest body weight (867.77 g) and it was intermediary in the group fed 0.025 per probiotic (890.11 g). The body weight of ducklings of T_3 group was significantly ($P<0.01$) higher than that of the control and T_2 groups. It was also evident that the body weight of ducklings fed the control diet and those supplemented with 0.025 per cent probiotic was comparable at fourth week of age.

The mean body weight of the ducklings at the end of sixth week was 1866.62, 1879.08 and 1997.80 g for the dietary treatments T_1, T_2 and T_3 respectively. It could be seen that the groups supplemented with 0.05 per cent probiotic showed maximum body weight (1997.80 g), while the body weight of control group was the lowest. Statistical analysis of the data showed significant differences between the treatment groups as observed at fourth week of age. The body weight at sixth week of age was significantly higher ($P<0.01$) in 0.05 per cent probiotic supplemented group than in the control and the 0.025 per cent probiotic supplemented group.

At the end of eighth week, the mean body weight of birds of the three dietary treatment groups T_1, T_2 and T_3 were 2463.89, 2529.98 and 2643.20 g respectively. The body weight pattern noticed among the different treatment groups during fourth and sixth week was reflected at the end of eighth week too. Maximum body weight was recorded with the group supplemented with 0.05 per cent of probiotic and minimum with the control group. The body weight recorded

Table 5. Influence of dietary supplementation of probiotic on fortnightly mean body weight in White Pekin ducks, g

Treatment	Age in weeks				
	0	2	4	6	8
T_1R_1	40.78	184.52	845.71	1857.40	2446.50
R_2	41.31	176.91	858.93	1864.48	2468.33
R_3	41.82	171.22	891.43	1894.61	2457.73
R_4	40.08	162.86	875.00	1850.00	2483.00
Mean ± SE	41.00 ± 0.37	173.88 ± 4.55	867.77 ± 9.91 [b]	1866.62 ± 9.79 [b]	2463.89 ± 7.75 [b]
T_2R_1	42.35	183.73	887.85	1861.40	2492.50
R_2	40.90	178.22	874.29	1896.22	2542.08
R_3	40.41	169.72	897.27	1890.52	2540.91
R_4	42.80	196.60	901.01	1868.17	2544.42
Mean ± SE	41.62 ± 0.57	182.07 ± 5.64	890.11 ± 5.96 [b]	1879.08 ± 8.45 [b]	2529.98 ± 12.52 [b]
T_3R_1	39.96	200.69	920.07	1971.20	2615.00
R_2	42.22	185.05	911.43	2033.94	2634.50
R_3	40.72	162.89	919.28	1950.39	2658.75
R_4	42.48	189.29	956.79	2035.68	2664.55
Mean ± SE	41.34 ± 1.21	184.48 ± 7.74	926.89 ± 10.16 [a]	1997.80 ± 21.79 [a]	2643.20 ± 11.44 [a]

Means bearing the different superscripts within the same column differ significantly ($P<0.01$)

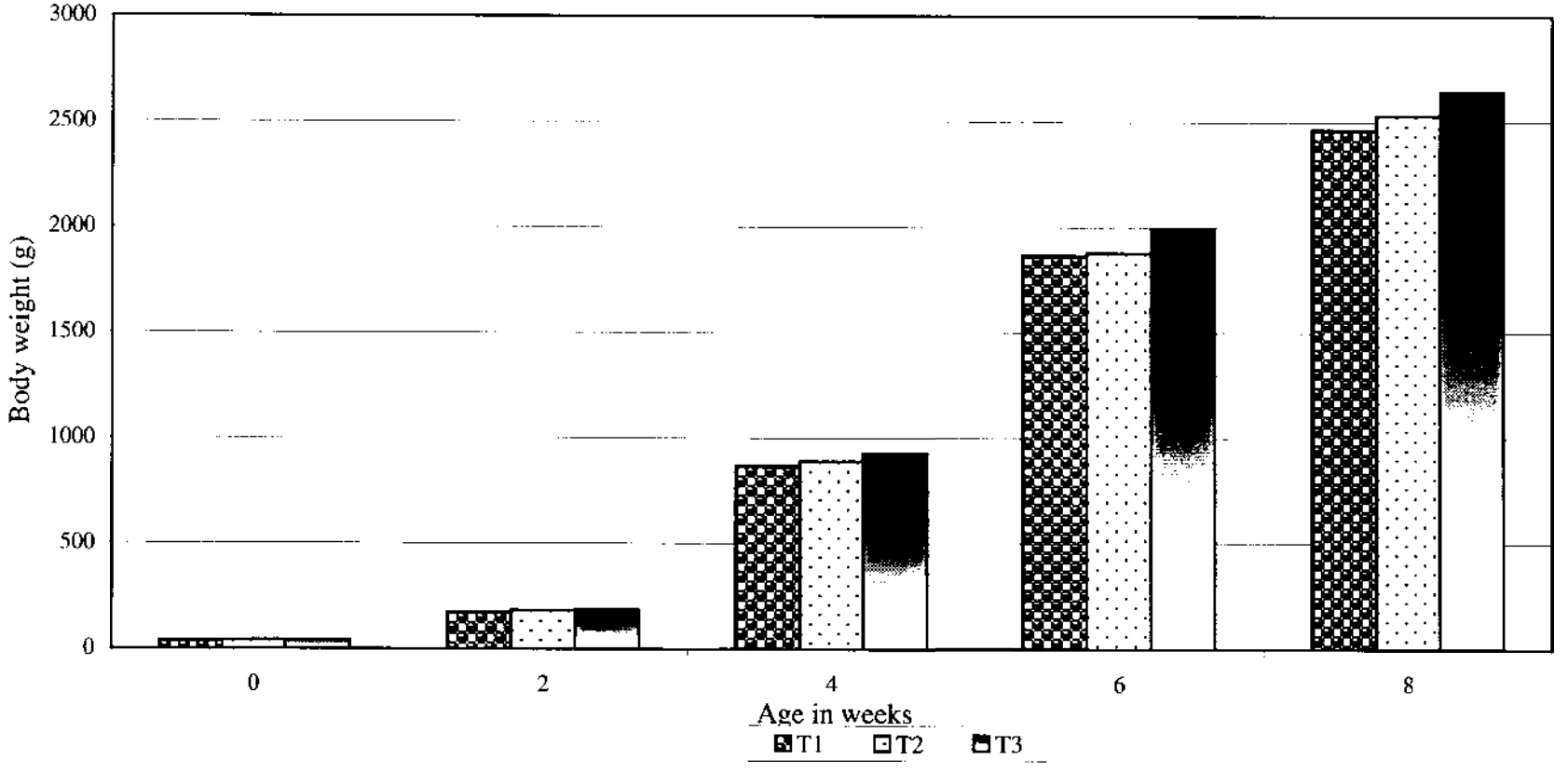

Fig. 1. Influence of dietary supplementation of probiotic on fortnightly mean body weight in White Pekin ducks

with the group supplemented with 0.025 per cent probiotic was intermediary. Statistical analysis of the data on body weight at eighth week also confirmed this trend. The 0.05 per cent probiotic supplemented group showed significantly higher ($P<0.01$) body weight than the 0.025 per cent supplemented group and the control.

The influence of dietary supplementation of probiotic in White Pekin ducks with respect to mean fortnightly body weight is graphically represented in Fig. 1.

4.3 BODY WEIGHT GAIN

The mean fortnightly body weight gain of White Pekin ducks maintained on different dietary regimen during the eight weeks experimental period is shown in Table 6 and Fig.2.

The mean fortnightly body weight gain at the end of second week among the different treatment groups T_1, T_2 and T_3 were 132.88, 140.45 and 143.14 g respectively. Analysis of the data showed no significant difference among treatments.

The mean gain in body weight during the second fortnight was 693.89, 708.04 and 742.41 g for the treatments T_1, T_2, and T_3 respectively. Analysis of mean body weight gain of ducks during this period indicated that the gain in T_1 (693.89 g) and T_2 (708.04 g) were statistically comparable though the 0.025 per cent probiotic fed group had numerically higher value than control group, but both values were significantly lower ($P<0.05$) than T_3 (742.41 g). Thus the ducks fed starter ration supplemented with 0.05 per cent probiotic showed significantly higher body weight gain during the second fortnight.

The body weight gain at the end of third fortnight was 998.86, 988.97 and 1070.91 g for the three dietary treatments T_1, T_2 and T_3 respectively. Statistical interpretation of the data showed that the body weight gain in the 0.05 per cent

Table 6. Influence of dietary supplementation of probiotic on fortnightly mean body weight gain in White Pekin ducks, g

Treatment	Age in weeks			
	2	4	6	8
T_1R_1	143.74	661.19	1011.69	589.1
R_2	135.60	682.02	1005.55	603.85
R_3	129.40	720.21	1003.18	563.12
R_4	122.78	712.14	975.00	633.00
Mean ± SE	132.88 ± 4.47	693.89 ± 13.65 [b]	998.86 ± 8.15 [b]	597.27 ± 14.59
T_2R_1	141.38	704.12	973.55	631.09
R_2	137.32	696.07	1021.93	645.86
R_3	129.31	727.55	993.25	650.39
R_4	153.80	704.41	967.16	676.25
Mean ± SE	140.45 ± 5.11	708.04 ± 6.79 [b]	988.97 ± 12.31 [b]	650.90 ± 9.40
T_3R_1	160.73	719.38	1051.13	643.80
R_2	142.83	726.38	1122.51	600.56
R_3	122.17	756.39	1031.11	708.36
R_4	146.81	767.50	1078.89	628.87
Mean ± SE	143.14 ± 7.97	742.41 ± 11.59 [a]	1070.91 ± 19.79 [a]	645.40 ± 22.82

Means bearing the different superscripts within the same column differ significantly ($P<0.05$)

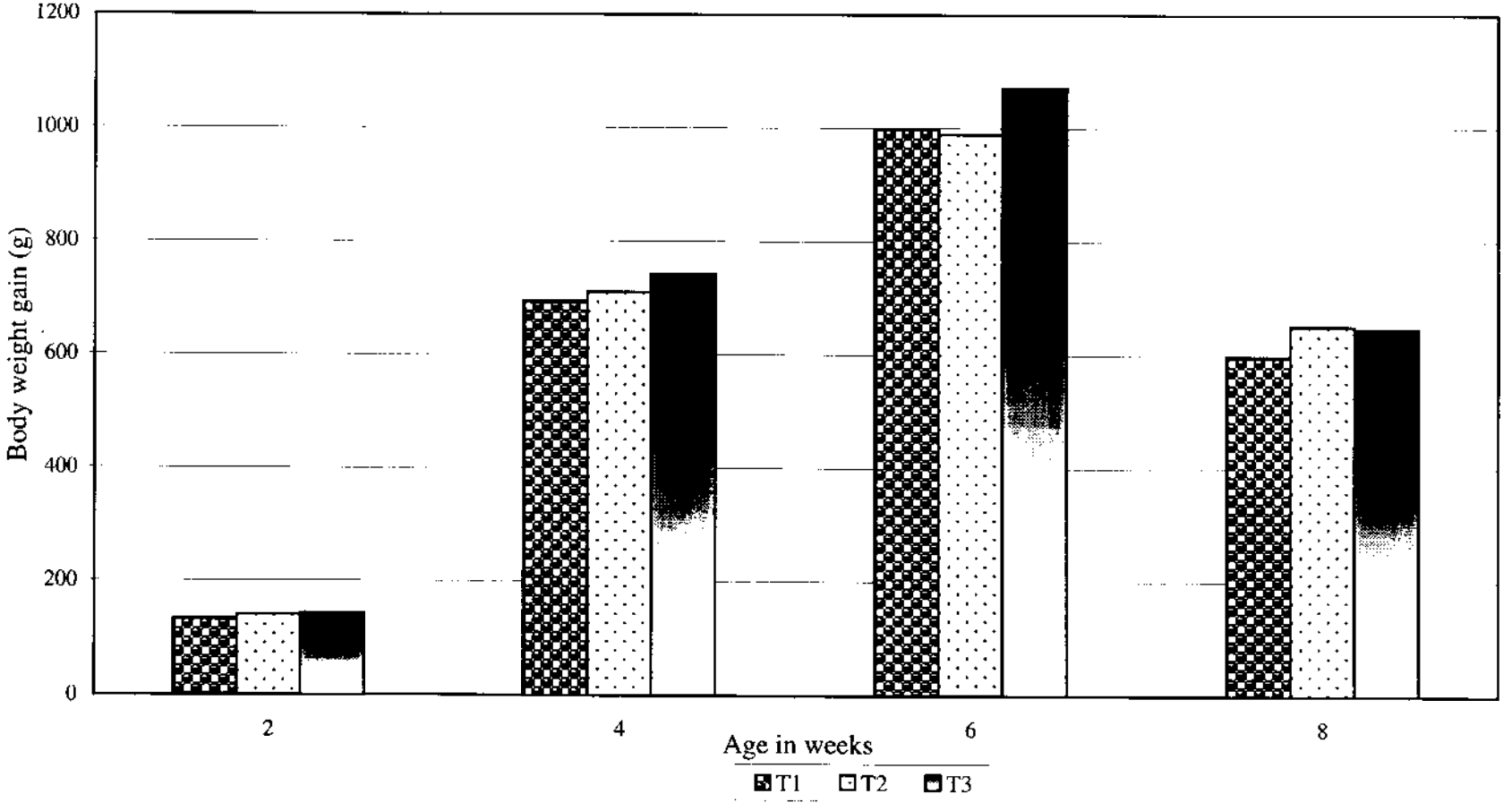

Fig. 2. Influence of dietary supplementation of probiotic on fortnightly mean body weight gain in White Pekin ducks

probiotic supplemented group was significantly higher ($P<0.05$) than the control group and 0.025 per cent probiotic supplemented group.

The mean body weight gains during the fourth fortnight for the three dietary treatments T_1, T_2 and T_3 were 597.27, 650.90 and 645.40 g respectively. No significant difference was observed between the treatment groups for body weight gain during the fourth fortnight.

The cumulative mean body weight gain upto the end of sixth week was 1825.63, 1837.46 and 1956.46 g for the treatments T_1, T_2 and T_3 respectively as shown in Table 9. Statistical analysis of the data revealed that the 0.05 per cent probiotic supplemented group had significantly higher cumulative weight gain at the end of sixth week than the other two groups ($P<0.01$).

