

**UTILIZATION OF ORANGE POMACE AT DIFFERENT  
LEVELS IN BROILER DIET**

**T H E S I S**

**Submitted**

**In partial fulfillment of the requirements for the Degree of**

**MASTER OF VETERINARY SCIENCE  
IN  
POULTRY SCIENCE**

**BY**

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**2009**

## DECLARATION OF STUDENT

I hereby declare that the experimental research work and interpretation of the thesis entitled "**UTILIZATION OF ORANGE POMACE AT DIFFERENT LEVELS IN BROILER DIET**" or part thereof has not been submitted for any other degree or diploma of any University, nor the data have been derived from any thesis/publication of any University or scientific organization. The sources of materials used and all assistance received during the course of investigation have been duly acknowledged.

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**MEHARE AWESH MURLIDHAR** has satisfactorily prosecuted his course of research for a period of not less than one semester and that the thesis entitled, "**UTILIZATION OF ORANGE POMACE AT DIFFERENT LEVELS IN BROILER DIET**" submitted by him is the result of research work and is sufficient to warrant its presentation to the examination in the subject of **POULTRY SCIENCE** for the award of **MASTER OF VETERINARY SCIENCE** degree by the Maharashtra Animal and Fishery Sciences University, Nagpur.

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This is to certify that the thesis entitled, "UTILIZATION OF ORANGE POMACE AT DIFFERENT LEVELS IN BROILER DIET" submitted by **MEHARE AWESH MURLIDHAR** to the Maharashtra Animal and Fishery Sciences University in partial fulfillment of the requirement for the degree of **MASTER OF VETERINARY SCIENCE** has been approved by the Student's Advisory Committee after examination in collaboration with the External Examiner.

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## LIST OF ABBREVIATIONS

Abbreviation	-	Full form
%	-	Per cent
@	-	at the rate
A.O.A.C.	-	Association of official analytical chemist
ANOVA	-	Analysis of variance
Avg.	-	Average
C.D.	-	Critical difference
Cal	-	Calorie
CF	-	Crude fibre
CP	-	Crude protein
DM	-	Dry matter
EE	-	Ether extract
<i>et al.</i>	-	et alia (and others)
etc.	-	Etcetera
FCR	-	Feed conversion ratio
g	-	gram
GDP	-	Gross domestic product
i.e.	-	that is
Kcal	-	kilo calories
Kcal/kg	-	kilo calorie per kilogram
ME	-	Metabolizable energy
mg	-	Milligram
mg/dl	-	Milligram per deciliter
mg/g	-	Milligram per gram
mg/kg	-	Milligram per kilogram
mg/kg/day	-	Milligram per kilogram per day
ml	-	Millilitre
ml/bird	-	Millilitre per bird
NCDV	-	New Castle Disease Virus
NFE	-	Nitrogen free extract
No.	-	Number
SE	-	Standard error
US	-	United States
Vit.	-	Vitamin
viz.,	-	Namely
Vs	-	Verses
Wt.	-	Weight



Chapter I

*Introduction*

## CHAPTER I

### INTRODUCTION

India has an agribased economy. Major part of Indian population depends on agriculture for livelihood. Along with agriculture, poultry business has helped to farmer for improving the economical and nutritional status of the family. Poultry industry has improved vastly in last four decades. Poultry industry in India has transformed itself from old backyard farming into dynamic agro based industry. Its development is not only been in size but also in productivity and quality. Poultry industry is ever growing due to awareness among masses about high nutritional values of eggs and meat as a human food.

Indian poultry industry has been in the news, attracting foreign investor with good returns, booming markets and expanding economy. Like the other sector, trusty chicks are also chirping ahead. The poultry production in India has made significant improvement over the years due to research and development, thrust of government and organized private sector.

Poultry production is one of the fasted growing sectors of Indian agriculture. While egg production is increasing at a rate of 6-8% per annum and broiler production is increasing at the rate of 10-12%. India at present is the 3<sup>rd</sup> largest producer of eggs and 5<sup>th</sup> largest producer of poultry meat in the world. Egg production has reached to 46.17 billion eggs and egg mass is 2492.0 thousand tones in the year 2005-2006. This represented a 16 fold increase for egg number and 14.7 fold increase for egg mass over 1961. Poultry meat production increased 23.46 fold from 81 thousand tones in 1961 to 1900 thousand tons in 2005-06 (Mohapatra and Mishra, 2008).

The most important constraint in the development of poultry industry is shortage of feed ingredient and their high cost, which are significant limiting factor to increasing the production cost of poultry. This shortage of feed, especially the major cereals often prevent any significant

development in production of poultry as these stocks mainly depend on a constant supply of cereal grains like maize, jowar and other millets as a basic source of energy (Adegbola, 1976). Thus, this has led to increasing cost of finished feeds which offend accounted for about 70 to 75 per cent of the total cost required for raising poultry. Due to this, it has been suggested by poultry nutritionist time to time that, the utilization of various new and unconventional sources of material as poultry feeds, which are not detrimental to poultry production. Maize is the conventional sources of energy in poultry feed in India while soy bean, groundnut cake and fish meal are the sources of proteins. At present, the continuous rise in the prices of these ingredients has put enormous pressure on the poultry farmers to look for alternatives. In view of such situation, efforts should be made to utilize the agro- industrial byproducts as poultry and livestock feeds.

In recent year a number of fruits, vegetables and oilseeds processing factories have come up in country and byproduct from these sources are available now in plenty. The important fruits wastes are Orange peel, Mango peel, Apple Peel, Apple core, Pine- Apple peel, Tomato pomace, Apple pomace etc. The wastage from fruit processing plant constitutes large untapped sources of energy and protein (Mahadevaswamy and Venkataraman, 1990).

However, considerable amount of vegetable and fruits processing waste product are thrown away every year which are unfit for human consumption. The disposal of such waste is a serious problem and simply it is thrown away in manure pit which also causes environmental problem. These economically valuable byproducts and easily available waste are not being properly utilized at present in our country. If these waste products are processed properly and dried, these could yield a suitable quantity of feed ingredient for poultry feeding which will not only reduce cost of feed but also minimize the environmental problem.

In India around 3.48 lakh hectares land are under citrus cultivation yielding 27.58 lakh tones of fruits (Singh and Pandey, 1993). In

Vidarbha, 90,000 hectares area is under orange production from which 10 lakh metric tones oranges are produced. These Orange is available from the month of September to November and February to May (Anonymous, 2000).

In Vidarbha 90 per cent citrus area is shared by Nagpur mandarin. Hence, most of orange processing units are concentrated in Vidarbha region of Maharashtra state especially in and around Nagpur. Two mega orange processing units have been established by Government of Maharashtra i.e. one at Katol Dist. Nagpur and second at Morshi Dist. Amaravati which have processing capacities of 1000 tones daily. Several private orange processing units are also present in Nagpur (Zinjarde, 1998). The byproducts from orange processing plants are peel, rags, citrus molasses, seed meal and pomace, Analysis of Nagpuri orange has shown that it yields 32 to 62 per cent of juice and 38 to 44 per cent of rind and seeds which is non edible (Jadhao *et al.*, 1994).

Orange pomace is left over material of Orange processing unit. After extraction of juice, it consists of pulp and seeds. It is one of the most important horticultural wastes byproduct available in this region having feed potential but Pomace is not only a loss of national property but also creates atmospheric pollution after its fermentation. As it is nutritious, it needs to process and preserve for livestock and poultry feeding.

Now a day nutritionists are trying to exploit new sources of feed ingredients. Orange pomace is one of the feed ingredient can be used as poultry feed due to its moderately high energy content. Preservation of orange pomace by dehydration technology is possible but it is quite laborious and time consuming due to content of high moisture, sticky in nature due to high content of pectin and required area for drying hence a suitable technology for its preservation is the only solution for its efficient, ecological and economical use in the ration of poultry (Patel *et al.*, 2001). Orange pomace is cheap and easily available in Vidarbha. However, scanty information is available on utilization of orange pomace in broiler diets. Hence, to exploit the possibility to utilize orange pomace in broiler diets as

energy sources the investigation entitled "Utilization of Orange pomace at different levels in broiler diet" was undertaken to find out level of incorporation of orange pomace in broiler diets without affecting broiler performance and to study its cost structure.

The present investigation was therefore undertaken to study the nutritive significance with following objective

- 1) Utilization of orange pomace at different level in broiler diets which may be used by the farmer for feeding poultry.
- 2) To study the performance of broilers on orange pomace included diets.
- 3) Diets effect of on carcass quality of broiler.
- 4) To study the economics of broiler production.



Chapter II

*Review of Literature*

## CHAPTER II

### REVIEW OF LITERATURE

The feed is the major important factor, affecting the production performance and economics of broiler production next to genetic potential. Moreover, it is major inputs constituting about 70-75 per cent of the total cost of production. Prime objective of poultry producers always seems to be improve feed efficiency and productivity by reducing the cost of production per bird. Now a days cost of poultry feed ingredients is quite high and they compete with human diets. To over come this situation, some other low cost by-products such as agro industrial by-products were tried by various workers. But very little work has been done on utilization of citrus by-products in poultry. In this chapter, a by-product from citrus industry i.e. orange pomace meal has been used on broiler performance and reviewed as below.

#### 2.1 Proximate Composition

Kunjukutty *et al.* (1966) studied the chemical composition and feeding value of lime (*Citrus aurantifolia*) and lemon (*Citrus lemon*) and concluded that lime seed was moderately rich in ether extract, fair in protein and low in calcium and phosphorus content. Vitamin C content was higher in lime juice than lemon juice. Lime juice was richer than lemon juice in vitamin C content. Lemon peel and lime had more or less an identical chemical composition.

Cottyn and Bouncque (1970) reported that citrus pulp contain crude protein, ether extract, crude fibre, Ash, calcium, phosphorus, NFE, sugar and dry matter was 5.87, 3.91, 11.66, 4.62, 1.50, 0.89, 61.85, 22.0 and 81.1% respectively. They observed mean digestibilities as 83.5, 53.0, 86.2, 81.0 and 90.8% for dry matter, crude protein, ether extract, crude fibre and nitrogen free extract, respectively. Starch equivalent of dry matter was 71.4%.

Bhattacharya and Harb (1973) reported that dried citrus pulp contain 8.1 per cent crude protein, 11 per cent crude fibre, 73 per cent nitrogen free extract, and 14 per cent sugar on dry matter basis . One half of the protein in citrus pulp was true protein and deficient lysine.

Ammerman *et al.* (1976) analyzed the data for 3,630 samples of dried citrus pulp obtained by the Feed Laboratory, Division of Chemistry, Florida Department of Agriculture during the year 1963-1975. The average moisture content was 8.48 per cent. The average proximate composition, expressed on a dry matter basis, was as follows: protein 6.80 per cent; ether extract 4.08 per cent; ash 5.42 per cent; crude fibre 13.32 per cent; and nitrogen –free extract 70.38 per cent. All nutrient levels differed ( $P < 0.05$ ) among production sources, among years or season, and for production source x season interaction. The range in proximate composition, expressed on a dry matter basis according to production source, was as follows: protein 6.58 to 7.50 per cent; ether extract 3.61 to 5.07 per cent; ash 5.07 to 6.26 per cent; crude fibre 12.15 to 15.68 per cent; and nitrogen – free extract 67.68 to 72.08 per cent.

Accardi *et al.* (1977) studied the digestibility of dried orange and lemon pulp. The composition of dried orange pulp and lemon pulp on dry matter basis was crude protein 10.5, 10.94; ether extract 5.37, 23.92; nitrogen free extract 60.8, 55.41 of which 13.91, 4.25 was sugar and Ash 7.46, 4.13 per cent, respectively. Digestibility values were for crude protein 60.22, 68.39, ether extract 86.55, 83.66, crude fibre 80.61, 75.84 and nitrogen free extract 89.2, 89.14 per cent, respectively.

Anonymous (1981) studied the chemical composition of digestibility of citrus pulp in sheep and reported the value for dry matter, crude protein, crude fibre, ash, ether extract, nitrogen free extract as 91.8, 6.9, 13.1, 7.1, 2.8, 70.1 per cent, respectively on dry matter basis. Digestibility percentage of crude protein, crude fibre, ether extract, nitrogen free extract, was 91.8, 6.9, 13.1, 7.1, 2.8, and 70.1 per cent, respectively on dry matter basis. Digestibility percentage for crude protein, crude fibre, ether extract,

nitrogen free extract and metabolic energy were 41.1, 79.7, 99.9, 87.7 per cent and 3.03 Kcal per g, respectively.

Martinez *et al.* (1981) reported the chemical composition of citrus pulp from eight groups of citrus fruit grown in Spain. Pulp on dry matter basis had peel 60 to 65 per cent, segment pulp 30 to 35 per cent and seed 0 to 10 per cent and contained organic matter 96.0 to 96.9 per cent, ether extract 3.4 to 6.3, fibre 7.4 to 10.9 and protein 5.0 to 8.0. Peel had similar composition of pulp. Seeds were rich in protein, ether and fibre. There were significant difference between varieties in fibre and acid detergent lignin of dried citrus pulp.

Banerjee (1998) reported that liquid obtained from pressing orange waste contained 10-15 percent soluble solids of which 50-70 per cent was sugar. This material amounted for more than half of the total weight of the waste.

Patel *et al.* (2001) conducted the analysis of orange pomace and studied the utilization of orange pomace at different levels on the performance of broiler. They reported that orange pomace contain 8.12 per cent crude protein, 4.92 per cent Ether extract, 13.50 per cent Crude fibre, 64.21 per cent Nitrogen free extract, 9.251 per cent Total Ash, Calcium-2.05 per cent, Phosphorus – 0.21 per cent on dry matter basis.

Jawale *et al.* (2005) conducted the analysis of orange pomace and studied the effect of orange pomace supplemented with xylanase and cellulose on the performance of broilers by partial replacement of maize. They reported that orange pomace contain 8.12 per cent crude protein, 4.92 per cent Ether extract, 13.45 per cent Crude fibre, 64.20 per cent Nitrogen free extract, 9.31 per cent Total Ash on dry matter basis.

## 2.2 Broiler

Driggers *et al.* (1951) reported the toxic factor in citrus seed meal and showed that, citrus seed meal contain 'Limonin' which was toxic to pigs and poultry. They indicated that 5 per cent inclusion, of citrus seed meal reduces the growth and at 20 per cent it caused mortality in chickens.

Perez *et al.* (1976) reported that citrus meal in diets for chickens on starting feed with 60 per cent maize or with 20, 30, and 40 per cent of its replacement by citrus meal gives significant result. Four groups of chicken gained 661, 571, 459, and 408 g respectively for intake of 1.6, 1.8, 3.0, and 3.8 g/g gained. The finishing feed had 64 per cent maize or the same replace with citrus meal gains to 56 days were 1669, 1374, 1293, and 1099 g and efficiency were 1.8, 2.3, 2.6, and 3.1 g/g respectively in these treatment groups but the difference were found to be significant.

Mohammed and EL- Nagger (1979) reported that mixed feeds of undecorticated cotton seed cake, sawdust and fishmeal with orange varieties "Baladi" and "Naval" ( after extraction of juice) have high nutritive value viz., 62.05 and 64.05 per cent in form of total digestible nutrients. These mixed feeds can be used for feeding poultry and animal, saving about 20 to 40 per cent of concentrate feed staffs.

Sharma and Kotch (1981) studied some horticulture by-product in chicks starter rations, Banana peels, Jaman seed and Kaenth fruit meal were sun dried and substituted at 1,2,and 3 per cent levels to replace equal parts of maize and wheat( low grade) in the control diet. One hundred seventy five day-old chicks were reared on control diets for eleven day in electric battery brooder. They were grouped at random into ten groups of fifteen chicks in each group the average gain in body weight and FER were slightly lower in all treatments in comparison to control except in 3 per cent Jaman seed meal fed group which was higher. The feed consumption had been higher in all treatments in comparison to control. The overall results indicate

jaman seed meal and kaenth fruit meal can be safely feed up to 3 per cent levels to the starter chicks.

Kang and Chol (1984) reported the feeding value of dried citrus peel. Day old 192 moniker strain broiler chicks fed 2 or 4 per cent of citrus peel gained numerically more weight and consumed more feed than those fed the basal diets without citrus peel. Citrus peel at 6 per cent level showed slightly decreased weight gain and feed intake. As the level of citrus peel in diets increased, more feed was required per unit weight gained ( $P < 0.05$ ), indicating that citrus peel probably contains less metabolizable energy than wheat bran due to higher fibre content.

Yang and Chung (1984) studied the effect of citrus peel and pulp in the diet of broiler chicks. Their weight gain and feed intake tended to fall as the level of citrus increased. However, citrus peel which had been heated and dried could replace 5 per cent of the conventional diet for broiler chicks.

Suh *et al.* (1985) conducted an experiment on utilization of citrus pulp and its effect on the cholesterol metabolism in chicks. The neutral detergent fibre (NDF) and acid detergent fibre (ADF) contents were analysed in the experimental materials and residues (celluloses) of excreta from birds fed diets contained wheat bran, citrus pulp, acetone extracted (AE) citrus pulp and ultrasonically treated (UT) citrus pulp. Cholesterol deposition in carcass and steroids excretion in excreta of birds fed diets contained cellulose (cotton seed meal), wheat bran, citrus pulp, citrus pulp-AE and citrus pulp-UT were investigated.

Lanza (1986) reported usefulness of dried orange and lemon pulp for feeding dairy cows, pigs, laying hens and broilers with the conclusion that dried orange and lemon pulp is the best substitute for cereals in feeding. There was no negative effect on yield, if cereals in the concentrate mixture were completely replaced by dried orange pulp.

Rao and Ladaniya (1989) reported that the diet with orange pomace peel meal for broiler was palatable and it increased feed conversion

efficiency and also there was saving of Rs 1.29 in cost of diet per kg gain broiler weight by replacing 10 per cent maize as compared to control.

Kukde (1990) conducted an experiment on broilers on the inclusion of orange pomace meal as a substitute for maize. Sixty day old broiler chicks were randomly allotted to three groups each having 20 chicks fed with three rations consisting of control basal diet of maize plus GNC and remaining two diets with maize replaced by 5 per cent and 10 per cent orange pomace meal. There was no significant difference in the body weight gained between the treatment and control groups. The broilers in 5 and 10% orange pomace meal group gained 129 and 242 g, weight respectively, which was more than control group. He reported that broiler fed by orange pomace meal at 5 and 10 per cent level was beneficial.