The cumulative mean body weight gain upto the end of eighth week was 2422.89, 2488.36 and 2601.86 g, for the treatments T_1, T_2 and T_3 respectively as shown in Table 9. The statistical interpretation of the data showed that there were significant differences between treatments ($P<0.01$). Both the probiotic supplemented groups showed a significantly higher weight gain than the unsupplemented group. Among the probiotic fed groups the group supplemented with higher concentration gained more ($P<0.01$) weight than the lower level fed group.

The influence of supplementation of probiotic in White Pekin ducks with respect to mean fortnightly body weight gain is shown in Fig.2.

4.4 FEED CONSUMPTION

The mean daily feed intake/duck/day during the eight weeks experimental period among different treatment groups are given in Table 7 and Fig.3.

The mean daily feed intake/duck/day during the first week among the three treatment groups T_1, T_2 and T_3 were 15.29, 15.50 and 15.64 g respectively.

Table 7. Influence of dietary supplementation of probiotic on mean daily feed consumption in White Pekin ducks, g

Treatments		Age in weeks							
		1	2	3	4	5	6	7	8
T_1	R_1	15.30	30.20	85.92	166.83	200.05	205.78	190.49	191.05
	R_2	15.69	29.38	89.50	167.00	202.60	206.30	193.78	194.90
	R_3	15.01	26.25	88.00	170.30	201.35	204.25	190.70	190.20
	R_4	15.14	26.10	89.10	171.50	202.90	200.50	197.30	194.61
Mean ± SE		15.29±0.15	27.98±1.06	88.13±0.80 [b]	168.91±1.18 [b]	201.73±0.65 [b]	204.21±1.31	193.07±1.60	192.69±1.21
T_2	R_1	15.28	30.09	86.68	166.52	201.75	206.80	198.65	199.90
	R_2	15.76	29.37	89.30	168.80	204.33	205.42	192.30	196.34
	R_3	15.02	26.00	90.90	171.03	202.80	203.20	193.19	195.37
	R_4	15.95	30.20	87.00	166.70	200.10	202.00	195.43	197.80
Mean ± SE		15.50±0.21	28.92±0.99	88.47±0.99 [b]	168.26±1.06 [b]	202.25±0.89 [b]	204.36±1.08	194.89±1.42	197.35±1.80
T_3	R_1	15.98	30.87	90.00	171.20	204.63	205.20	194.50	196.60
	R_2	15.46	30.34	91.90	171.85	208.01	209.40	190.01	191.20
	R_3	15.21	26.08	92.56	173.89	205.00	206.15	198.60	199.50
	R_4	15.90	30.76	94.98	174.50	208.30	209.85	194.00	195.30
Mean ± SE		15.64±0.18	29.51±1.15	92.36±1.03 [a]	172.86±0.79 [a]	206.49±0.97 [a]	207.65±1.16	194.28±1.76	195.65±1.72

Means bearing the different superscripts within the same column differ significantly ($P<0.05$)

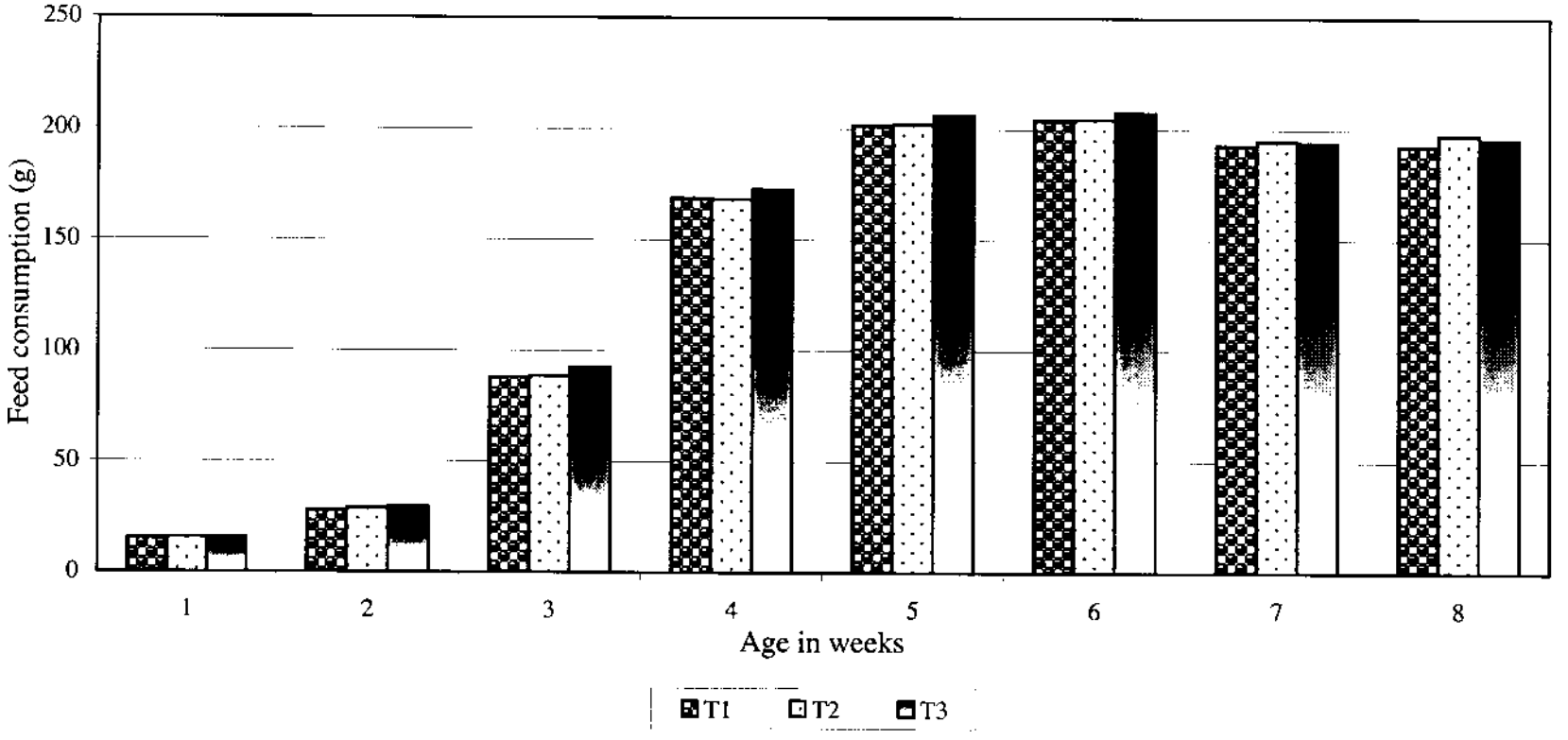

Fig. 3. Influence of dietary supplementation of probiotic on mean daily feed consumption in White Pekin ducks

Significant difference was not observed with respect to mean daily feed intake during the first week.

The mean daily feed consumption during the second week was 27.98, 28.92 and 29.51 g for the treatments T_1, T_2 and T_3 respectively. Though there was a numerical increase in feed consumption for the probiotic supplemented groups, the difference was not significant.

The data on the mean daily feed intake per duck during the third week (Table 7) indicated that the ducks supplemented with 0.05 per cent probiotic in the ration consumed more feed (92.36 g) than the control (88.13 g) and the group offered 0.025 per cent probiotic (88.47 g). Statistical analysis of the data also confirmed this trend. Probiotic supplementation at 0.05 per cent level significantly increased ($P<0.05$) daily feed intake than unsupplemented group as well as the group supplemented with probiotic at 0.025 per cent level.

The fourth week mean daily feed consumption/duck/day for the three dietary treatments T_1, T_2 and T_3 was 168.91, 168.26 and 172.86 g respectively. The 0.05 per cent probiotic supplemented group showed significantly higher ($P<0.05$) feed intake than 0.025 per cent probiotic supplemented group and the control.

At fifth week, the feed consumption was 201.73, 202.25 and 206.49 g per duck/day for the treatments T_1, T_2 and T_3 respectively. The pattern of feed intake during this period by ducks under different treatments revealed that it was significantly higher ($P<0.05$) for 0.05 per cent probiotic supplemented group than T_2 and control.

The mean daily feed consumption at sixth week of age was 204.21, 204.36 and 207.65 g for the treatments T_1, T_2 and T_3 respectively. Statistical analysis revealed that the mean values did not differ significantly.

At seventh week of age, the mean daily feed intake among the various treatments, T_1, T_2 and T_3 were 193.07, 194.89 and 194.28 g respectively. When

the data was analysed statistically it was revealed that probiotic supplementation did not have significant effect on feed consumption during this period.

At eighth week, mean daily feed intake per bird was 192.69, 197.35 and 195.65 g for the dietary treatments T_1, T_2 and T_3 respectively. Statistical interpretation inferred no significant difference between the treatments.

The cumulative feed intake of ducks upto six weeks of age as influenced by probiotic supplementation is presented in Table 9. The cumulative feed intake upto sixth week was 4943.66, 4954.25 and 5071.54 g for the treatments T_1, T_2 and T_3 respectively. Statistical analysis revealed that 0.05 per cent probiotic supplemented group consumed significantly more feed ($P<0.01$) than 0.025 per cent probiotic supplemented group as well as the control.

The cumulative feed intake upto eighth week was 7643.97, 7699.97 and 7801.03 g for the treatments T_1, T_2 and T_3 respectively. The statistical analysis showed that 0.05 per cent probiotic supplemented group had significantly higher ($P<0.01$) feed intake than 0.025 per cent probiotic supplemented group and the control.

The mean feed consumption of ducks for the different treatment groups is pictured in Fig.3.

4.5 FEED CONVERSION RATIO

The data on fortnightly mean feed conversion ratio (FCR) among different treatment groups are given in Table 8 and Fig.4.

The mean feed conversion ratio among the treatments T_1, T_2 and T_3 was 2.28, 2.22 and 2.22 respectively during the first fortnight. Statistical analysis showed no significant difference between treatments.

During the second fortnight covering third and fourth weeks, the various treatments T_1, T_2 and T_3 recorded a mean feed conversion ratio of 2.60, 2.54 and 2.50 respectively. Though addition of probiotic in the diet improved the feed

Table 8. Influence of dietary supplementation of probiotic on fortnightly mean feed conversion ratio in White Pekin ducks

Treatment		Age in weeks			
		2	4	6	8
T_1	R_1	2.22	2.68	2.81	4.53
	R_2	2.33	2.63	2.85	4.51
	R_3	2.23	2.51	2.83	4.73
	R_4	2.35	2.56	2.90	4.33
Mean ± SE		2.28 ± 0.03	2.60 ± 0.04	2.85 ± 0.02 [b]	4.53 ± 0.08
T_2	R_1	2.25	2.52	2.94	4.42
	R_2	2.30	2.60	2.81	4.20
	R_3	2.22	2.52	2.86	4.18
	R_4	2.10	2.52	2.91	4.07
Mean ± SE		2.22 ± 0.04	2.54 ± 0.02	2.88 ± 0.03 [b]	4.22 ± 0.07
T_3	R_1	2.04	2.54	2.73	4.25
	R_2	2.24	2.54	2.60	4.44
	R_3	2.37	2.47	2.79	3.93
	R_4	2.22	2.46	2.71	4.33
Mean ± SE		2.22 ± 0.07	2.50 ± 0.02	2.71 ± 0.04 [a]	4.24 ± 0.11

Means bearing the different superscripts within the same column differ significantly ($P<0.05$)

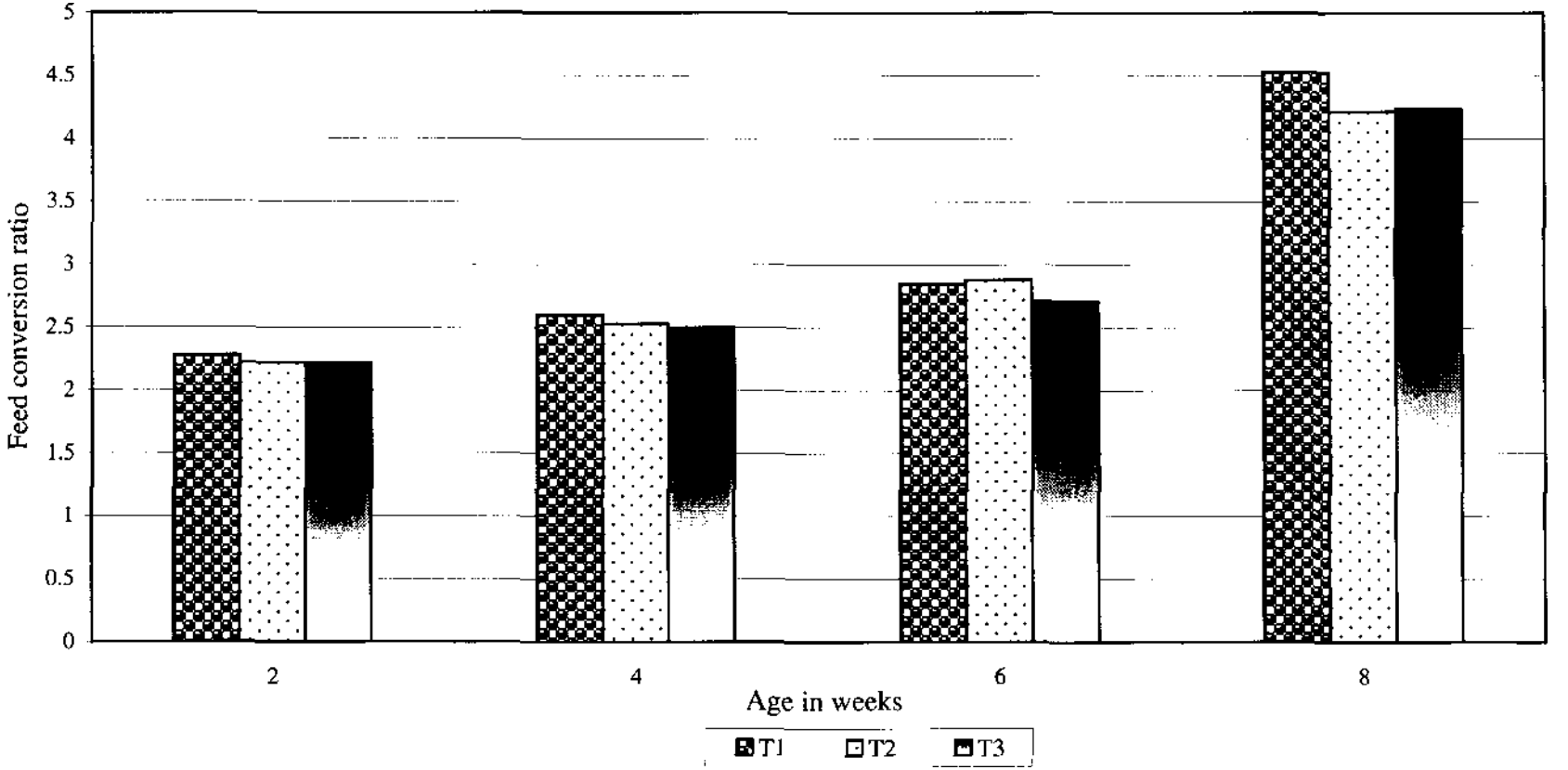

Fig. 4. Influence of dietary supplementation of probiotic on fortnightly mean feed conversion ratio in White Pekin ducks