Squires *et al.* (1992) conducted two experiment to determine the effects of heat, water, acid, and alkali treatment of tomato pomace on wait gain, feed to gain ratio, nitrogen utilization, and ME of diets for broiler chicks. In Experiment 1, both treated and untreated tomato pomace was included in broiler diets at a 10 or 20 per cent level. Results indicated that the level of antinutritional factors present in untreated tomato cannery waste did not appreciably depress any measured production parameter. Hence, it appeared that untreated tomato cannery wastes might be used as a feed ingredient in low-energy poultry diets. The second experiment was designed to test the effect of alkali concentration and treatment time of tomato pomace on the performance of broiler chicks. Alkali treatment of tomato cannery wastes increased the weight gain and decreased feed to gain ratios of broiler chicks over those of untreated tomato waste controls.

Matoo *et al.* (2001) studied performance of broilers fed on apple pomace diets supplemented with enzyme(s). In an experiment with broiler birds maize was replaced with dried apple pomace at 0, 10, 15 and 20 per cent levels with or without enzyme(s) supplementation. Birds fed enzyme supplemented pomace above 10 per cent levels; body weight gain was comparable to control groups. Differences in feed consumption at all levels of

replacements except at 15 per cent replacement with enzyme supplementation were statistically non-significant. At 15 per cent replacement with enzyme supplementation, the average feed consumption was significantly ( $P<0.05$ ) higher than all other treatment groups. It was concluded that enzyme supplementation improved the feed conversion efficiency of birds fed diets with 15 and 20 per cent replacement.

Patel *et al.* (2001) studied effect of different levels of orange pomace on body weight gain, feed intake, feed conversion ratio and carcass characteristic of broiler chicks. A total 100 day-old broiler chicks were divided in to five experimental groups with three replicates in each. Orange pomace was incorporated in the experimental groups at rates of 0.0, 5.0, 10, 15 and 20 per cent in both starter and finisher feeds to replace similar rates maize. They concluded that broiler performance was better by partial replacement of maize by orange pomace.

Rabayaa *et al.* (2001) studied effect of different levels of olive pulp on body weight gain, feed intake and feed conversion efficiency of broiler chicks. A total 160 day-old chicks were divided into five experimental groups with four replicates in each. Olive pulp was incorporated in the experimental groups at rates of 0.0, 2.5, 5.0, 7.5 and 10.0 per cent in both starter and finisher feeds to replace similar rates of yellow corn. Weight gain of chicks was the same in chicks consuming up to 7.5 per cent of olive pulp. However, weight gain of chicks fed 10% olive pulp had the lowest ( $P<0.05$ ) weight gain. Similar trends were observed in for feed intake, and feed conversion efficiency. It concluded that olive pulp could be considered as potential low cost feed for broilers.

Keithly and Thomas (2004) received United States Patent no. 20040219279 for study entitled 'Commercial poultry breeder citrus by-product feed supplement and method and its incorporation in feed. The breeder feed diet compositions include by-product or waste material from citrus juice extraction. The citrus peel by-product compositions improve poultry breeder characteristics and economics.

Antongiovanni *et al.* (2005) reported that citrus by-products are rich in Esperidin, Eriocitrin and Narirutin, flavonones with immune modulating properties. Aim of this preliminary study was to test one of the most important classes of natural compounds as flavonoids, pigments with auxinic and antiparasitic properties contained in fruits and vegetables. A great problem in poultry feeding is the control of animal infections as coccidiosis, which could be faced by natural products other than drugs. A trial was conducted on 160 hybrid Ross chicks, randomly allotted to 4 groups and kept on litter. The birds were fed diets supplemented with 4 different levels of a citrus by-product. The diets were composed with maize, soybean meal, maize gluten meal, olive oil and a mineral-vitamin supplement. The by-product used in the present trial consisted of the residue from the orange juice industry. It was included in the diets either as a liquid or as a dry product at different levels: 0 per cent in the control group (C), 1 per cent dry product (group S1), 2 per cent dry product (group S2), 4 per cent liquid product (group L4). The concentration of flavonoids in the dry product was the double of that in the liquid one, so that groups S2 and L4 received the same amount. The analysis of excreta showed a high concentration of coccidia in the control group only, and a very low concentration in group S1. On the contrary, no trace of enteroparasites was found in any group. The ELISA test on blood samples showed higher levels of immunoproteins in the chickens fed flavonoids. It may be concluded that the liquid supplement showed the same antiparasitic properties than the dry one.

Jawale *et al.* (2005) studied the effect of orange pomace supplemented with xylanase and cellulose on the performance of broilers by partial replacement of maize. From the result of this investigation it concluded that replacement of maize by orange pomace is economical at 15 % level and enzyme supplementation increase the body weight gain but to widen the margin of profit when the dose of enzyme supplemented need to be increased.

Odunsi (2005) assessed the nutritive value and utilization of mango (*Mangifera indica* L.) seed kernel (MSK) in the diets of broiler chickens. Meal from the seed kernel contained 61.6 g crude protein, 136.2 g ether extract, 22.3 g ash, 46.4 g crude fibre, 673.5 g nitrogen-free extract and appreciable mineral content. MSK was incorporated at levels of 0, 50, 100, 150 and 200 g/kg at the expense of maize but with slight adjustments to the soybean meal so as to achieve isonitrogenous diets. Body weight and body weight gains increased significantly ( $P < 0.05$ ) up to 100 g/kg and then decreased. MSK at 150 or 200 g/kg had no significant effects ( $P > 0.05$ ) on feed intake and feed efficiency when compared with control diet. Marginal improvement was recorded in the broiler diet.

Zafar *et al.* (2005) conducted an experiment on one hundred day old broiler chicks. They were divided into two groups A and B. the feed of group A contain maize in addition to other ingredients, whereas the feed of group B substituted maize with apple by-products. Both group of birds gained appropriate weight required to be marketed at the end of 6 weeks. Live weight and carcass weight were also recorded. There was significant difference between these two parameters. Group B gained more live weight as compared to group A. It concluded that apple pomace can be used safely as energy source in broiler ration replacing maize by 10 per cent without any adverse effect on the broiler production. Further, they concluded that inclusion of agro industrial by-product in poultry feeds will help to reduce the cost of production.

Keithly and Thomas (2006) received the U.S. Patent no. 7115298 for study entitled 'Dried citrus peel supplement for use in commercial poultry feed'. The feed composition includes byproduct or waste material from citrus juice extraction. These feed supplements improve poultry characteristics and enhance feed conversion when compared with traditional poultry feed diets or supplements which rely on components that are not in their respective native states as present in citrus byproduct from juice extraction equipment.

Oluremi *et al.* (2006) conducted feeding trial with one week old, one hundred and fifty Anak broiler chicken to assess the nutritive value of sun dried sweet orange (*Citrus sinensis*) rind (SOR). They were randomly assigned to five dietary group in which rind replace with maize at 0, 5, 10, 15, and 20 per cent levels in both starter and finisher diets. Experimental diets had no significant effect ( $P>0.05$ ) on feed intake, body weight gain, water consumption, water: feed ratio, feed conversion ratio and feed cost per broiler. while final live weight was affected significantly ( $P<0.05$ ). Increasing dietary SOR beyond 15 per cent reduced the growth rate, which cumulatively caused a decrease in final live weight. Diets had significant effect only thigh + drumstick and abdominal fat, and the dressing percentage values of broiler on the SOR diets were higher those on the control. It has shown that dried SOR can be used to replace dietary maize in the diet of broiler at 15 per cent level.

Oluremi *et al.* (2007) studied the effect of fermentation of sweet orange (*Citrus sinensis*) fruit peels on its replacement value of as a dietary energy source. The trial was conducted on 120, one week old Anak 2000 broiler chicks. Sweet orange peels fermented for duration of 0, 24, and 48 h and thereafter dried and ground. The powder was used to replace maize at 30 per cent level in the test diets. The chicks were divided into four groups with three replicates each having 10 chicks. The diets were maintained isonitrogenous. The dietary treatment groups were CD (control), SP0D and SP24D, SP48D. The performance and carcass quality were evaluated. Fermentation of sweet orange peels depressed the mean feed intake, body weight gain and live weight of broiler among the treatment groups highly significantly ( $P<0.01$ ) the longer its duration. The performance of boilers in the orange peels based diets was inferior to the control.

Kumar *et al.* (2008) studied effect of feeding mango seed kernel as a replacer of rice polish on the performance of broiler starter. Trial was conducted on 200 broiler chicks to find out the economic level of inclusion of mango seed kernel in the broiler ration. The five ration containing 0 ( $T_1$ ), 2.5 per cent ( $T_2$ ), 5 per cent ( $T_3$ ), 7.5 per cent ( $T_4$ ) and 10 per cent

(T<sub>5</sub>) mango seed kernel were fed to broiler starter from 0-4 weeks of age. Body weight gain, feed consumption, feed efficiency, dressing weight percentage, eviscerated percentage liver weight, gizzard weight, heart weight, and spleen weight under T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub> and T<sub>5</sub> respectively did not differ significantly among various levels of inclusions. The price of the feed per kg was reduced as the level of mango seed kernel was increased in the feed and was minimum in 10% inclusion. Treatments T<sub>4</sub> and T<sub>5</sub> gave higher net profit suggested that mango seed kernel can be economically incorporated up to 10 per cent levels in broiler starter ration.