Table 9. Influence of dietary supplementation of probiotic on production performance at six and eight weeks of age in White Pekin ducks

Treatments		Upto six weeks			Upto eight weeks		
		Body weight gain (g)	Total feed consumption (g)	Cumulative FCR	Body weight gain (g)	Total feed consumption (g)	Cumulative FCR
T_1	R_1	1816.62	4928.56	2.71	2405.72	7599.34	3.16
	R_2	1823.17	4973.29	2.73	2427.02	7694.05	3.17
	R_3	1852.79	4936.12	2.66	2415.91	7602.42	3.15
	R_4	1809.92	4936.68	2.78	2442.92	7680.05	3.14
Mean ± SE		1825.63± 9.45 ^{b}	4943.66± 10.05 ^{b}	2.72± 0.02 ^{b}	2422.89± 7.97 ^{c}	7643.97± 25.05 ^{b}	3.16 ± 0.01 ^{b}
T_2	R_1	1819.05	4949.84	2.72	2450.15	7739.69	3.16
	R_2	1855.32	4990.86	2.69	2501.18	7711.34	3.08
	R_3	1850.11	4962.65	2.68	2500.50	7682.57	3.07
	R_4	1825.37	4913.65	2.69	2501.62	7666.26	3.06
Mean ± SE		1837.46± 10.22 ^{b}	4954.25± 16.02 ^{b}	2.70± 0.01 ^{b}	2488.36± 12.74 ^{b}	7699.97± 15.78 ^{b}	3.08 ± 0.03 ^{b}
T_3	R_1	1931.24	5025.16	2.60	2575.04	7762.86	3.01
	R_2	1991.72	5088.72	2.55	2592.28	7757.19	2.99
	R_3	1909.67	5032.23	2.64	2618.03	7818.93	2.99
	R_4	1993.20	5140.03	2.58	2622.07	7865.13	3.00
Mean ± SE		1956.46± 21.25 ^{a}	5071.54± 26.90 ^{a}	2.59± 0.02 ^{a}	2601.86± 11.11 ^{a}	7801.03± 25.51 ^{a}	3.01 ± 0.01 ^{a}

Means bearing the different superscripts within the same column differ significantly ($P<0.01$)

conversion ratio numerically the difference between treatments was not statistically significant.

The mean feed conversion ratio during the third fortnight was 2.85, 2.88 and 2.71 for the various dietary treatments T_1, T_2 and T_3 respectively. On statistical analysis it was found that 0.05 per cent probiotic supplemented group had significantly superior feed conversion ratio ($P<0.05$) than that of 0.025 per cent probiotic supplemented group and the control.

In the fourth fortnight, the treatments T_1, T_2 and T_3 recorded a mean feed conversion ratio of 4.53, 4.22 and 4.24 respectively. Statistical analysis of the data indicated that the feed conversion ratio among the different treatments did not vary significantly.

The cumulative mean feed conversion ratio upto six weeks of age for T_1, T_2 and T_3 were 2.72 2.70 and 2.59 respectively as shown in Table 9. The statistical analysis revealed that there was significantly better ($P<0.01$) FCR in 0.05 per cent probiotic supplemented group than the control and 0.025 per cent probiotic supplemented group.

The cumulative feed conversion ratio upto eighth week for the treatments T_1, T_2 and T_3 were 3.16, 3.08 and 3.01 respectively (Table 9). The statistical analysis of the cumulative feed conversion ratio upto eight weeks revealed that 0.05 per cent probiotic supplemented group recorded significantly superior ($P<0.01$) feed conversion ratio than 0.025 per cent probiotic supplemented group and the control. Generally the control and the lower level of probiotic supplemented group had inferior feed conversion ratio when compared to the 0.05 per cent probiotic supplemented group.

The mean feed conversion ratio for the different dietary treatment groups during the experimental period is depicted in Fig. 4.

4.6 BIOCHEMICAL PARAMETERS

The mean serum cholesterol as influenced by dietary supplementation of probiotic in White Pekin ducks at eight weeks of age is presented in Table 10.

The mean serum cholesterol values for the treatments T_1, T_2 and T_3 were 174.28, 161.26 and 156.27 mg per cent in male ducks. The corresponding values for female ducks were 164.56, 153.91 and 140.48 mg per cent respectively. In general the female ducks and the probiotic supplemented groups had numerically lower cholesterol levels at eight weeks of age. However the different treatment groups could not show any statistical variations among themselves.

The mean serum cholesterol levels as influenced by dietary supplementation of probiotic are shown in Fig. 5.

The mean serum protein levels as influenced by dietary supplementation of probiotic in White Pekin ducks at eight weeks of age are is presented in Table 11.

The mean serum protein for the treatments T_1, T_2 and T_3 were 3.27, 3.83 and 4.03 g/dl in respect of male ducks and 3.53, 3.94 and 4.29 g/dl in case of female ducks at the end of eighth week.

Statistical analysis of the mean serum protein levels showed that probiotic supplementation had significant influence on serum protein values in both male and female ducks. The 0.05 per cent probiotic supplemented group of ducks recorded significantly higher serum protein levels ($P<0.01$) compared to those supplemented with 0.025 per cent probiotic and the control. Sex had no significant influence on mean serum protein levels.

The mean serum protein levels as influenced by dietary supplementation of probiotic are shown in Fig. 6.

Table 10. Influence of dietary supplementation of probiotic on mean serum cholesterol in White Pekin ducks, mg per cent

Treatment	Serum cholesterol mg per cent	
	Male	Female
T_1R_1	168.35	167.65
R_2	189.21	165.47
R_3	164.75	173.67
R_4	174.82	151.44
Mean ± SE	174.28 ± 5.40	164.56 ± 4.70
T_2R_1	153.36	146.62
R_2	165.11	155.74
R_3	150.85	162.56
R_4	175.72	150.72
Mean ± SE	161.26 ± 5.74	153.91 ± 3.43
T_3R_1	168.35	104.82
R_2	165.47	140.32
R_3	158.90	154.68
R_4	132.37	162.09
Mean ± SE	156.27 ± 8.21	140.48 ± 12.72

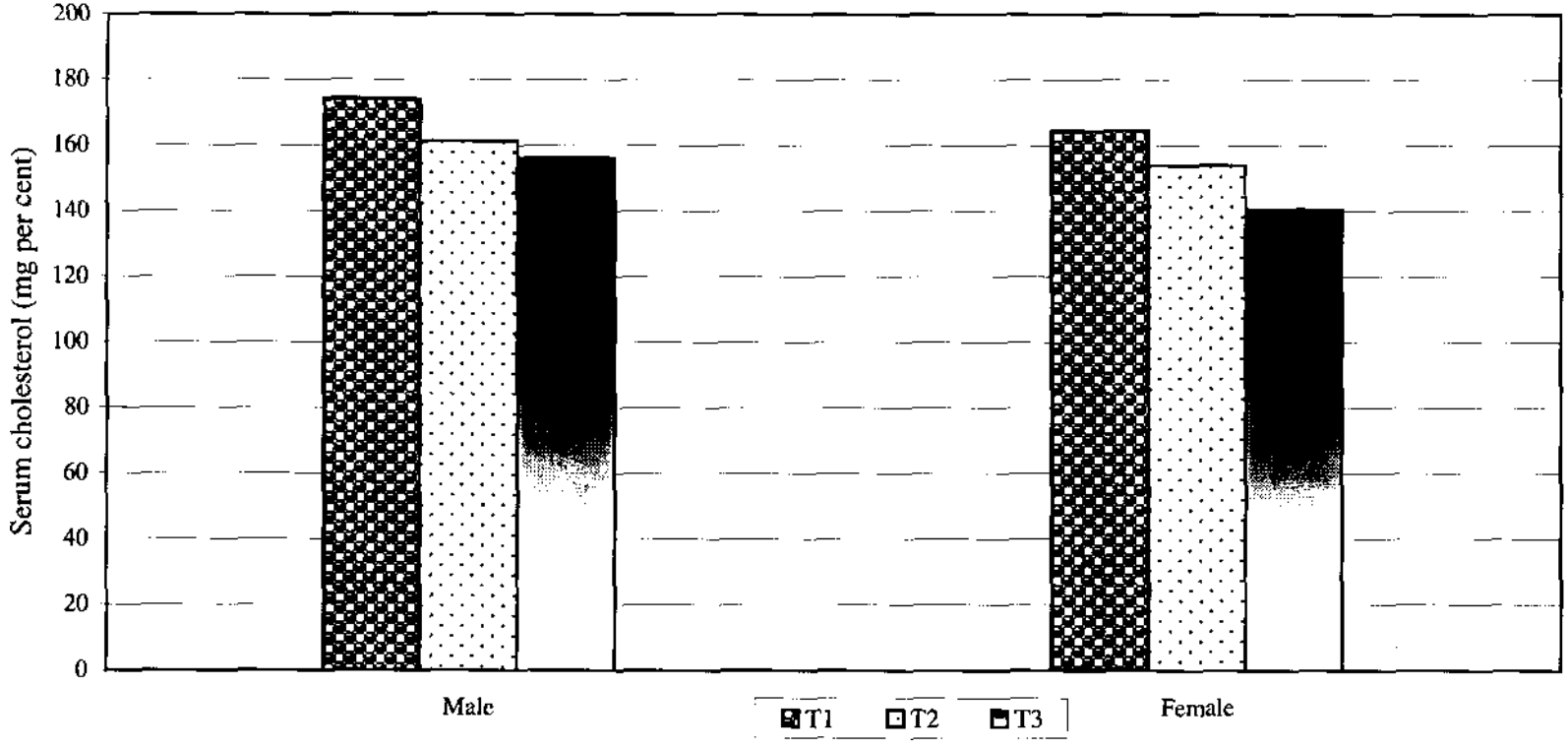

Fig. 5. Influence of dietary supplementation of probiotic on mean serum cholesterol in White Pekin ducks

Table 11. Influence of dietary supplementation of probiotic on mean serum protein in White Pekin ducks, g/dl

Treatment	Serum protein, g/dl	
	Male	Female
T_1R_1	2.92	3.69
R_2	3.63	3.61
R_3	3.32	3.72
R_4	3.21	3.11
Mean ± SE	3.27 ± 0.15^{b}	3.53 ± 0.14^{b}
T_2R_1	4.01	3.79
R_2	3.88	4.31
R_3	3.65	4.11
R_4	3.79	3.56
Mean ± SE	3.83 ± 0.08^{b}	3.94 ± 0.17^{b}
T_3R_1	4.03	4.90
R_2	3.90	4.37
R_3	3.78	3.88
R_4	4.41	4.01
Mean ± SE	4.03 ± 0.14^{a}	4.29 ± 0.23^{a}

Means bearing the different superscript within the same column differ significantly ($P<0.01$)

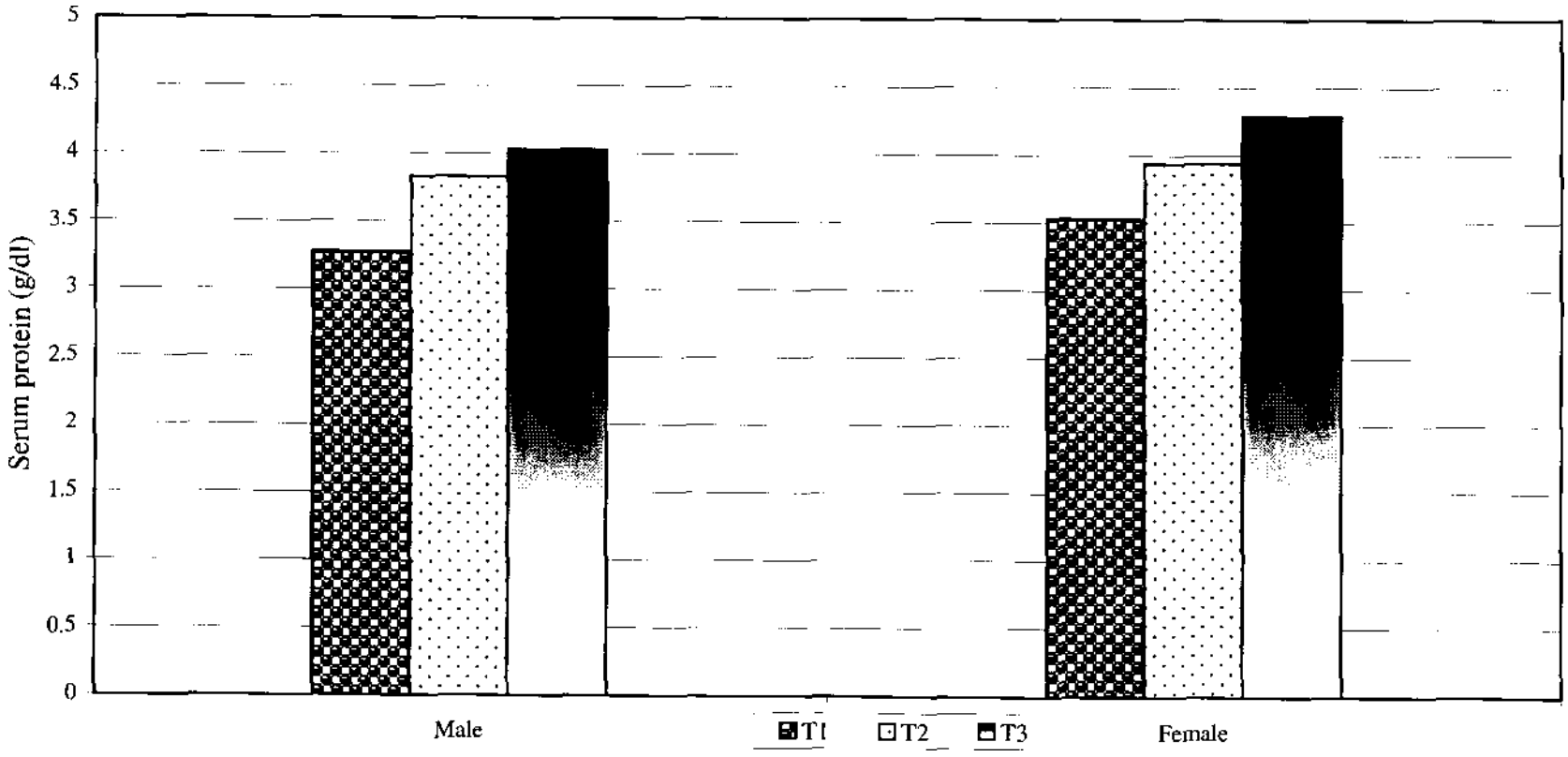

Fig. 6. Influence of dietary supplementation of probiotic on mean serum protein in White Pekin ducks

4.7 PROCESSING YIELDS

The data on ready-to-cook yield as influenced by probiotic supplementation in ducks are given in Table 12 and Fig.7. The mean per cent ready-to-cook yield for the various dietary treatments T_1, T_2 and T_3 were 64.78, 62.77 and 60.60 in males and 60.71, 63.85 and 65.73 in female ducks. The ready-to-cook yields did not show any significant difference among different treatment groups and between sexes, suggesting that growth promoter used in the trial had little influence on the yields of the carcass.