Meena Kumari *et al.* (2008) evaluated orange pomace as energy source in broiler feeds. The dietary treatment groups were designated as C (control basal feed), OPE-5, OPE-10, OPE-15 i.e. feeds prepared by obtaining 5% 10% 15% of total ME, respectively, from dried ground orange pomace instead of maize. During starter phase FCRs of C, OPE-5, OPE-10 and OPE-15 did not differ significantly, whereas that of OPE-15 was significantly higher. During starter phase weight gain in OPE-10 was higher than other group. The expenditure on feed per kg gain in weight was lowest in OPE-10 and hence profit earned per kg gain in weight was the highest in this treatment. It concluded that dried orange pomace could be used as source of energy.

Mourao *et al.* (2008) investigated the impact of incorporating citrus pulp (5 or 10%) or dehydrated pasture (5 or 10%) on the performance, carcass yield, and characteristics of broiler chickens. A diet containing neither citrus pulp nor dehydrated pasture was used as control. The results on growth performance showed that daily weight gain was reduced by 26 per cent in birds of the 10 per cent citrus pulp treatment ( $P < 0.05$ ) as compared with the control.

Wadhawa *et al.* (2008) conducted a study on one hundred and eighty, day old broiler chicks were randomly assigned to four treatments designated as C ( control, basal feed ), OSE-5, OSE-10 and OSE-15, i.e. feed prepared by obtaining 5 per cent, 10 per cent, and 15 per cent of the total ME,

respectively, from dried ground orange skin instead of maize. During the starter phase gain in weight of OSE-5 and OSE-10 did not differ significantly ( $P < 0.05$ ) from that of C, but that of OSE-15 was significantly ( $P < 0.05$ ) from that of C. The FCR of C, OSE-5, and OSE-10 were not differ but that of OSE - 15 was significantly ( $P < 0.05$ ) lower. During the finisher phase FCRs did not differ despite significantly ( $P < 0.05$ ) less feed intake on OPE -10 groups. Overall, the replacement did not affect the FCRs, but a mortality of 6.67 per cent was observed in OSE-15 against no mortality in other treatments. The profit earned per Kg gain in weight was the highest in OSE-10 group. Thus, it was concluded that orange skin could safely replace maize upto 9 per cent and increase the profit of broiler rearing.

El-Deek *et al.* (2009) studied the possibility of incorporating raw or treated guava by-product in broiler finisher diets. Three hundred and fifteen broilers of four weeks old were used in this feeding trial. The chickens assigned to 21 experimental diets in three replicates of 5 chickens each. The first experimental diet (control), while other twenty experimental diets contained raw and the treated guava by-product with the following percentage 2, 4, 6 and 8 at the expense of the control diet. Results showed that the experimental diets had no significant effect on body weight and body weight gain throughout the experimental period. Increasing level of raw or treated guava by-product had a significant effect on feed intake, protein intake and energy intake, when compared to those of the control diet. Mortality rate was affected by dietary treatment however the level of inclusion, 6 or 8 per cent significantly increased the mortality rate. Data from the present study indicated that up to 4 per cent level of Sun-dried raw guava by-product containing diet could be utilized effectively by finisher broiler chicks without adversely affecting on performance parameters.

### 2.3 Layer

Gohl (1975) made an attempt to increase the usefulness of citrus pulp by drying and reported that dried citrus pulp at 10 per cent inclusion had reduce the growth rate in chickens and may be toxic at level 30 per cent when added to diets of layers, it adversely affect the yolk colour.

Yang and Chung (1986) studied the utilization and feeding value of dried citrus by-product on layers. 150 hens initially 19 weeks old were given basal diets containing maize 60, wheat bran 10, soybean meal 16, and fish meal 3.5 per cent or with 5, 10, or 15 per cent dried citrus peel or 5 per cent dried citrus segment and pulp, generally replacing bran. Egg weight and average daily egg mass decreased in the last two groups. The diets with 15 per cent dried citrus peel decreased protein digestibility and dry matter and reduced feed efficiency. There was no significant difference between the groups in weight gain was reported.

Velloso (1988) conducted an experiment on pelted orange pulp in the diets of laying hens. When Pelted orange pulp was included at 10 per cent level by partially replacing maize, it does not affect growth and age of sexual maturity.

Bhat *et al.* (2005) studied the effect of feeding different levels of apple pomace in the ration with or without supplementation on the performance of pullets. A trial was conducted on 315 pullets, distributed in 7 treatments groups in deep litter system to assess the effect of replacing maize by apple pomace in the ration at 0, 10, 15, and 20 per cent levels with or without enzyme supplementation, on age at sexual maturity, egg production, egg weight, and mortality. There was no significant effect on age at sexual maturity among the different groups, though it was numerically higher in the groups in which maize was replaced by apple pomace at different levels irrespective of enzyme supplementation. Numerical decrease in egg production was observed by replacing maize by apple pomace at 10 and 15% levels with enzyme supplementation which was not statically

significant, but significant adverse effect was observed in those groups where replacement was made at the same level (10 and 15%) without enzyme supplementation and at 20 per cent level with or without enzyme supplementation. Numerically but statically insignificant increase in egg weight was observed in the groups in which maize was replaced by apple pomace at 10 per cent with enzyme supplementation and 15 per cent with or without enzyme supplementation, but when the replacement was made at 10 per cent level without enzyme supplementation and 20 per cent with or without enzyme supplementation increase in eggs weight was statically significant.

Odunsi (2005) conducted an experiment to assess the nutritive value and utilization of mango (*Mangifera indica* L.) seed kernel (MSK) in the diets of layer chickens. Meal from the seed kernel contained 61.6 g crude protein, 136.2 g ether extract, 22.3 g ash, 46.4 g crude fibre, 673.5 g nitrogen-free extract and appreciable mineral content. MSK replaced with maize on weight by weight basis at 0, 50, 100, 150, 200 and 250 g/kg. Results indicated a significant decrease ( $P < 0.05$ ) in feed intake, rate of lay, egg mass and feed efficiency with increase in dietary level of MSK. Layers on 150, 200 and 250 g/kg MSK exhibited the highest body weight losses. The results indicated that at higher levels, MSK can not readily substituted maize in layer diets

Yang, Seung-Ju *et al.* (2008) studied the effect of feeding citrus by-products on nutritional properties of Korean native chickens. Two samples of Korean native chicken eggs were used for this study:  $T_0$  (Eggs of chickens that were not fed with citrus byproducts until they became 30 weeks old) and  $T_1$  (Eggs of chickens that were fed with 4% citrus byproducts when they were between 17 and 30 weeks old). There was no statistically difference between  $T_0$  and  $T_1$  in terms of various properties, such as general components of egg albumen and yolk, total structural amino acid, and total free amino acid. Also, no significant difference was noticed between  $T_0$  and  $T_1$  in terms of various components of egg yolk, such as amount of mineral,

vitamin, and xanthophyll, which showed that those components are not affected by citrus byproducts. However, the amount of cholesterol of egg yolk for T<sub>1</sub> was 1,168 mg/100 g, which was significantly lower than that of T<sub>0</sub> which was 1,207 mg/100 g (P<0.05). The amount of L-glutamic acid, one of the free amino acids, of the egg albumen was 39.22 and 58.54 ppm for T<sub>0</sub> and T<sub>1</sub>, respectively. The results of this study showed that citrus by-products can be used for the feed for Korean native chickens by adding them to general feed.

## 2.4 Ostrich

Lanza, *et al* (2004) conducted a trial to study the effect of citrus pulp inclusion in ostrich diets on meat quality, evaluated on *iliofibularis* and *gastrocnemius* muscles. *M. iliofibularis* had a lower ultimate pH (P<0.05) and was lighter in colour (P<0.05) than *M. gastrocnemius*. The latter had higher moisture (P<0.05) and lower crude protein contents (P<0.05) as compared to *M. iliofibularis*. Citrus pulp diet increased (P<0.05) meat ultimate pH and reduced cooking losses (P<0.05) as compared to the control diet. Meat from animals given citrus pulp had lower crude fat (P<0.05) and ash percentages (P<0.05) in comparison to that from the control group. The proportions of intramuscular saturated and monounsaturated fatty acids were lower (P<0.05) in the citrus pulp group as compared to the control one. Meat from the citrus pulp treatment group had a higher (P<0.05) percentage of polyunsaturated fatty acids than meat from the control groups. Overall, the use of a citrus pulp in ostrich diet did not adversely affect meat quality and, therefore, citrus pulp seems to be a possible ingredient to reduce feeding costs.



Chapter III

*Materials and Methods*

## **CHAPTER III**

### **MATERIALS AND METHODS**

The present study was undertaken at Poultry Research Centre, Post Graduate Institute of Veterinary and Animal Sciences, Akola. The total experimental period was 42 days from 17<sup>th</sup> May to 29<sup>th</sup> June of 2009. The experimental trial was conducted with the objective to study the "Utilization of Orange pomace at different levels in broiler diet".

#### **3.1 Procurement of Orange Pomace**

Orange pomace is agro-industrial left over material of orange processing unit, was collected from NOGA (Nagpur Orange Groups Association) and Bagh fruits processing factory, Hingana Road, Nagpur. After collection of orange pomace, it was sun dried and after drying, seeds were separated manually. After separation of seeds, dried orange pomace was coarsely ground. Other feed ingredients were purchased locally for preparation of broiler ration.

#### **3.2 Experimental Trial**

Two hundred and forty day old commercial straightrun broiler chicks were purchased from Venkateshwara Hatcheries, Pune for this experiment. The chicks were wing banded and randomly distributed into five treatment groups with three replicates having 16 chicks in each replicates.

#### **3.3 Management**

The chicks were reared on deep litter system. Saw dust was used as the litter material. The chicks were provided with clean and fresh water throughout the experimental period. During first 10 days of brooding period "Lixen" powder was added in drinking water at the dose rate of 0.5



**Plate 1. Orange pomace before sun drying**



**Plate 2. Orange pomace after sun drying**



**Plate 3. Coarsely ground orange pomace**

g/litre as a preventive medication against *Salmonella*, *Coliforms*, etc. Vimeral (Vit. A, D<sub>3</sub>, E, B<sub>12</sub>) was also added in drinking water @ 4 ml/litre of water during early days.

The chicks were immunized against Marek's disease at the Hatchery on day old age. The chicks were also vaccinated against Ranikhet and Gumboro (I.B.D.) disease.

**Table 1. Vaccination schedule followed during chick management**

Age of birds	Vaccine	Route
5 <sup>th</sup> day	Lasota strain	Intra ocular
14 <sup>th</sup> day	Mild strain (I.B.D.)	Intra ocular

Broiler prestarter mash was provided from day old to first week, later on broiler starter mash was provided from second to third weeks and broiler finisher mash from fourth to sixth weeks of age. The diets for all the treatment groups were maintained isocaloric and isonitrogenous. Orange pomace was incorporated at the levels of 0, 3, 5, 7 and 10% at the expense of maize. The diets were prepared as per National standards (2005). Orange pomace was included at different levels in the broiler diets as given in Table2.

The birds were offered feed and water ad-libitum. Uniform managerial practices were followed for all treatment groups during the experimental period.

### 3.4 Details of treatments

**Table 2. Details of dietary treatments**

Treatments	Details of treatment
A	Corn Soya (Basal diet)
B	Corn Soya diet + 3% orange pomace
C	Corn Soya diet + 5% orange pomace
D	Corn Soya diet + 7 % orange pomace
E	Corn Soya diet +10 % orange pomace

### 3.5 Chemical Composition of Orange Pomace (D.M. Basis)

The chemical analysis of orange pomace was carried out at Department of Animal Nutrition P.G.I.V.A.S. Akola as per A.O.A.C. (1990). The chemical composition of orange pomace is presented in Table 3.

**Table 3. Chemical composition of Orange pomace (D.M. Basis)**

Particulars	Percentage
Dry matter	92.10
Crude Protein	7.76
Ether extract	4.96
N.F.E.	71.95
Crude Fibre	11.00
Total ash	4.33
*ME(Kcal/kg)	2900

\* - Calculated as per the equation proposed by Lodhi *et al.* (1976).  
Metabolizable energy =  $32.25 (\% \text{crude protein} + \% \text{ether extract} \times 2.25 + \text{available carbohydrate}) - 29.20$

### 3.6 Per cent Composition of Experimental Diets

The per cent composition of experimental broiler prestarter, starter and finisher diets with different levels of orange pomace is presented in Table 4.

### 3.7 Parameters Studied

#### 3.7.1 Weekly weight gains and cumulative body weight

The broiler chicks were individually weighed on electronic weighing balance at first day of experiment, then at weekly intervals up to six weeks of age, weekly body weight gain was calculated by subtracting the weight at previous week and cumulative body weight gain was determined treatment wise by adding weekly body weight gain per bird in previous weeks along with weekly body weight of that particular week.

**Table 4. Percent composition of experimental diets**

Sr. No.	Feed Ingredient (kg)	Pre starter					Starter					Finisher				
		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
1	Maize, yellow	50.66	47.61	45.41	43.21	39.62	51.50	48.25	46.15	42.50	40.85	39.85	53.15	50.95	48.85	45.36
2	Soybean, DOC	42	42	42	42	42.4	39.65	39.70	39.70	39.85	39.70	34	34	34	34	34.19
3	Orange pomace	-----	3	5	7	10	-----	3	5	7	10	-----	3	5	7	10
4	Edible oil	3.5	3.6	3.8	4	4.2	5	5.2	5.3	5.6	5.8	6	6.2	6.3	6.6	
5	DL-methionine	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	
6	Trace mineral Mix.	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	
7	Vitamin Mix.	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	
8	Dicalcium phosphate (DCP)	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	
9	Lime stone Powder (LSP)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	
10	Salt	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	
11	Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
	<b>Nutrients</b>															
12	Crude protein	23.09	22.99	22.94	22.90	22.98	22.07	21.99	21.99	21.92	22.92	20.03	19.97	19.92	19.92	
13	Crude fibre	4.02	4.25	4.43	4.58	4.82	3.91	4.15	4.31	4.43	4.70	3.73	3.96	4.11	4.27	
14	Lysine	1.38	1.37	1.36	1.36	1.36	1.20	1.30	1.30	1.29	1.28	1.15	1.14	1.14	1.12	
15	ME Kcal/kg(Calculated)	2999.5	2995.5	2998.5	3001.5	2999.7	3103	3101.5	3099.06	3093.5	3095.56	3196.15	3195.15	3198.15	3196	3193.77

Vitamin Mix includes (per Quintal of feed) - Vit.A, B2, D3, K-10g, Vit.B care plus-20g, DOT-50g, choline chloride-50g, Antioxidant-15g and Trace mineral-5g (Mn, I, Zn, Fe and Cu).

### **3.7.2 Weekly and cumulative feed consumption**

Weekly feed consumption was recorded by subtracting the left over feed from total feed offered during the week and cumulative feed consumption was work out for all the treatment groups by adding the feed consumption of previous weeks along with feed consumption of that particular week.

### **3.7.3 Weekly and cumulative feed conversion ratio**

Weekly feed conversion ratio was calculated in terms of Feed: Gain ratio by using formula.

$$\text{FCR} = \frac{\text{Total feed consumed}}{\text{Total gain in body weight}}$$

### **3.7.4 Mortality percentage**

▫Mortality and gross pathological observation of dead birds, was recorded for each group and treatment wise separately during the experimental period.

### **3.7.5 Dressing percentage**

Dressing percentage was determined by using following formula.

$$\text{Dressing percentage} = \frac{\text{Weight (g) after slaughter}}{\text{Live weight (g) before slaughter}} \times 100$$

#### **3.7.5.1 Edible meat per cent**

Edible meat percent was calculated by using following formula.

$$\text{Edible meat per cent} = \frac{\text{Weight of edible meat (g)}}{\text{Live weight (g) before slaughter}} \times 100$$

### **3.7.6 Economics**

The economics of broiler production was worked out by considering the total cost of production, which included the feed cost, chicks, labour, medicines, vaccine, and other overhead cost.

### **3.7.7 Statistical analysis**

The data collected during the experiment were analyzed statistically by using factorial completely randomized design as per Snedecor and Cochran (1994).



Chapter IV

*Results and Discussion*

## CHAPTER IV

### RESULTS AND DISCUSSION

Orange pomace, an agro-industrial by-product, which is left over of orange juice factory is widely available in the Vidharbha region of Maharashtra state. Therefore the present study was undertaken with an objective to study the utilization of orange pomace at different levels in broiler diets. In the present chapter the observations were recorded during the period of experiment were analyzed statistically and have been presented in systematic sequence.

#### 4.1 Weekly Live Body Weight

The average weekly live body weight of broilers from day old to six weeks of age in all treatment groups are presented in Table 5 and the same has been graphically depicted in Fig. 1. The analysis variance of average weekly live body weights are presented in Appendix-I.