The data on the mean per cent abdominal fat as influenced by dietary supplementation of probiotics is presented in Table 13 and Fig.8. The abdominal fat deposition in the various treatments T_1, T_2 and T_3 were 0.72, 0.77 and 0.90 per cent in male ducks and 0.65, 0.88 and 0.98 per cent in female ducks respectively. The statistical analysis revealed no significant difference between treatments or sex on per cent abdominal fat at eight weeks of age in ducks.

The mean giblet percentage as influenced by the supplementation of probiotics at various levels is shown in Table 14 and Fig.9. The mean giblet percentage was 5.24, 5.76 and 5.50 in male ducks and 5.04, 4.93 and 5.88 in female ducks for the treatments T_1, T_2 and T_3, respectively. Similar to ready-to-cook yield and abdominal fat the giblet yield also did not differ significantly among different groups.

The data on per cent liver, heart and gizzard as influenced by probiotic supplementation are presented in Table 15 and Fig.10. The mean percentage weight of liver was 2.10, 2.42 and 2.50 in male ducks and 2.18, 2.06 and 2.49 in female ducks respectively for the treatments T_1, T_2 and T_3. The mean percentage of heart was 0.57, 0.56 and 0.63 in male ducks and 0.57, 0.60 and 0.66 in female ducks respectively for the treatments T_1, T_2 and T_3. The various dietary treatments T_1, T_2 and T_3 recorded the mean percentage weight of gizzard as 2.58, 2.79 and 2.48 in males and 2.30, 2.27 and 2.59 in females, respectively.

Table 12. Influence of dietary supplementation of probiotic on ready-to-cook yield in White Pekin ducks, per cent

Treatment	Ready-to-cook yield, per cent	
	Male	Female
T_1R_1	67.63	54.64
R_2	64.89	63.70
R_3	62.88	61.76
R_4	63.71	62.75
Mean ± SE	64.78 ± 1.04	60.71 ± 2.06
T_2R_1	65.07	63.41
R_2	59.51	63.27
R_3	63.40	64.78
R_4	63.08	63.95
Mean ± SE	62.77 ± 1.17	63.85 ± 0.34
T_3R_1	62.99	62.03
R_2	62.55	60.77
R_3	60.83	66.43
R_4	56.03	73.68
Mean ± SE	60.60 ± 1.59	65.73 ± 2.92

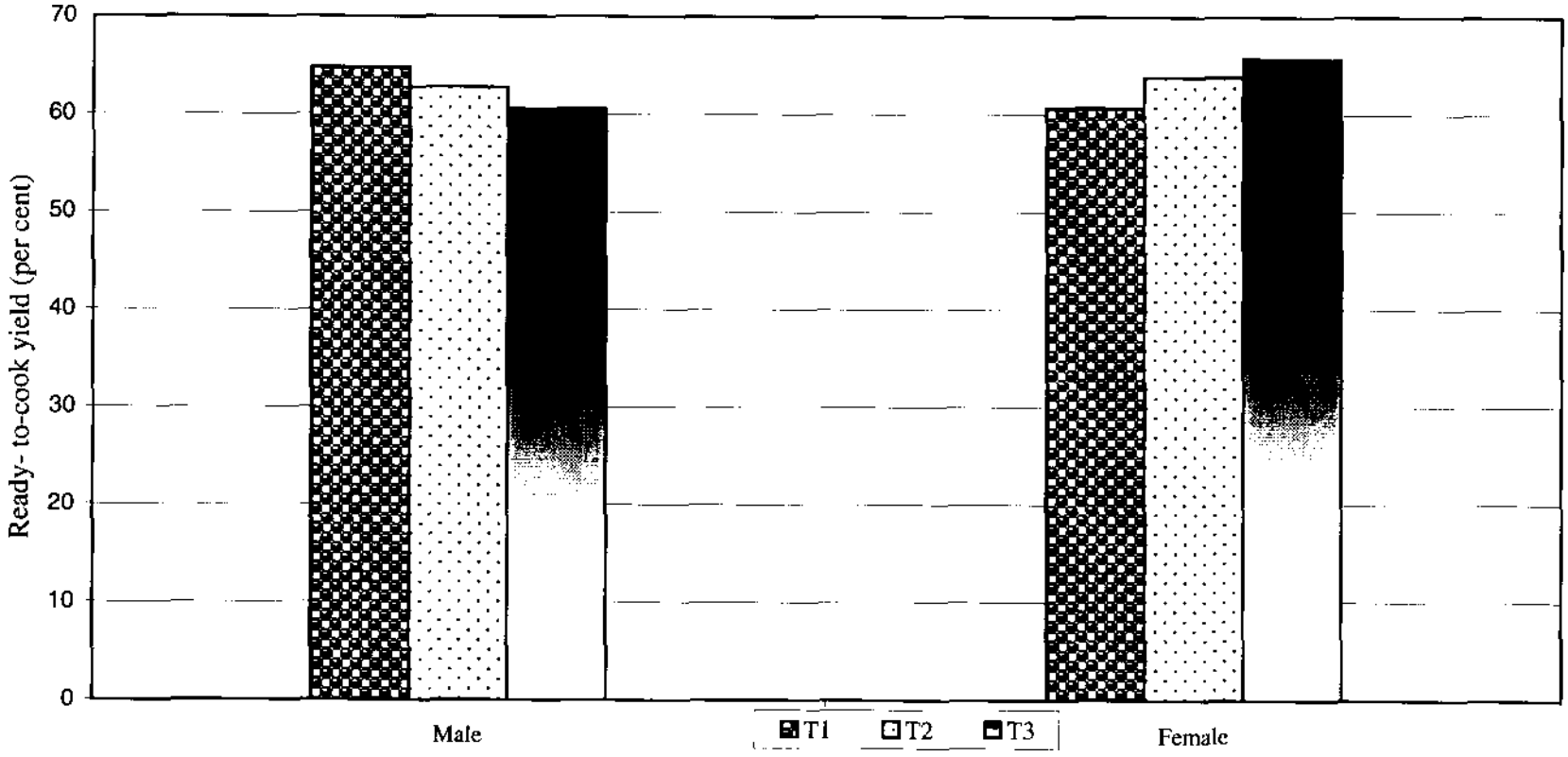

Fig. 7. Influence of dietary supplementation of probiotic on ready-to-cook yield in White Pekin ducks

Table 13. Influence of dietary supplementation of probiotic on abdominal fat in White Pekin ducks, per cent

Treatment	Abdominal fat, per cent	
	Male	Female
T_1R_1	0.43	0.81
R_2	0.98	0.64
R_3	0.86	0.55
R_4	0.61	0.58
Mean ± SE	0.72 ± 0.12	0.65 ± 0.06
T_2R_1	0.76	1.25
R_2	0.66	0.78
R_3	0.61	0.72
R_4	1.05	0.75
Mean ± SE	0.77 ± 0.10	0.88 ± 0.13
T_3R_1	1.20	0.68
R_2	0.74	0.80
R_3	0.64	0.82
R_4	1.01	1.62
Mean ± SE	0.90 ± 0.13	0.98 ± 0.22

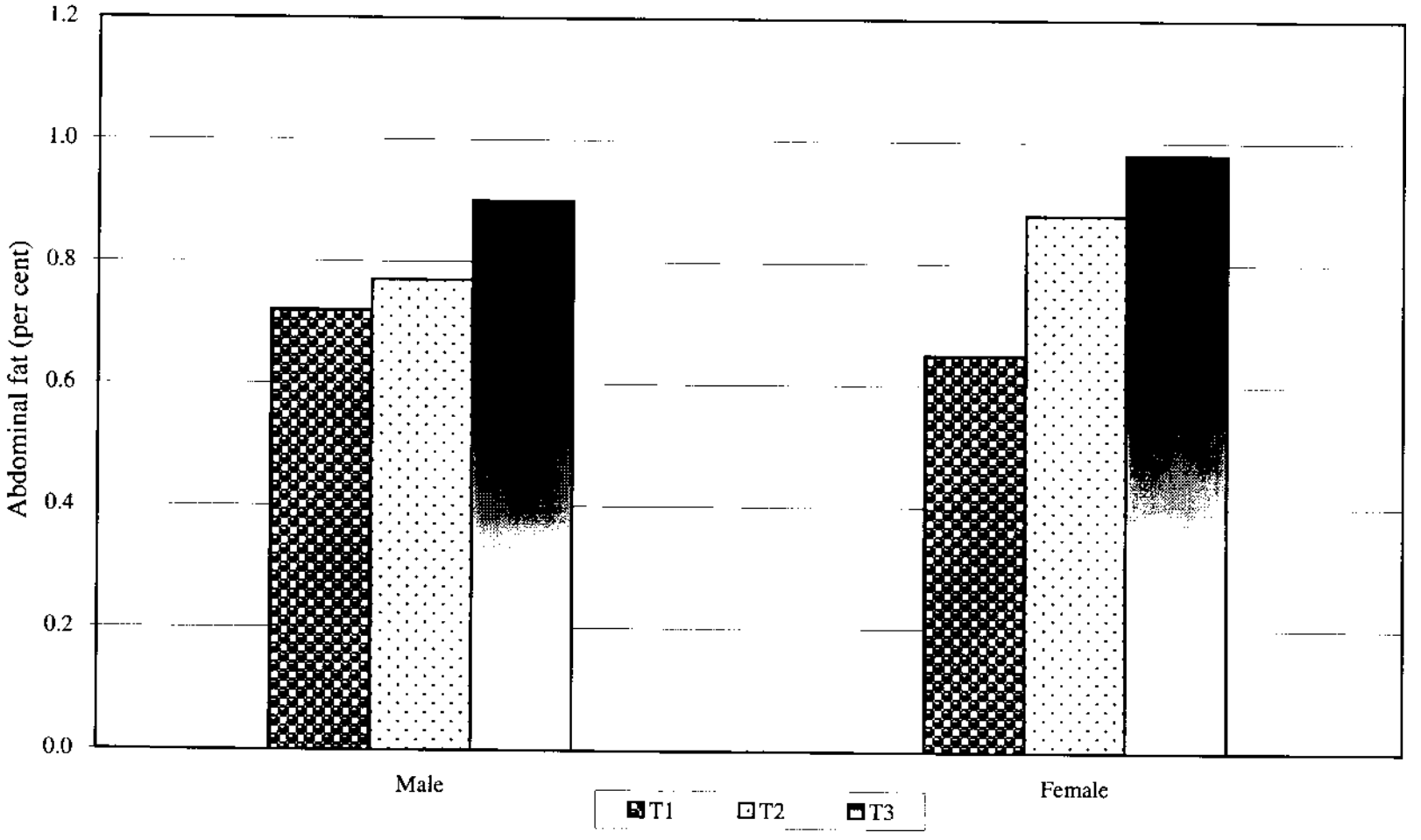

Fig. 8. Influence of dietary supplementation of probiotic on abdominal fat in White Pekin ducks

Table 14. Influence of dietary supplementation of probiotic on giblet yield in White Pekin ducks, per cent

Treatment	Giblet yield, per cent	
	Male	Female
T_1R_1	5.66	4.42
R_2	5.36	5.30
R_3	4.33	5.30
R_4	5.61	5.13
Mean ± SE	5.24 ± 0.31	5.04 ± 0.21
T_2R_1	5.79	4.84
R_2	5.66	5.13
R_3	6.45	5.22
R_4	5.15	4.51
Mean ± SE	5.76 ± 0.27	4.93 ± 0.16
T_3R_1	4.95	6.21
R_2	5.01	6.02
R_3	6.83	5.53
R_4	5.21	5.75
Mean ± SE	5.50 ± 0.45	5.88 ± 0.15