**Table 5. Average weekly live body weights (g) of broilers from 0-6 weeks**

Weeks Treatment	0	I	II	III	IV	V	VI	Treatment mean
A	43.42 ± 1.48	124.06 ± 1.81	293.73 ± 3.50	622.92 <sup>a</sup> ± 11.45	933.96 <sup>c</sup> ± 9.52	1440.75 <sup>g</sup> ± 12.57	1825.27 ± 15.85	754.87 ± 34.63
B	43.15 ± 1.51	130.35 ± 1.97	309.44 ± 7.82	641.67 <sup>ab</sup> ± 3.28	975.77 <sup>d</sup> ± 7.28	1419.85 <sup>f</sup> ± 21.93	1831.21 ± 18.03	764.49 ± 34.56
C	43.65 ± 0.46	128.94 ± 1.69	290.73 ± 5.67	603.94 <sup>a</sup> ± 18.47	936.65 <sup>c</sup> ± 10.24	1372.33 <sup>e</sup> ± 15.63	1817.35 ± 15.71	741.94 ± 34.08
D	42.25 ± 1.25	125.35 ± 3.10	295.79 ± 3.19	636.35 <sup>b</sup> ± 5.34	919.17 <sup>c</sup> ± 13.88	1411.85 <sup>f</sup> ± 39.59	1815.75 ± 47.36	749.50 ± 35.19
E	41.21 ± 1.24	128.42 ± 2.33	297.63 ± 3.70	623.94 <sup>a</sup> ± 18.70	913.04 <sup>c</sup> ± 13.50	1413.73 <sup>f</sup> ± 16.94	1807.10 ± 17.03	746.58 ± 34.23
Week mean	42.73 <sup>a</sup> ± 1.39	127.43 <sup>b</sup> ± 2.18	297.46 <sup>c</sup> ± 4.78	625.76 <sup>d</sup> ± 11.45	935.72 <sup>e</sup> ± 10.88	1411.70 <sup>f</sup> ± 21.33	1819.54 <sup>g</sup> ± 22.79	

Mean values bearing the common alphabet as a superscript within column do not differ significantly (P<0.05)  
 CD for treatment (A) = 22.85  
 CD for week (B) = 29.82  
 CD for interaction = 40.42

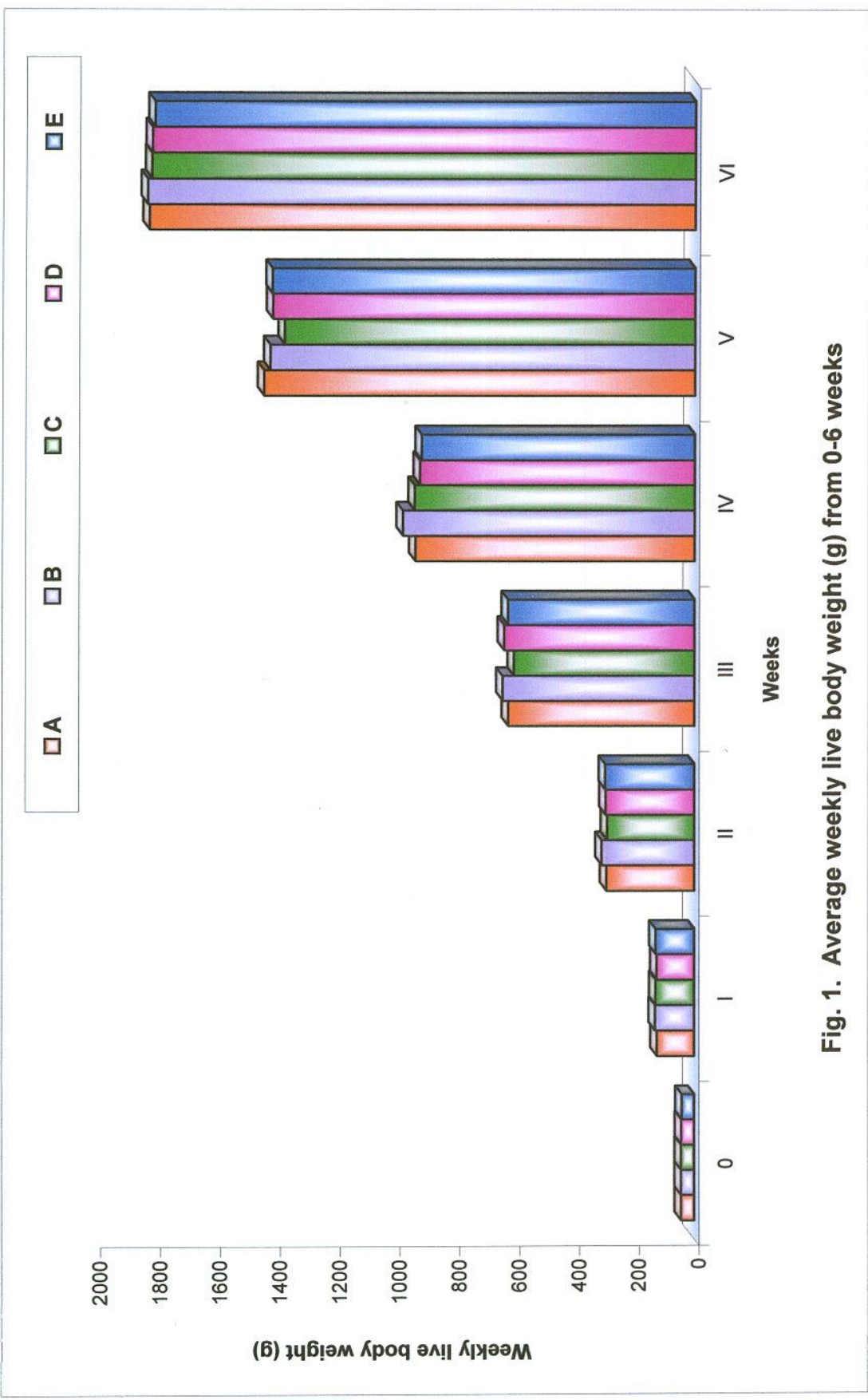


Fig. 1. Average weekly live body weight (g) from 0-6 weeks

It is seen from the present results that the mean live body weights of broilers at day old stage were  $43.42 \pm 1.48$ ,  $43.15 \pm 1.51$ ,  $43.65 \pm 0.46$ ,  $42.25 \pm 1.25$  and  $41.21 \pm 1.24$  g for the treatments A, B, C, D and E groups respectively with the mean value  $42.73 \pm 1.39$  g. The initial body weights of broilers were nearly the same in all dietary treatments. This shows that the treatment groups were homogenous in nature showing proper randomization of treatments.

At the end of 6<sup>th</sup> week the live body weights for groups A, B, C, D and E were  $1825.27 \pm 15.85$ ,  $1831.21 \pm 18.03$ ,  $1817.35 \pm 15.71$ ,  $1815.75 \pm 47.36$  and  $1807.10 \pm 17.03$  g respectively.

The highest body weight was found in group B ( $1831.21 \pm 18.03$  g) while the lowest in group E ( $1807.11 \pm 17.03$  g). The difference between these treatment groups were found to be non-significant.

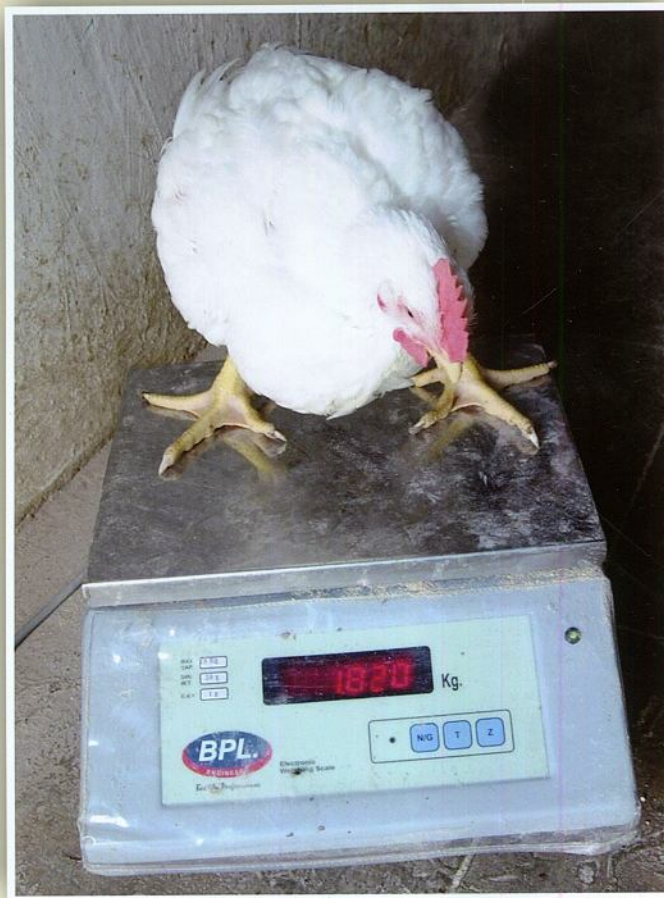
The average weekly live body weights from first to sixth weeks in different treatment groups viz., A, B, C, D and E were in the range of  $124.06 \pm 1.81$  to  $1825.27 \pm 15.85$ ,  $130.35 \pm 1.97$  to  $1831.21 \pm 18.03$ ,  $128.94 \pm 1.69$  to  $1817.35 \pm 15.71$ ,  $125.35 \pm 3.10$  to  $1815.75 \pm 47.36$  and  $128.42 \pm 2.33$  to  $1807.11 \pm 17.03$  g, respectively.

The weekly live body weights for different treatment mean ranged from  $741.94 \pm 34.08$  to  $764.49 \pm 34.56$  g. There was non significant difference among the treatment mean.

The weekly live body weights for 1<sup>st</sup> to 6<sup>th</sup> week mean were differed significantly in the range of  $127.43 \pm 2.18$  to  $1819.54 \pm 22.79$  g. The live body weight of all treatment upto 2<sup>nd</sup> week were found to be non-significant. However, significant difference were found from 3<sup>rd</sup> to 5<sup>th</sup> week ( $P < 0.05$ ). The interactions between treatments and weeks were found to be significant.