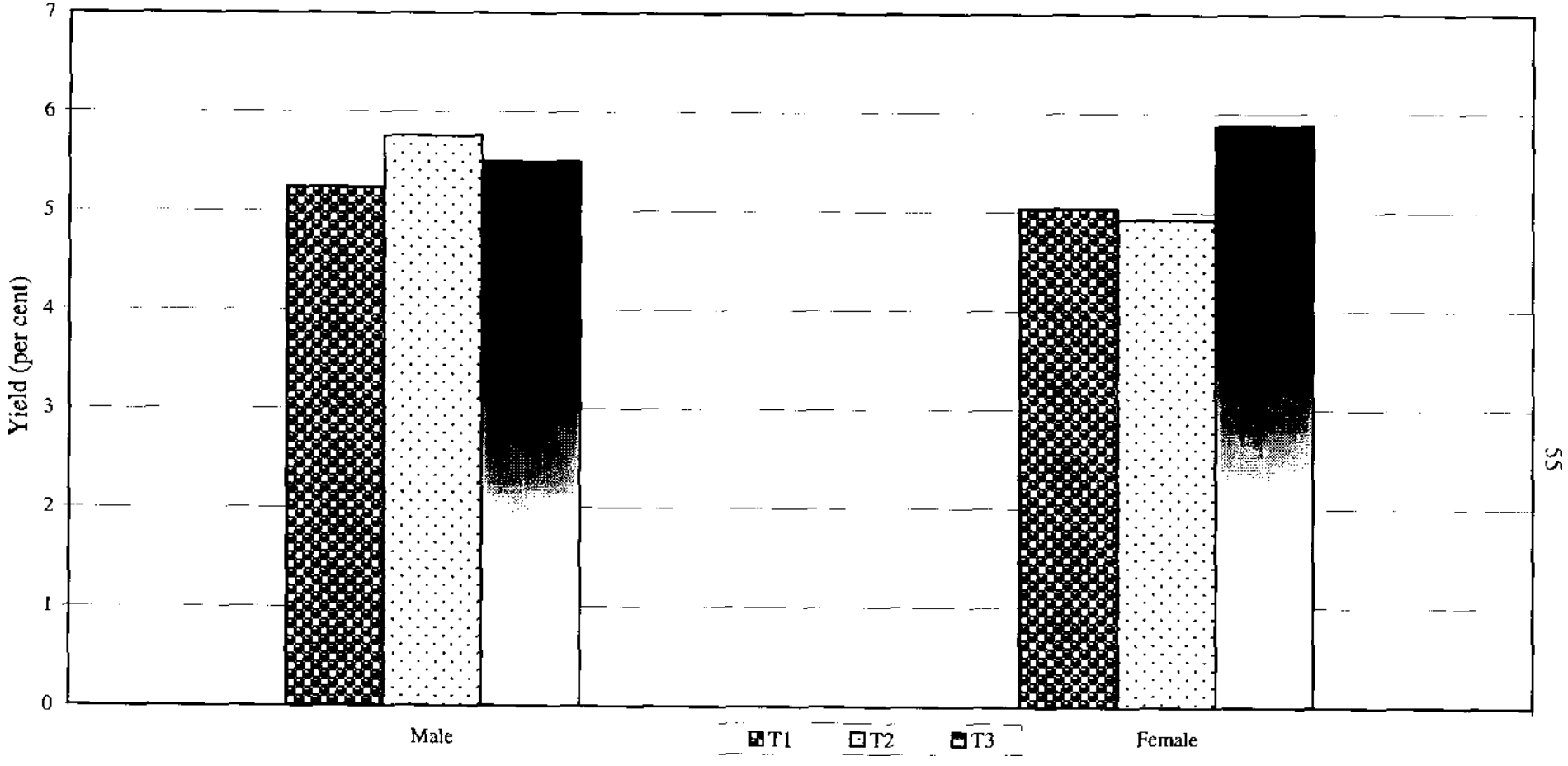

Fig. 9. Influence of dietary supplementation of probiotic on giblet yield in White Pekin ducks

Table 15. Influence of dietary supplementation of probiotic on liver, heart and gizzard in White Pekin ducks, per cent

Treatment	Male			Female		
	Liver	Heart	Gizzard	Liver	Heart	Gizzard
T_1R_1	2.43	0.60	2.63	1.94	0.56	1.92
R_2	2.07	0.57	2.74	2.23	0.58	2.49
R_3	1.72	0.48	2.13	2.32	0.58	2.41
R_4	2.17	0.62	2.82	2.23	0.54	2.37
Mean ± SE	2.10 ± 0.15	0.57 ± 0.03	2.58 ± 0.15	2.18 ± 0.08	0.57 ± 0.009	2.30 ± 0.13
T_2R_1	2.25	0.60	2.94	2.06	0.61	2.17
R_2	2.25	0.57	2.84	2.02	0.48	2.62
R_3	3.10	0.59	2.76	2.38	0.70	2.15
R_4	2.07	0.48	2.60	1.76	0.62	2.13
Mean ± SE	2.42 ± 0.23	0.56 ± 0.03	2.79 ± 0.07	2.06 ± 1.02	0.60 ± 0.05	2.27 ± 0.12
T_3R_1	2.44	0.70	2.23	2.38	0.62	2.73
R_2	2.49	0.57	2.63	2.42	0.74	2.13
R_3	2.92	0.70	2.76	2.67	0.67	2.58
R_4	2.14	0.56	2.28	2.49	0.61	2.91
Mean ± SE	2.50 ± 0.16	0.63 ± 0.04	2.48 ± 0.13	2.49 ± 0.06	0.66 ± 0.03	2.59 ± 0.17

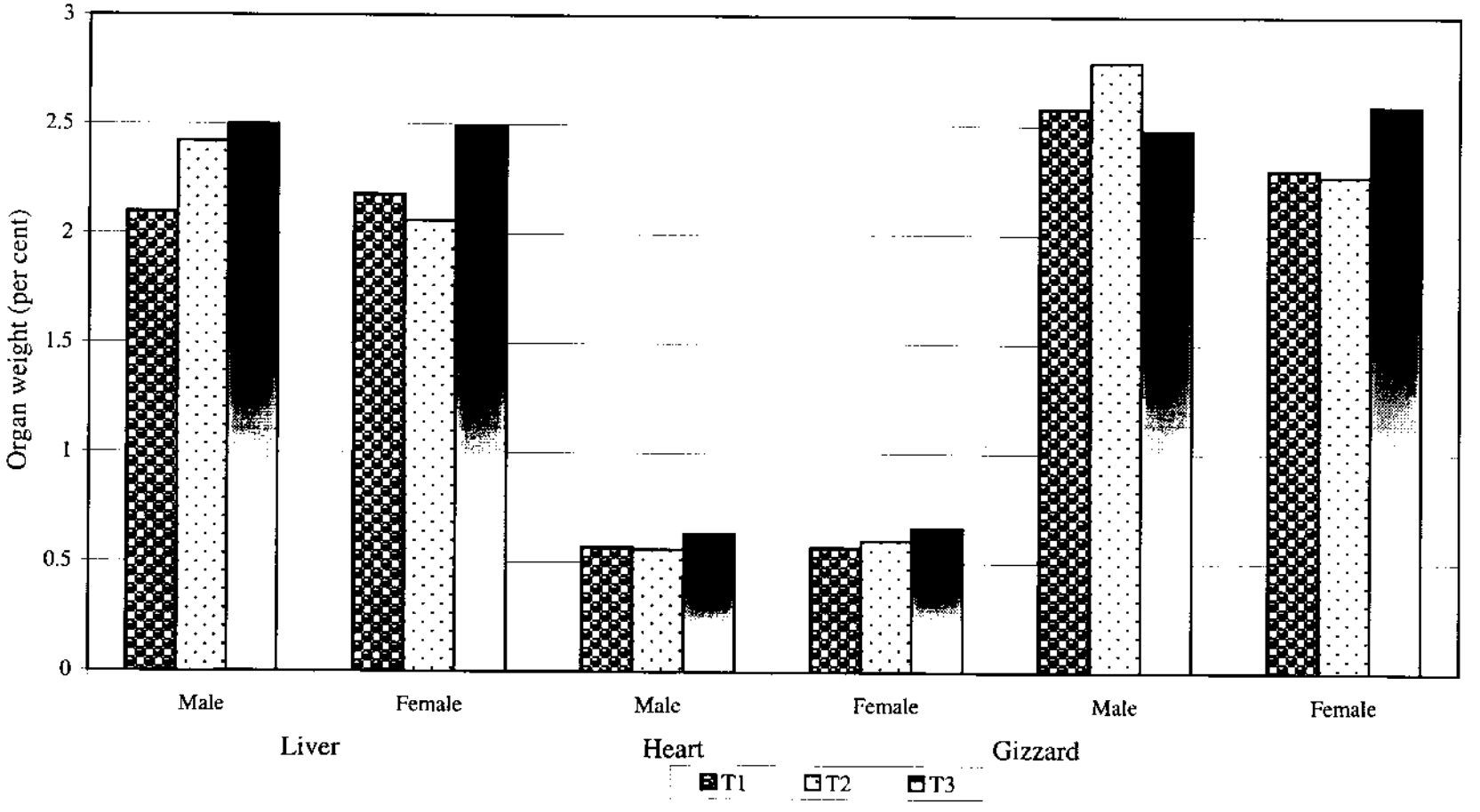

Fig. 10. Influence of dietary supplementation of probiotic on liver,heart and gizzard in White Pekin ducks

On statistical analysis it was found that weight of liver, heart and gizzard were not significantly different among treatment groups and sexes.

The percentage of ready-to-cook yield is depicted in Fig.7 and the percentage of abdominal fat and giblet percentage in Fig. 8 and Fig.9, respectively. The organ weight of liver, heart and gizzard are presented in Fig.10.

The mean per cent yield of cut-up parts in White Pekin ducks (average of both sexes) as influenced by probiotic supplementation is presented in Table 16.

The per cent yield of cut-up parts viz., neck, wings, thigh, drumsticks, breast and back for the different treatments were 8.46, 14.14, 13.91, 13.19, 26.09 and 23.86 for T_1 (control); 8.84,14.58, 13.86, 13.83, 24.87 and 23.76 for T_2 and 8.22, 14.58, 12.72, 13.06, 26.66 and 24.05 for T_3 respectively. No significance was observed between treatment groups for the various cut-up parts.

The mean component yield in per cent of various cut-up parts of White Pekin ducks at eight weeks of age are shown in Table 17.

The mean per cent of skin, meat and bone for the treatments T_1, T_2 and T_3 were 13.81, 13.85 and 13.56; 55.96, 55.58 and 55.99; and 30.17, 30.29 and 30.46 for the treatments T_1, T_2 and T_3 respectively.

The meat:bone ratio and meat+skin:bone ratio of the various dietary treatments is presented in Table 18.

The meat:bone ratio was 2.29, 2.27 and 2.24 for the dietary treatments T_1, T_2 and T_3 respectively. On the other hand, the meat+skin:bone ratio for the dietary treatments T_1, T_2 and T_3 were 2.79, 2.76 and 2.72, respectively. Upon statistical analysis, the mean ratios of edible to inedible components did not show any significant difference between treatments.

The mean ratios of meat:bone and that of meat + skin:bone are presented in Fig.11 and Fig.12, respectively.

Table 16. Influence of dietary supplementation of probiotic on percentage yield of cut-up parts at eight weeks of age in White Pekin ducks

PART	T_1	T_2	T_3
Neck	8.46 ± 0.14	8.84 ± 0.11	8.22 ± 0.34
Wings	14.14 ± 0.45	14.58 ± 0.47	14.58 ± 0.51
Thigh	13.91 ± 0.39	13.86 ± 0.62	12.72 ± 0.38
Drumsticks	13.19 ± 0.30	13.83 ± 0.55	13.06 ± 0.28
Breast	26.09 ± 0.62	24.87 ± 0.43	26.66 ± 0.71
Back	23.86 ± 0.53	23.76 ± 0.57	24.05 ± 0.56

Table 17. Influence of dietary supplementation of probiotic on mean component yield of various cut-up parts of White Pekin ducks at eight weeks of age, per cent

Part	Skin			Muscle			Bone		
	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
Neck	21.93 ± 0.65	23.35 ± 0.69	22.47 ± 0.62	41.82 ± 0.76	40.49 ± 0.81	40.82 ± 0.64	36.09 ± 0.15	36.17 ± 0.18	36.71 ± 0.52
Wings	14.66 ± 0.57	15.22 ± 0.38	14.27 ± 0.83	44.48 ± 0.47	43.97 ± 0.52	44.99 ± 0.60	40.86 ± 0.36	40.81 ± 0.23	40.75 ± 0.38
Thigh	10.12 ± 0.50	10.28 ± 0.19	9.75 ± 0.15	74.09 ± 0.36	73.45 ± 0.40	73.59 ± 0.51	15.80 ± 0.24	16.28 ± 0.43	16.66 ± 0.51
Drumsticks	11.70 ± 0.25	11.01 ± 1.11	11.91 ± 0.87	63.13 ± 0.62	64.81 ± 0.79	64.11 ± 0.77	25.17 ± 0.69	24.18 ± 0.92	23.98 ± 0.31
Breast	13.54 ± 0.33	12.49 ± 0.36	12.36 ± 0.70	65.93 ± 0.46	66.17 ± 0.29	65.88 ± 0.34	20.54 ± 0.19	21.26 ± 0.32	21.76 ± 0.41
Back	10.91 ± 0.29	10.76 ± 0.74	10.59 ± 0.45	46.28 ± 0.43	46.19 ± 0.32	46.52 ± 0.33	42.56 ± 0.46	43.05 ± 0.49	42.89 ± 0.71
Overall	13.81 ± 2.16	13.85 ± 2.49	13.56 ± 2.32	55.96 ± 6.73	55.58 ± 6.95	55.99 ± 6.76	30.17 ± 5.60	30.29 ± 5.58	30.46 ± 5.51

Table 18. Influence of dietary supplementation of probiotic on meat:bone and meat + skin:bone ratio in White Pekin ducks at eight weeks of age

Part	Meat:Bone			Meat + Skin:Bone		
	T_1	T_2	T_3	T_1	T_2	T_3
Neck	1.15 ± 0.03	1.12 ± 0.03	1.11 ± 0.03	1.76 ± 0.02	1.77 ± 0.01	1.73 ± 0.04
Wings	1.09 ± 0.02	1.08 ± 0.02	1.10 ± 0.01	1.45 ± 0.02	1.45 ± 0.02	1.46 ± 0.02
Thigh	4.69 ± 0.07	4.53 ± 0.14	4.43 ± 0.16	5.33 ± 0.10	5.13 ± 0.18	5.02 ± 0.18
Drumsticks	2.52 ± 0.10	2.69 ± 0.11	2.67 ± 0.04	2.99 ± 0.12	3.15 ± 0.15	3.17 ± 0.06
Breast	3.21 ± 0.05	3.11 ± 0.05	3.03 ± 0.05	3.87 ± 0.05	3.70 ± 0.07	3.60 ± 0.09
Back	1.09 ± 0.02	1.07 ± 0.01	1.09 ± 0.02	1.35 ± 0.03	1.33 ± 0.03	1.33 ± 0.04
Overall	2.29	2.27	2.24	2.79	2.76	2.72