**Plate 4. Broiler under 10 per cent orange pomace feeding at 6<sup>th</sup> week**



**Plate 5. Weighing of broiler at 6<sup>th</sup> week**

## 4.2 Weekly Live Body Weight Gain

The average weekly body weight gain of broilers from first to sixth week of age in all treatment groups are presented in Table 6 and the same has been graphically depicted in Fig. 2. The analysis of variance of average weekly body weight gain are given in Appendix-II.

**Table 6. Average weekly live body weight gain (g) in broilers**

Weeks Treatment	I	II	III	IV	V	VI	Treatment mean
A	80.65 ±2.42	169.67 ±4.16	329.19 ±12.51	311.04 ±14.71	506.79 ±14.59	384.52 ±11.69	296.98 ±9.36
B	87.21 ±2.40	179.08 ±8.24	332.23 ±8.62	332.44 ±8.62	449.92 ±23.31	407.19 ±15.02	298.01 ±9.08
C	85.29 ±1.97	161.79 ±6.01	313.21 ±15.81	332.71± 21.84	435.69 ±19.16	445.02 ±16.45	295.62 ±9.99
D	84.87 ±3.12	170.44 ±4.71	340.56 ±6.69	282.81 ±12.84	492.69 ±21.66	412.49 ±6.54	297.31 ±11.08
E	87.53 ±2.36	169.21 ±4.79	326.31 ±18.82	289.10 ±24.51	500.69 ±21.29	394.38 ±11.74	294.54 ±10.41
Week mean	85.11 <sup>a</sup> ±1.11	170.04 <sup>b</sup> ±2.58	328.30 <sup>c</sup> ±5.91	344.06 <sup>d</sup> ±7.86	477.15 <sup>f</sup> ±11.56	408.72 <sup>e</sup> ±5.82	

Mean values bearing the common alphabet as a superscript within column do not differ significantly ( $P < 0.05$ )

CD for treatment (A) = 17.03

CD for week (B) = 24.17

CD for interaction (A x B) = 32.20

The average weekly body weight gain of broilers at sixth week in different treatment groups viz., A, B, C, D and E were  $384.52 \pm 11.69$ ,  $407.19 \pm 15.02$ ,  $445.02 \pm 16.45$ ,  $412.49 \pm 6.54$  and  $394.38 \pm 11.74$  g, respectively. The weekly body weight gain for treatment mean were ranged between  $294.54 \pm 10.41$  to  $298.01 \pm 9.08$  g. There were non significant difference between the treatments mean, whereas comparatively better weight gain was observed in 3 per cent orange pomace group B among the treatment mean.

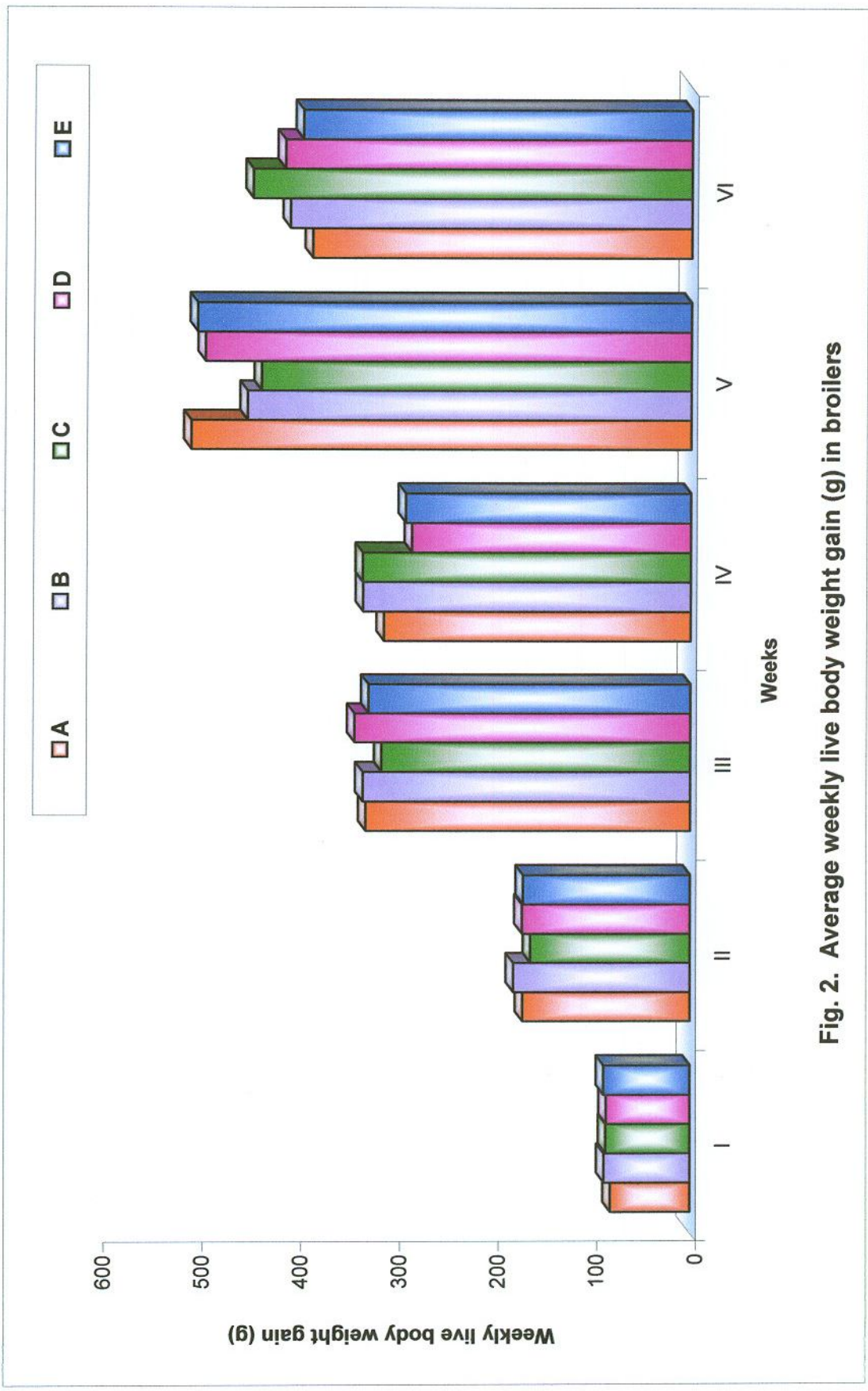


Fig. 2. Average weekly live body weight gain (g) in broilers

The mean body weight gain for weeks were found to be increased from first to fifth week which range from  $85.11 \pm 1.11$  to  $477.15 \pm 11.56$  g, where the differences among the weeks interval were statistically significant ( $P < 0.01$ ). The weekly body weight gain in all the treatments were observed highest in 5<sup>th</sup> week as compared to 1<sup>st</sup> to 4<sup>th</sup> week.

### 4.3 Weekly Cumulative Body Weight Gain

The average weekly cumulative body weight gain of broilers from first to six week of age in all treatment groups are presented in Table 7 and the same has been graphically depicted in Fig. 3. The analysis of variance of average weekly cumulative body weight gain are presented in Appendix-III.

**Table 7. Average weekly cumulative weight gain (g) in broilers**

Weeks Treatment	I	II	III	IV	V	VI	Treatment mean
A	80.65 ±2.42	250.31 ±3.50	579.50 ±12.57	890.54 ±9.74	1397.33 ±12.10	1781.85 ±15.53	830.03 ±35.93
B	87.21 ±2.40	266.29 ±8.01	598.52 ±3.57	930.96 ±7.23	1380.88 ±20.61	1788.06 ±17.89	841.77 ±35.70
C	85.29 ±1.97	247.08 ±6.08	560.29 ±19.02	893.00 ±10.47	1328.69 ±16.00	1773.71 ±15.80	814.68 ±35.39
D	84.87 ±3.12	253.54 ±3.39	594.10 ±5.69	876.92 ±14.03	1369.60 ±40.46	1773.50 ±48.31	825.42 ±36.77
E	87.53 ±2.36	254.92 ±4.18	581.23 ±19.47	870.33 ±13.54	1371.02 ±16.78	1767.13 ±16.14	821.72 ±35.51
Week mean	85.11 <sup>a</sup> ±1.11	254.43 <sup>b</sup> ±2.40	582.73 <sup>c</sup> ±6.15	892.35 <sup>d</sup> ±5.19	1369.50 <sup>e</sup> ±10.50	1776.85 <sup>f</sup> ±11.58	

Mean values bearing the common alphabet as a superscript within column do not differ significantly ( $P < 0.05$ )

CD for treatment (A) = 27.90

CD for week (B) = 26.12

CD for interaction (A x B) = 52.39

The average weekly cumulative body weight gain of broilers at sixth week of age in various groups i.e. A, B, C, D and E were  $1781.85 \pm$