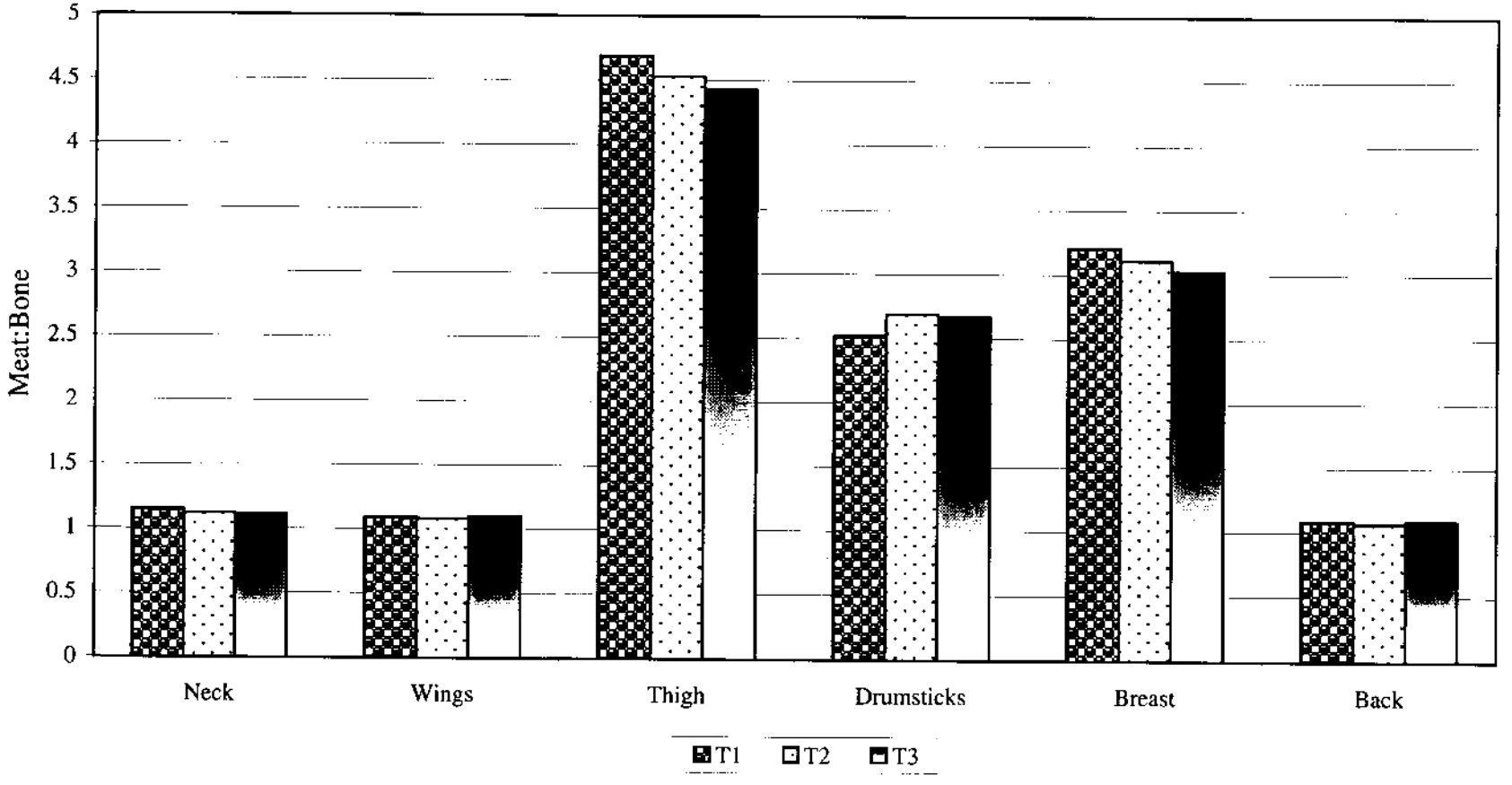

Fig. 11. Inflence of dietaty supplementation of probiotic on meat:bone ratio in White Pekin ducks at eight weeks of age

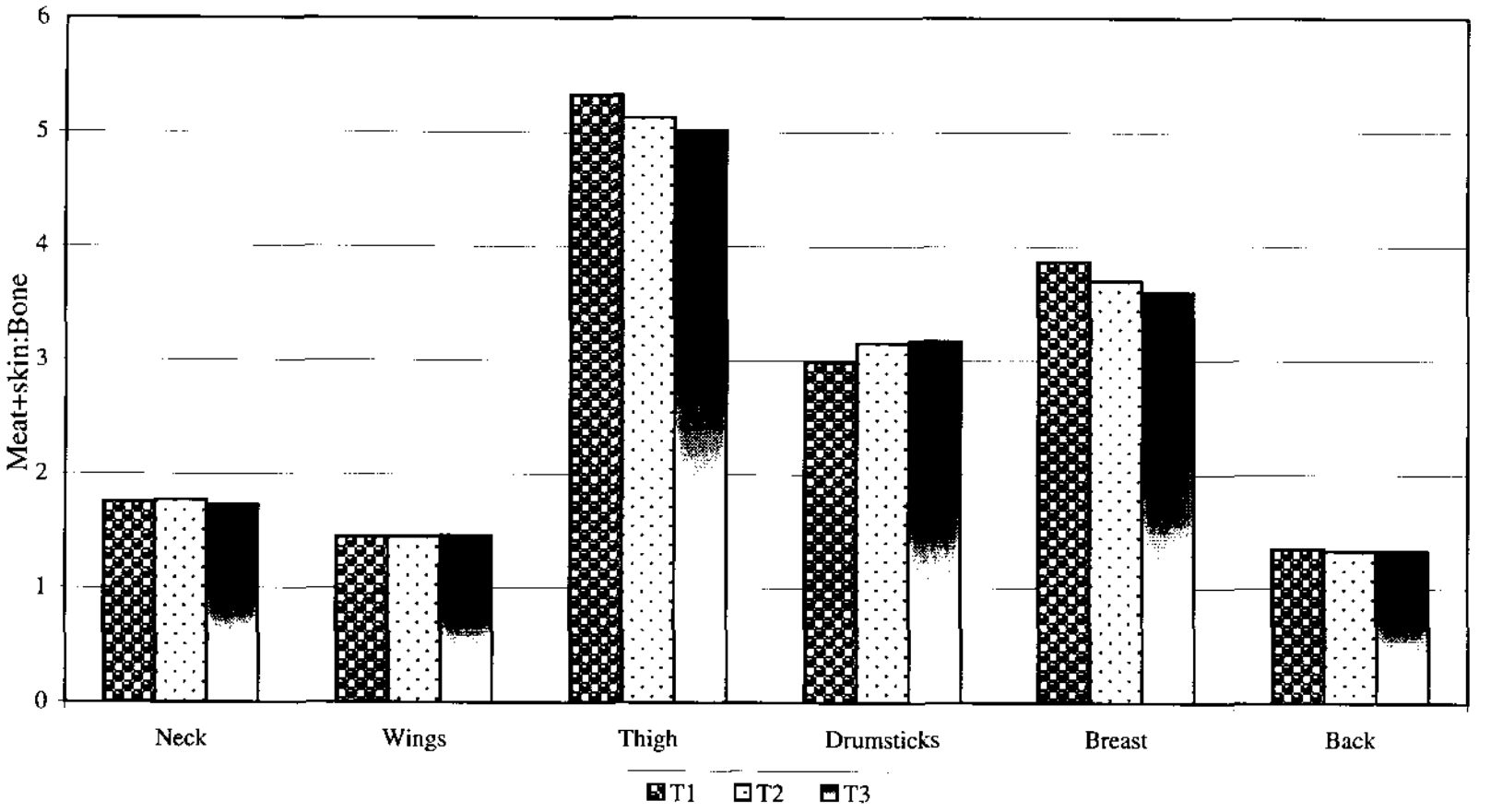

Fig. 12. Influence of dietary supplementation of probiotic on meat+skin:bone ratio in White Pekin ducks at eight weeks of age

4.8 LIVABILITY

Mortality pattern of ducks among the different treatments during the experimental period is shown in Table 19. Altogether seven ducks died during the entire experimental period and it was well within the standards prescribed for broiler house mortality. Four ducks died in the 0.05 per cent probiotic supplemented group, one in 0.025 per cent supplemented group and two in the control group. Post-mortem findings did not contribute any reason for the treatment effects.

4.9 ECONOMICS

Cost benefit analysis was carried out to assess the benefits of supplementation of probiotics in White Pekin ducks. The cost of the ration was calculated based on the actual price of feed ingredients, which prevailed in the University Poultry Farm, Mannuthy, at the time of the experiment. Cost of the rations was computed separately for starter and finisher diets for the treatments T_1, T_2 and T_3. The feed cost was Rs. 10.06, 10.11 and 10.15 per kg for starter feed and 9.19, 9.24 and 9.28 for finisher feed for the treatments T_1, T_2 and T_3 respectively.

The cost benefit analysis per bird for the different treatment groups at the end of six and eight weeks of age are shown in Table 20. The total cost per kg body weight/live weight for the various dietary treatments T_1, T_2 and T_3 was 35.56, 35.66 and 34.23 rupees at six weeks of age and 35.38, 34.84 and 33.96 at eight weeks of age. From the results it can be inferred that 0.05 per cent probiotic supplemented group had lower feed cost per kg body weight than 0.025 per cent supplemented and the control groups.

Table 19. Influence of dietary supplementation of probiotic on mortality in White Pekin ducks

Treatments		Age in weeks				
		3	6	7	8	Total
T_1	R_1	-	-	-	-	-
	R_2	-	-	-	-	-
	R_3	-	-	-	1	1
	R_4	-	-	1	-	1
Total		-	-	-	-	2
T_2	R_1	-	-	-	-	-
	R_2	-	-	-	-	-
	R_3	1	-	-	-	1
	R_4	-	-	-	-	-
Total		-	-	-	-	1
T_3	R_1	-	-	-	1	1
	R_2	-	1	1	-	2
	R_3	-	-	-	-	-
	R_4	-	-	-	1	1
Total		-	-	-	-	4

Table 20. Influence of dietary supplementation of probiotic on cost benefit analysis per duck for the different treatment groups at the end of six and eight weeks of age

Sl. No.	Particulars	Upto Six Weeks			Upto Eight Weeks		
		T_1	T_2	T_3	T_1	T_2	T_3
1.	Live body weight (kg)	1.87	1.88	2.00	2.46	2.53	2.64
2.	Feed consumption (kg)	4.92	4.95	5.07	7.62	7.70	7.83
3.	Feed cost/kg (Rs.)	10.06	10.11	10.15	9.19	9.24	9.28
4.	Total feed cost (Rs.)	49.50	50.04	51.46	70.03	71.15	72.66
5.	Feed cost per kg body weight (Rs.)	26.47	26.62	25.73	28.47	28.12	27.52
6.	Feed + chick cost (Rs.)	64.50	65.04	66.46	85.03	86.15	87.66
7.	Total cost (Rs.) *	66.50	67.04	68.46	87.03	88.15	89.66
8.	Total cost per kg body weight (Rs.)	35.56	35.66	34.23	35.38	34.84	33.96

* Rupees two as miscellaneous cost per duckling

Discussion

5. DISCUSSION

The results obtained from the study to evaluate the effect of probiotic supplementation on the performance of Vigova variety of White Pekin ducks and other related parameters are discussed in this chapter.

5.1 METEOROLOGICAL OBSERVATIONS

The mean weekly meteorological data during the experimental period is presented in Table 4. The overall mean maximum and minimum temperatures recorded inside the experimental house during the study were 32.65° and 25.78° C, respectively. The week wise variation within the maximum temperature recorded during the experimental period was 4.4°C. On the other hand, the magnitude of variation within the minimum temperature recorded during the trial period was only 1.7° C. It indicates that during the period of study there was not much fluctuation in the ambient temperatures.

The weekwise relative humidity (R.H) in the forenoon ranged from 61.3 to 78.3 per cent with an overall mean of 69.3 per cent, while the R.H per cent in the afternoon ranged from 31.7 to 49.3 with an overall mean of 41.14 per cent.

According to Somanathan (1980) the period of study fell under warm and dry season of Kerala. The maximum and minimum temperatures recorded were of 30.2 and 23.9°C with R.H of 79.93 per cent.

5.2 BODY WEIGHT

The fortnightly mean body weight data, as influenced by probiotic supplementation is presented in Table 5, which indicate that 0.05 per cent probiotic supplemented group registered highest body weight in all fortnights when compared to the control and 0.025 per cent supplemented groups. However,

when the magnitude of difference between treatments was tested statistically, it was evident that the body weight in group fed 0.05 per cent probiotic was significantly higher ($P<0.01$) at fourth, sixth and eighth weeks of age.

The difference in mean body weight of day-old ducklings in the different treatment groups was not significant since the ducklings were distributed to different treatments at random. During the second fortnight, the supplementation of probiotic at 0.025 per cent level resulted in an increase in body weight of 8.19 g as against 10.6 g with 0.05 per cent supplemented group in comparison with control group.

The improvement in body weight consequent to probiotic supplementation at 0.025 per cent level in comparison with control group was 22.34, 12.46 and 66.09 g during four, six and eight weeks of age, respectively. This shows that probiotic supplementation at 0.025 per cent level in White Pekin ducks could not make any substantial increase in body weight. Whereas, a significant increase in body weight of 59.12, 131.18 and 179.31 g could be achieved with 0.05 per level supplementation at four, six and eight weeks of age, respectively. In this study there was 6.8 per cent increase at four weeks of age, 7.03 per cent increase at six weeks of age and 7.28 per cent increase in body weight at eight weeks of age with 0.05 per cent probiotic supplementation as compared to the control diet.

When the magnitude of difference in fortnightly mean body weights between treatments was tested statistically, it was evident that the group fed 0.05 per cent probiotic was significantly higher ($P<0.01$) at four, six and eight weeks of age than control and 0.025 per cent probiotic supplemented groups. Though the 0.025 per cent probiotic supplemented group attained numerically higher body weight than the control in all the fortnightly periods, it was statistically comparable.

The commercial use of feed additives in the livestock industry, especially poultry, is relatively important in the recent years. Within the last few years research workers documented the results of incorporating feed additives into poultry diets. The above findings are in agreement with White (1992), Parova *et*

al. (1994), Dadashko and Sirvidis (1996), Cowan and Hastrup (1997), Weis *et al.* (1997), Hruby (2002) in ducks and Punnagai *et al.* (2002) in Japanese quails who reported that additives such as probiotics, yeasts and enzymes have been found to increase body weight.

On the other hand, experiments carried out by Aydin *et al.* (1994) with yeast and Farrell and Martin (1992 and 1998) with enzymes could not observe any significant improvement in growth when they are added to the diet of ducklings.

The probiotics supplementation in the diet may favour colonization with a specific group of beneficial micro organisms and create an environment biased against undesirable organisms and hence could improve the birds performance. The Lactobacillus based probiotic might be responsible for the synthesis of biotin, Vit B_1, B_2, B_{12} and Vit K, which are required for growth and metabolism. Probiotics may also enhance the absorption of amino acids, vitamins and pigments, which result in an improvement in body weight.

The average weight recorded at eighth week of age in the present trial ranged from 2463 g to 2643 g, which was in close association with Broadbent and Bean (1952) who recorded a body weight of 2.7 kg at nine weeks of age.

The NRC (1994) has recorded a body weight of 3.61 kg in males and 3.29 kg in females in White Pekin ducks at eight weeks of age with 2900 ME/kg and 22 per cent crude protein from 0 to 2 weeks of age and 3000 ME/kg and 16 per cent crude protein from 2 to 7 weeks of age. Similarly Leeson *et al.* (1982) had given the body weight as 3279 g in males and 3113 g in females on an average at seven weeks of age. These values are higher than the present experimental values. The wider variations in body weights at seven or eight weeks of age could be attributed to the genetic architecture of the stock from where the ducklings are procured. In the present study, the ducklings were procured from the Central Duck Breeding Farm, Hessarghatta, Bangalore, which is the sole place in the country where systematic selection procedures are adopted in duck breeding. The lower weight in the present study may also be due to lower energy levels adopted during the experimental period.

5.3 BODY WEIGHT GAIN

The fortnightly mean body weight gain data given in Table 6 revealed that there was significant increase in body weight gain with 0.05 per cent probiotic supplemented group during second and third fortnight. In all fortnights the mean body weight gain were comparable between the control and 0.025 per cent probiotic supplemented groups. The gain in body weight was more with higher level of probiotic supplementation than with the lower level of supplementation. Addition of probiotics at 0.025 per cent level in the diet could improve the weight gain only to the extent of 7.57, 14.15 and 53.63 g in the first, second and fourth fortnightly periods in comparison to control. In the third fortnight the gain in 0.025 per cent supplemented group was 9.89 g less than that in the control group.

On the other hand, the gain in weight with probiotics supplemented at 0.05 per cent level in the first, second, third and fourth fortnightly periods were 10.26, 48.52, 72.05 and 48.13 g respectively in comparison to control.

Statistical analysis of the fortnightly mean body weight gain indicated that in the second and third fortnights significant differences existed between the control and 0.05 per cent probiotic supplemented group, whereas in the first and fourth fortnights the weight gain was statistically comparable between the treatments. In the second and third fortnights body weight gain was significantly superior ($P<0.05$) with 0.05 per cent probiotic supplemented group than other two treatments. The gain in body weight between the groups fed a control diet and a diet supplemented with lower levels of probiotics (0.025 per cent) was statistically comparable. This result shows the superiority of higher level of probiotic feeding with respect to body weight gain.

An assessment of cumulative body weight gain data is also essential in order to spell out meaningful conclusions. A perusal of the mean cumulative body weight gain data presented in Table 9 indicate that 0 to 6 weeks gain was more with the group fed a control diet supplemented with 0.05 per cent probiotic. The cumulative gain in body weight upto six weeks was 130.83 g higher with 0.05

per cent probiotic supplemented group as against 11.83 g more with 0.025 per cent supplemented group in comparison with control group.

Similarly, cumulative weight gain data upto eight weeks showed that the 0.05 per cent probiotic supplemented group gained more weight than all other groups. In comparison to control the weight gain in 0.025 per cent probiotic supplemented group was 65.47 g more, whereas 0.05 per cent probiotic supplemented group recorded an additional weight gain of 113.5 g. When the magnitude of difference in 0 to 6 weeks weight gain was analysed statistically, it was revealed that group offered 0.05 per cent probiotic gained significantly ($P<0.01$) more weight than other groups.

The cumulative weight gain from 0 to 8 weeks also showed statistical differences between the treatments. The gain in weight was lowest with control and highest ($P<0.01$) with 0.05 per cent probiotic supplemented group. The 0.025 per cent probiotic supplemented group also gained significantly ($P<0.01$) more weight than control, however, the gain was lower ($P<0.01$) to 0.05 per cent probiotic supplemented group.

It implies that probiotic supplementation is capable of bringing large changes in weight gain performance of ducklings and it is in agreement with Jeroch *et al.* (1995) and Ningguo and Zhengkang (1997) who reported improvement in body weight gain by the supplementation of enzymes in ducks. Hong *et al.* (2002) also reported a 6 to 8 per cent increase in body weight gain by the supplementation of enzyme.

The most likely explanation for the enhanced weight gains is that selected strains of *Lactobacillus acidophilus* colonise the intestine of the birds to varying degree and, once established, improve the bioavailability of essential nutrients, such as calcium and zinc. It may also prevent the establishment of Gram-negative species like *Escherichia coli.* Similarly experiments conducted in chickens to study the effect of probiotics also showed positive effects in body weight gain (Jin *et al.,* 2000; Banday and Risam, 2001). On the other hand, Shome *et al.* (2000)

could not observe any improvement in body weight gain with probiotic supplementation in chickens.

Upon consumption, probiotics deliver many lactic acid bacteria into the G.I tract. These micro organisms have been reported to modify the intestinal milieu to deliver enzymes and other beneficial substances into the intestine and ultimately improve the performance of birds.

5.4 FEED CONSUMPTION

The week wise mean daily feed consumption as influenced by probiotic supplementation given in Table 7 indicated that during the initial two weeks, the differences in feed consumption among the treatment groups were narrow. The trend in feed intake among ducks belonging to different treatment groups revealed that the groups supplemented with 0.05 per cent probiotic (T_3), consumed more feed right from first week through sixth week and then slightly declined. This increase in feed intake was more pronounced during third, fourth and fifth weeks of age. Ducks in 0.05 per cent probiotic supplemented group consumed 4.23, 3.95 and 4.76 g more feed than T_1 (control) and 3.89, 4.60 and 4.24 g more feed than T_2 (0.025 per cent supplemented group) during third, fourth and fifth weeks, respectively. This difference in daily feed intake was reflected in the statistical significance also.

Interestingly, the feed consumption in all the groups was reduced during seventh week of age than that at six weeks of age. It was almost same in all the groups. This is in agreement with Banday and Risam (2001) who reported that commercial broiler chicken consumed significantly more feed during starter phase but the feed consumption decreased during the finisher phase.

The mean cumulative feed consumption per bird presented in Table 9 indicates that probiotic supplementation at 0.025 per cent level led to an increase in feed intake of only 10.59 g during 0 to 6 weeks of age and 56.00 g during 0 to 8 weeks of age over the control group. The corresponding values with 0.05 per cent

supplementation of probiotics were 127.88 and 157.06 g, respectively. Statistical analysis of the cumulative feed intake data confirmed that the 0.05 per cent probiotic supplementation enhanced the feed intake ($P<0.01$) in ducks.

The mean cumulative feed intake upto six and eight weeks was significantly higher ($P<0.01$) in ducks fed a control diet supplemented with 0.05 per cent probiotic supplemented group than other two groups. Though the cumulative feed intake of 0.025 per cent probiotic supplemented group was numerically higher than control it was statistically comparable.

According to Leeson *et al.* (1982) the cumulative feed consumption was 8432 and 8657 g in male and female White Pekin ducks respectively at seven weeks of age. On the other hand the NRC (1994) reported feed intake at eight weeks as 9.86 kg and 9.61 kg in male and female White Pekin ducks, respectively. Khan (2002) also reported cumulative feed intake of White Pekin ducks as 8.63 kg for a period of seven weeks. In all these studies the cumulative feed intake were more than the mean values reported in the present experiment. But this factor should be considered in conjunction with the body weight recorded at seventh or eighth weeks of age. In all these works the body weights were definitely higher than that obtained in the present study.

Significantly higher feed intake observed in 0.05 per cent probiotic supplemented group could be due to increased amylase production extracellularly and intracellularly *in vitro*. Supplementation of Lactobacillus cultures might have increased the amylolytic activity in the intestine of ducks, which in turn leads to an increase feed consumption pattern in the treated groups. It is also possible that the increased feed consumption results from a self-regulatory mechanism or appetite.

From the few literatures available, Farrell and Martin (1992 and 1998) opined that additives like enzymes and probiotics had no significant effect on feed consumption in ducks.

Increased feed consumption with 0.05 per cent probiotic supplementation in the present study was compensated by higher body weight in this group. The effect of increased feed consumption was reflected in the trait feed conversion ratio which is discussed below.

5.5 FEED CONVERSION RATIO

Perusal of the fortnightly mean feed conversion ratio given in Table 8 indicates that during third fortnight probiotic supplementation resulted in an improvement in the feed conversion ratio, while in all other periods the treatment groups were statistically comparable. During the third fortnight, though 0.05 per cent probiotic supplementation resulted significantly better feed conversion ratio (0.14), it was less (to a tune of 0.03) with 0.025 per cent probiotics as compared to control.

The feed conversion ratio during the first fortnight was same (2.22) in both low and high levels of probiotic supplemented groups and it was 0.06 less than the control group. In the second and fourth fortnights, feed conversion ratio was better to a tune of 0.06 and 0.1 and 0.31 and 0.29 for the low and high levels of probiotic supplemented groups, respectively than the control.

When the magnitude of difference in fortnightly feed conversion ratio was tested statistically, it could reveal that significant difference existed only during the third fortnight, while in all other periods it was statistically comparable. During this period probiotic supplementation at 0.05 per cent level resulted significantly superior ($P<0.05$) feed conversion ratio than other groups.

The observation of the cumulative feed conversion ratio (Table 9) clearly shows that this trait was improved by probiotic supplementation. In comparison with the control group, 0.025 and 0.05 per cent probiotic supplementation resulted in superior feed conversion ratio to the tune of 0.02 and 0.13 at 0 to 6 weeks of age and 0.08 and 0.15 at 0 to 8 weeks of age, respectively.

The data on cumulative feed conversion ratio upto six weeks (Table 9) when subjected to statistical analysis, indicated that there was a significant difference between the treatments. Probiotic supplementation at higher level (0.05 per cent) resulted in significantly superior ($P<0.01$) feed conversion ratio than lower level of supplementation (0.025 per cent) and control. The superior performance of 0.05 per cent probiotic supplemented group was due to the significantly higher body weight and feed consumption which led to a significantly better feed conversion ratio than other two groups.

Parova *et al.* (1994) and Weis *et al.* (1997) could also observe significant improvement in feed conversion ratio with probiotic supplementation in ducks, while Punnagai *et al.* (2002) has opined that though the feed conversion ratio was numerically improved in the treated quail group it was not significant.

Jeroch *et al.* (1995), Cowan and Hastrup (1997) and Hong *et al.* (2002) also reported that enzyme supplementation in ducks resulted in improvement in feed conversion ratio. But, Bentz *et al.* (1983) and Aydin *et al.* (1994) reported that intakes per kg gain had not been significantly influenced by yeast supplementation. On the other hand Bonomi *et al.* (1980) could observe positive effect on feed conversion ratio with yeast supplementation.

Leeson *et al.* (1982) reported the cumulative feed conversion ratio as 2.62 and 2.83 for male and female White Pekin ducks, respectively during the period of seven weeks. Khan (2002) calculated the feed conversion ratio as 2.7 for White Pekin ducks for a period of seven weeks while, Campbell *et al.* (1985) assessed for a period of eight weeks and reported that the feed conversion ratio was 3.28 and 3.31 for male and female White Pekin ducks, respectively. It is obvious that all these values were within the range of present experimental data on feed conversion ratio.

The improvement in feed to gain ratio might be due to the fact that supplementation of bacteria like *Lactobacillus* species survive and colonize the gastrointestinal tract so that their beneficial functions are performed by attaching to the intestinal epithelium (Jin *et al.*, 1996), and are resistant to the bile and

acidic conditions and are able to antagonize and competitively exclude some pathogenic bacteria *in vitro,* thereby leading to beneficial effects.

5.6 BIOCHEMICAL PARAMETERS

Serum cholesterol in White Pekin ducks as influenced by probiotic supplementation at eight weeks of age given in Table 10 indicates that with each increment level of probiotics in feed there was a non-significant linear reduction in serum cholesterol concentration in both sexes. On the other hand directly proportional increase in serum protein per cent was noted with increasing concentration of probiotic in feed in both male and female White Pekin ducks.

In comparison with the control group, a reduction of 13.02 and 18.01 mg per cent in serum cholesterol levels were noted with 0.025 and 0.05 per cent supplementation of probiotic in male ducks and 10.65 and 24.08 mg per cent in female ducks respectively. In all the treatment groups, female ducks recorded lower serum cholesterol values than male ducks. The reduction in serum cholesterol in female ducks fed a control diet was to a tune of 9.72 mg per cent than the males. The corresponding reduction in serum cholesterol in females in the 0.025 and 0.05 per cent probiotic supplemented groups were 7.35 and 15.79 mg per cent, respectively. Though there were numerical differences in serum cholesterol with probiotic supplementation it was not influenced statistically. Similarly, sex also had no significant influence on serum cholesterol values.

The data on mean serum protein of ducks belonged to different treatments presented in Table 11 indicated that probiotic supplementation did have a significant influence on serum protein. It was significantly higher ($P<0.01$) in ducks fed a control diet supplemented with 0.05 per cent probiotic. Serum protein levels of unsupplemented group and the group supplemented with low level of probiotic were significantly lower. Reports from broiler chicken attribute that the serum protein levels were not significantly influenced by probiotic supplementation (Joy and Samuel, 1997; Kadari, 2001).

In contrast to serum cholesterol, female ducks in all treatments recorded higher serum protein values than their respective males. The serum protein values obtained in the present study were well within that reported by Defalco (1942), Werner (1944) and Peethambaran (1991). However the serum cholesterol levels were well below the normal total cholesterol levels in plasma for ducks as reported by Landauer *et al.* (1941).

On reviewing the literature it was felt that information on the influence of probiotic supplementation on the biochemical parameters is meagre in case of ducks and this is an area where further studies are warranted for drawing valid conclusions.

5.7 PROCESSING YIELDS

The ready-to-cook yields did not show significant differences among treatments and between sexes as shown in Table 12, suggesting that the growth promoter used in this trial had little influence on the yields of the carcass. The ready-to-cook yield ranged from 60.71 to 65.73 per cent.

The average ready-to-cook yield in male Kuttanad ducks was 68.36 per cent (Anon, 2003), which was slightly higher in comparison to the present study. Ahmed *et al.* (1984) has reported the ready-to-cook yield in Khaki Campbell males as 72.94 per cent and in females as 68.40 per cent.

The carcass yield obtained in this study also agrees with the research works of Aydin *et al.* (1994) in Pekin ducks and Punnagai *et al.* (2002) in Japanese quails. On the other hand, Parova *et al.* (1994) and Cowan and Hastrup (1997) could observe numerically positive response in carcass yield with probiotic supplementation. Jeroch *et al.* (1995) also opined that carcass quality variables were not consistently influenced in male Muscovy ducks fed a diet supplemented with enzymes.

The mean per cent abdominal fat is presented in Table 13. The per cent abdominal fat had no significant effect among treatment groups and between

sexes. Jeroch *et al.* (1995) indicated that carcass of ducks given the enzyme supplement contained more adipose tissue. Leeson *et al.* (1982) also stated that the abdominal fat was 2.0 per cent in male and 2.2 per cent in female and these values were much higher than the values recorded in the present study.

The mean giblet yield as influenced by the supplementation of probiotic at various levels is shown in Table 14. Similar to ready-to-cook yield and abdominal fat the giblet per cent did not differ significantly between diets with and without probiotic supplementation.

The giblet yield in the present study averaged from 5.24 to 5.76 in males and 4.93 to 5.88 in females, while the giblet yield was 6.27 per cent in Kuttanad ducks (Anon, 2003). Ahmed *et al.* 1984 reported the giblet yield of 7.03 per cent in male and 5.7 per cent female in Khaki Campbell ducks.

The data on the weight of liver, heart and gizzard is presented in Table 15. Upon statistical analysis it was found that organ weights of liver, heart and gizzard were not significantly different between treatments and sex. In the same line, Leeson *et al.* (1982) reported comparable values in White Pekin ducks. On the contrary, Aydin *et al.* (1994) claimed that administration of yeast has significantly influenced the weight of liver and gizzard.

The mean per cent yield of cut-up parts of duck carcasses at eight weeks of age, mean component yield of various cut-up parts and ratios of meat:bone and meat + skin:bone ratios are presented in Table 16, 17 and 18 respectively. A perusal of this data indicates that no significant differences existed between treatments. As there are no authentic data available on these parameters as well as on per cent ready-to-cook yield and other related parameters it is difficult to corroborate the beneficial effects of probiotic supplementation in ducks.

5.8 LIVABILITY

The overall per cent livability of ducks under different dietary treatments ranged from 97.92 to 91.67 per cent. During the entire course of the experiment covering eight weeks only seven ducks died. During the experimental period two ducks died in the control, one duck in the 0.025 per cent probiotic supplemented group and four ducks in the 0.05 per cent probiotic supplemented group as shown in Table 19. Necropsy findings revealed that probiotic supplementation did not have detrimental effect on the physiological well being of broiler ducklings and the mortality was not related with any adverse effects due to supplementation of probiotics.

This is in agreement with Gippert and Bodrogi (1992) who reported that incorporation of probiotic had no effect on mortality in ducks. However, Weis *et al.* (1997) could observe a reduction in mortality in ducks fed ration supplemented with probiotic and similar line of results were also reported by Shome *et al.* (2000) in chicken. After conducting a trial on Japanese quail, Punnagai *et al.* (2002) opined that probiotic supplementation did not influence mortality significantly.

5.9 ECONOMICS

An analysis of the cost of different rations employed in this experiment revealed that the control broiler diets for both starter and finisher periods, formulated as per BIS specifications (1992) were cheaper by five and seven paise (Table 20) than 0.025 per cent and 0.05 per cent probiotic supplemented group, respectively. Supplementation of probiotic in control diets enhanced the cost of rations.

When the cost of production per kg body weight was calculated, it was observed that 0.05 per cent probiotic supplemented group recorded the lowest cost of production when compared to 0.025 per cent probiotic supplemented group and

the control both at 0 to 6 and 0 to 8 weeks of age. During six weeks period, the production cost per duck was Rs.1.33 less with 0.05 per cent probiotic supplemented group as compared to control, while it was 10 paise more with 0.025 per cent probiotic supplemented group. When the whole period of 0 to 8 weeks was considered probiotic supplementation at both levels was beneficial with respect to cost of production per kg body weight. It was 0.54 and 1.42 rupees less with 0.025 per cent and 0.05 per cent probiotic supplemented group respectively than the control.

The beneficial effect of probiotic supplementation on cost of production of meat observed in this study is in close agreement with Parova *et al.* (1994).

The results obtained in the present study clearly indicated that probiotic supplementation at the rate of 0.05 per cent level upto six weeks of age can be advised when meat type (Vigova) ducks are reared on commercial basis.

The ideal age for marketing may be fixed as six weeks of age as the profit margin did not show remarkable increase at eight weeks of age. With 0.05 per cent level, the margin of difference in comparison with the control group was Rs.1.33 at six weeks of age and the same was increased to Rs.1.42 at 8 weeks of age. At the same time the cost of feed alone accounted to Rs.51.46 at six weeks of age which was increased to Rs. 72.66 at eight weeks of age.

Since a proportional marginal increase could not be achieved at eight weeks of age, the ideal market age of ducks may be fixed at sixth week of age.

Summary

6. SUMMARY

A biological trial was conducted in the Department of Poultry Science, College of Veterinary and Animal Sciences, Mannuthy, using one hundred and forty four (144) day-old commercial broiler ducklings to assess the influence of dietary supplementation of probiotic on the growth performance and meat yield of White Pekin (Vigova) ducks. The ducklings were divided randomly into three dietary treatments each with four replicates consisting of 12 ducklings. The dietary treatments consisted of standard broiler ration (T_1), broiler ration with 0.025 per cent probiotic (T_2) and broiler ration with 0.05 per cent probiotic (T_3). Standard broiler rations formulated as per BIS specification (1992) were used as duck starter and finisher rations.

Feed ingredients *viz.*, yellow maize, groundnut cake, gingelly oil cake, rice polish and unsalted dried fish were used for the formulation of the experimental diets. Each replicate was housed at random in individual pens and reared under deep litter system of management. Scientific managemental procedures were adopted throughout the experimental period. The duration of the experiment was eight weeks (September to October, 2002). Feed and water were provided *ad libitum*. Duck starter diets containing 23 per cent crude protein and 2800 kcal/kg of ME were fed upto six weeks of age and then switched over to duck finisher diets containing 20 per cent crude protein and 2900 kcal/kg of ME till the end of the experiment. The body weights of individual ducks were recorded at the beginning of the experiment and at fortnightly intervals. Replicate wise weekly feed consumption was recorded. From the above data, the body weight gain and the feed conversion efficiency for different treatments were worked out.

At eight weeks of age, two ducks from each replicate (one male and one female) were randomly selected and blood samples were collected. Serum was separated and was analysed for total protein and cholesterol using standard kits. The biochemical parameters were studied in order to ascertain the physiological status of the ducks.

Two ducks from each replicate were utilized for slaughter studies at eight weeks of age to assess the per cent yield of ready-to-cook, abdominal fat, giblets and organ weights of liver, heart and gizzard. Mortality of the ducks was recorded and livability percentages were worked out. Cost-benefit analysis was also worked out.

The overall performance of the ducks fed different dietary regimens are summarized in Table 21. The salient observations along with conclusions and inferences drawn during the course of the study are presented below.

1. The body weight of 0.05 per cent probiotic supplemented group was significantly ($P<0.01$) higher than 0.025 per cent probiotic supplemented group and the control from fourth week of age and followed the similar pattern till the end of the experiment. The mean body weights were 867.77, 890.11 and 926.89 g during the second fortnight, 1866.62, 1879.08 and 1997.80 g during the third fortnight and 2463.89, 2529.98 and 2643.20 g during the last fortnight for the various dietary treatments T_1, T_2 and T_3, respectively.

2. The cumulative body weight gains upto six weeks and eight weeks for the dietary treatments T_1, T_2 and T_3 were recorded as 1825.63, 1837.46 and 1956.46 g and 2422.89, 2488.36 and 2601.86 g, respectively and upon statistical analysis 0.05 per cent probiotic supplemented group had higher body weight gain ($P<0.01$) than the control and 0.025 per cent probiotic supplemented group.

3. The mean feed consumption per duck for the dietary treatments T_1, T_2 and T_3 was recorded as 4943.66, 4954.25 and 5071.54 g and 7643.97, 7699.97 and 7801.03 g upto six and eight weeks of age, respectively. The 0.05 per cent probiotic supplemented group showed significantly higher ($P<0.01$) feed consumption than the control and 0.025 per cent probiotic supplemented group.

4. The feed conversion ratio was calculated as 2.72, 2.70 and 2.59 for the dietary treatments T_1, T_2 and T_3 upto six weeks of age and 3.16, 3.08 and 3.01 from day-old to eight weeks of age for the dietary treatments T_1, T_2 and T_3,

respectively. The cumulative feed conversion ratio was significantly superior ($P<0.01$) in 0.05 per cent probiotic supplemented group than 0.025 per cent probiotic supplemented group and the control.

5. The biochemical studies showed that the level of serum cholesterol did not show any statistical variations among treatments and between sexes due to probiotic supplementation. The males recorded 174.28, 161.26 and 156.27 mg per cent while females recorded 164.56, 153.91 and 140.48 mg per cent of serum cholesterol for the dietary treatments T_1, T_2 and T_3, respectively.

6. The levels of serum protein recorded were 3.27, 3.83 and 4.03 g/dl in males and 3.53, 3.94 and 4.29 g/dl in females for the dietary treatments T_1, T_2 and T_3, respectively. The serum protein value of 0.05 per cent probiotic supplemented group was significantly higher ($P<0.01$) than the control and 0.025 per cent probiotic supplemented group.

7. The processing yields at eight weeks of age did not infer any significant difference between treatments and sexes due to supplementation of probiotics.

8. The overall meat:bone ratio in duck carcasses at eight weeks of age was 2.29, 2.27 and 2.24 for the dietary treatments T_1, T_2 and T_3 , respectively and there was no significant difference among treatment groups.

9. The livability percentage was calculated as 95.83, 97.92 and 91.67 for the dietary treatments T_1, T_2 and T_3, respectively. Probiotic supplementation did not have detrimental effect on the physiological well being of broiler ducks.

10. The total cost of production per kg body weight for the dietary treatments at the end of sixth week was Rs.35.56, 35.66 and 34.23 for the dietary treatments T_1, T_2 and T_3 and Rs. 35.38, 34.84 and 33.96 at the end of eighth week respectively, implying that 0.05 per cent probiotic supplemented group proved to be beneficial.

Among the different treatments, the performance of ducks fed with 0.05 per cent probiotic was found to be economical. Based on the results of this study it could be inferred that the addition of 500 g probiotic per tonne of feed (0.05 per cent) enhances the utilization of nutrients and increases the overall performance of the ducks.

Table 21. Influence of probiotic supplementation on the performance of White Pekin ducks

Sl. No.	Parameters	Dietary Treatments		
		T_1	T_2	T_3
1.	Mean body weight at six weeks (g)	1866.62	1879.08	1997.80
2.	Mean body weight at eight weeks (g)	2463.89	2529.98	2643.20
3.	Cumulative body weight gain upto six weeks (g)	1825.63	1837.46	1956.46
4.	Cumulative body weight gain upto eight weeks (g)	2422.89	2488.36	2601.86
5.	Cumulative feed consumed upto six weeks (g)	4943.66	4954.25	5071.54
6.	Cumulative feed consumed upto eight weeks (g)	7643.97	7699.97	7801.03
7.	Cumulative feed conversion ratio upto six weeks	2.72	2.70	2.59
8.	Cumulative feed conversion ratio upto eight weeks	3.16	3.08	3.01
9.	Serum cholesterol (mg per cent) i) Male ii) Female	 174.28 164.56	 161.26 153.91	 156.27 140.48
10.	Serum protein (g/dl) i) Male ii) Female	 3.27 3.53	 3.83 3.94	 4.03 4.29
11.	Processing yields (per cent) i) Male a) Ready-to-cook yield b) Giblet c) Abdominal fat d) Liver e) Heart f) Gizzard	 64.78 5.24 0.72 2.10 0.57 2.58	 62.77 5.76 0.77 2.42 0.56 2.79	 60.60 5.50 0.90 2.50 0.63 2.48
	ii) Female a) Ready-to-cook yield b) Giblet c) Abdominal fat d) Liver e) Heart f) Gizzard	 60.71 5.04 0.65 2.18 0.57 2.30	 63.85 4.93 0.88 2.06 0.60 2.27	 65.73 5.88 0.98 2.49 0.66 2.59
12.	Meat:bone ratio	2.29	2.27	2.24
13.	Livability (per cent)	95.83	97.92	91.67
14.	Feed cost per kg of feed (Rs.) i) Starter ration ii) Finisher ration	 10.06 9.19	 10.11 9.24	 10.15 9.28
15.	Total cost per kg body weight in Rs. (sixth week)	35.56	35.66	34.23
16.	Total cost per kg body weight in Rs. (eighth week)	35.38	34.84	33.96

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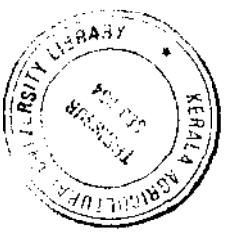

EFFECT OF PROBIOTIC SUPPLEMENTATION ON THE PERFORMANCE OF WHITE PEKIN DUCKS

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ABSTRACT

One hundred and forty-four straight run day-old broiler ducklings, randomly divided into three treatment groups of four replicates with 12 ducklings each were used to study the effect of probiotic 'Livesac' (Lactic acid bacilli, live yeast cells and traces of enzymes) supplementation on the performance of Vigova variety of White Pekin ducks for a period of eight weeks. Standard broiler rations formulated as per BIS specifications (1992) were used as duck starter and finisher rations. Ducklings in T_1 were fed with control ration, T_2 control + 0.025 per cent probiotic and T_3 control + 0.05 per cent probiotic. Similar managemental practices were followed for all treatments.

The 0.05 per cent probiotic supplemented group recorded a significantly higher body weight from second fortnight and followed a similar pattern till the end of the experiment. The fortnightly body weight gains were significantly higher ($P<0.05$) in 0.05 per cent probiotic supplemented group during the second and fourth fortnights, while the cumulative body weight gain showed a significantly higher ($P<0.01$) value in T_3 upto six and eight weeks period.

The weekly feed consumption was statistically significant ($P<0.01$) and was higher in 0.05 per cent probiotic supplemented group during third, fourth and fifth weeks. The cumulative feed consumption upto six and eight weeks also showed similar trend. The cumulative feed conversion ratio was statistically significant ($P<0.01$) between treatments and superior value was observed in 0.05 per cent supplemented group upto six and eight weeks of age. The serum cholesterol level was not affected by probiotic supplementation. The serum protein level was significantly higher ($P<0.01$) in 0.05 per cent probiotic supplemented group. The processing yields were not significantly influenced by probiotics. Livability percentage between treatments was not affected by probiotics. The total feed cost per kg body weight was lower in the 0.05 per cent probiotic supplemented group upto six and eight weeks of age.

Thus it can be concluded that probiotic supplementation at 0.05 per cent level was beneficial in the overall production performance of White Pekin ducks.