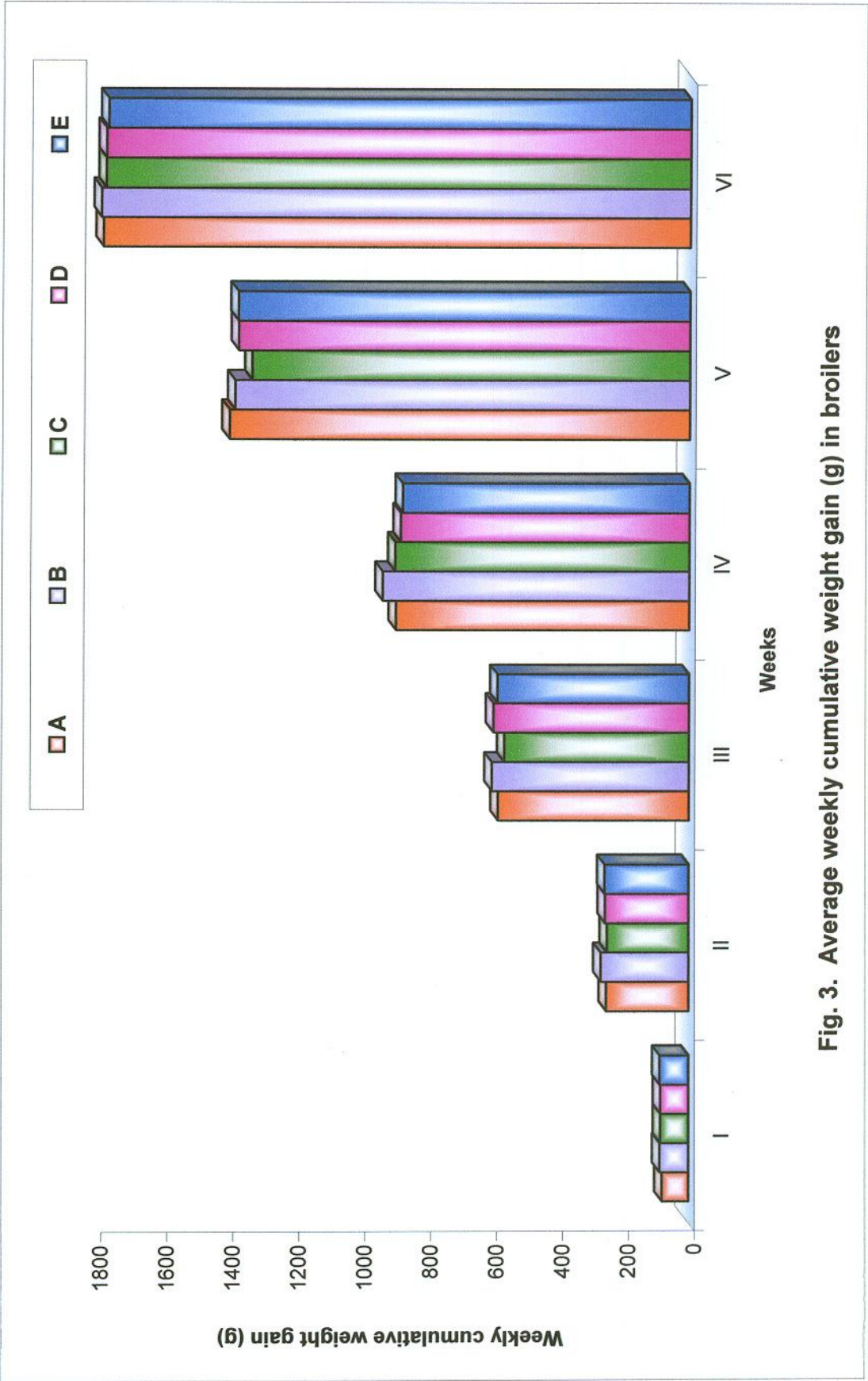


Fig. 3. Average weekly cumulative weight gain (g) in broilers

15.53,  $1788.06 \pm 17.89$ ,  $1773.71 \pm 15.80$ ,  $1773.50 \pm 48.31$  and  $1767.13 \pm 16.14$ g respectively.

The overall weekly cumulative body weight gain for the treatment mean ranged between  $814.68 \pm 35.39$  to  $841.77 \pm 35.70$  g whereas the higher cumulative weight gain was found in group B ( $1788.06 \pm 17.89$  g) and lowest for group E ( $1767.13 \pm 16.14$  g) and the differences between treatments mean were non significant.

The overall cumulative body weight gain of broilers for the week mean were ranged from  $85.11 \pm 1.11$  to  $1776.85 \pm 11.58$  g and the comparison of week mean indicated the significant difference between successive weeks. The interactions between treatments and weeks were found to be significant.

Numerically slight increase in live body weight in experimental diet may be due to the fat contain present in rind, a fraction of orange pomace it may be advantages not only as dietary energy source but also in binding the powdery constitute of mash feed (Oluremi *et al.*, 2006). The reduction of dustiness in absence of pelleting may increase feed in take and there by slight improvement in performance of broilers.

Feeding orange pomace up to 10 per cent level was similar live body weight in broiler chicks receiving the basal diet (control). The chicks receiving the 10 per cent orange pomace had the lowest live body weight among the experimental groups. The reduce intake observed in birds of these group might be the reason behind that. However the high fibre intake by the chicks might cause rapid passaging rate of digestive tract in chickens which caused the slight depression in body weight gain. (Rabayaa *et al.*, 2001).

These observations are in accordance with Kang and Chol (1984) who reported broiler chicks fed 2 per cent and 4 per cent of citrus peel gained numerically more weight and consumed more feed than those fed the basal diets without citrus peel. Citrus peel at 6 per cent level showed slight decreased weight gain and feed intake. Similarly Yang and Chung (1984) reported that weight gain and feed intake tended to fall as the level of citrus increased.

The similar findings were reported by Kukde (1990) who found non-significant difference in the body weight gained between the treatment and control groups. Patel *et al.* (2001) also found non-significant difference between treatment groups on body weight gain when orange pomace was incorporated at different levels in broiler diet. Oluremi *et al.* (2007) reported non-significant difference ( $P>0.05$ ) in live weights of broilers among the treatment receiving the sweet orange peel meal based diets. Rabayaa *et al.* (2001) reported that weight gain of chicks was the same in chicks consuming up to 7.5 per cent of olive pulp. However, weight gain of chicks fed 10 per cent olive pulp had lowest ( $P<0.05$ ) weight gain.

The present finding are also in agreement with Oluremi *et al.* (2006), who reported non significant effect ( $P>0.05$ ) on body weight gain when broiler chickens fed with sun dried sweet orange (*Citrus sinensis*) rind (SOR). Kumar *et al.* (2008) reported the non significant difference in body weight gain when mango seed kernel were fed to broiler starter from 0-4 weeks of age.

Yang and Chung (1986) reported non significant difference between the groups in weight gain when layers were fed with dried citrus by-product.

#### **4.4 Weekly Feed Consumption**

Average weekly feed consumption per bird was calculated from first to sixth weeks in each treatment groups and is presented in Table 8 and the same has been graphically depicted in Fig. 4. The analysis of variance for average weekly feed consumption are presented in Appendix-IV.

It revealed from the table that, treatment mean for feed consumption were  $589.88 \pm 20.25$ ,  $593.70 \pm 19.31$ ,  $586.06 \pm 18.69$ ,  $583.98 \pm 20.86$ ,  $580.78 \pm 19.65$  g for treatment A, B, C, D and E, respectively.

**Table 8. Average weekly feed consumption (g/bird/week) of broilers**

Weeks Treatment	I	II	III	IV	V	VI	Treatment mean
A	97.34 ± 1.85	295.19 ± 6.34	602.38 ± 3.52	559.45 ± 10.72	1011.03 ± 2.82	973.88 ± 21.25	589.88 ± 20.25
B	126.91 ± 3.86	312.17 ± 4.00	608.67 ± 0.88	549.57 ± 11.59	1006.96 ± 1.08	957.89 ± 23.52	593.70 ± 19.31
C	102.00 ± 1.93	291.15 ± 1.41	592.71 ± 5.12	637.94 ± 8.33	908.13 ± 11.17	984.43 ± 3.33	586.06 ± 18.69
D	101.02 ± 1.86	290.92 ± 4.64	615.10 ± 1.19	476.60 ± 11.30	1041.42 ± 6.99	978.86 ± 7.87	583.98 ± 20.86
E	98.02 ± 1.82	305.25 ± 0.20	607.08 ± 1.52	510.74 ± 10.40	1060.26 ± 7.01	903.35 ± 6.87	580.78 ± 19.65
Week mean	105.06 <sup>a</sup> ± 1.30	298.93 <sup>b</sup> ± 1.85	605.19 <sup>c</sup> ± 1.39	546.86 <sup>d</sup> ± 5.90	1005.56 <sup>f</sup> ± 4.55	959.68 <sup>e</sup> ± 8.81	

Mean values bearing the common alphabet as a superscript within column do not differ significantly (P<0.05)

CD for treatment (A) = 13.90  
 CD for week (B) = 15.49  
 CD for interaction (A x B) = 27.14

The treatment mean were found to be non significant. The highest weekly feed consumption was found in 3% orange pomace group B and lowest in 10% orange pomace group E.

The weekly feed consumption for the different week mean was in the range of 105.06 ± 1.30 to 1005.56 ± 4.55 g and varied significantly. The interaction between treatment and weeks were found to be significant.

#### 4.5 Cumulative Feed Consumption

The average cumulative feed consumption per bird from first to sixth weeks in different treatment groups are presented in Table 9 and the same has been graphically depicted in Fig. 5. The analysis of variance is presented in Appendix-V.

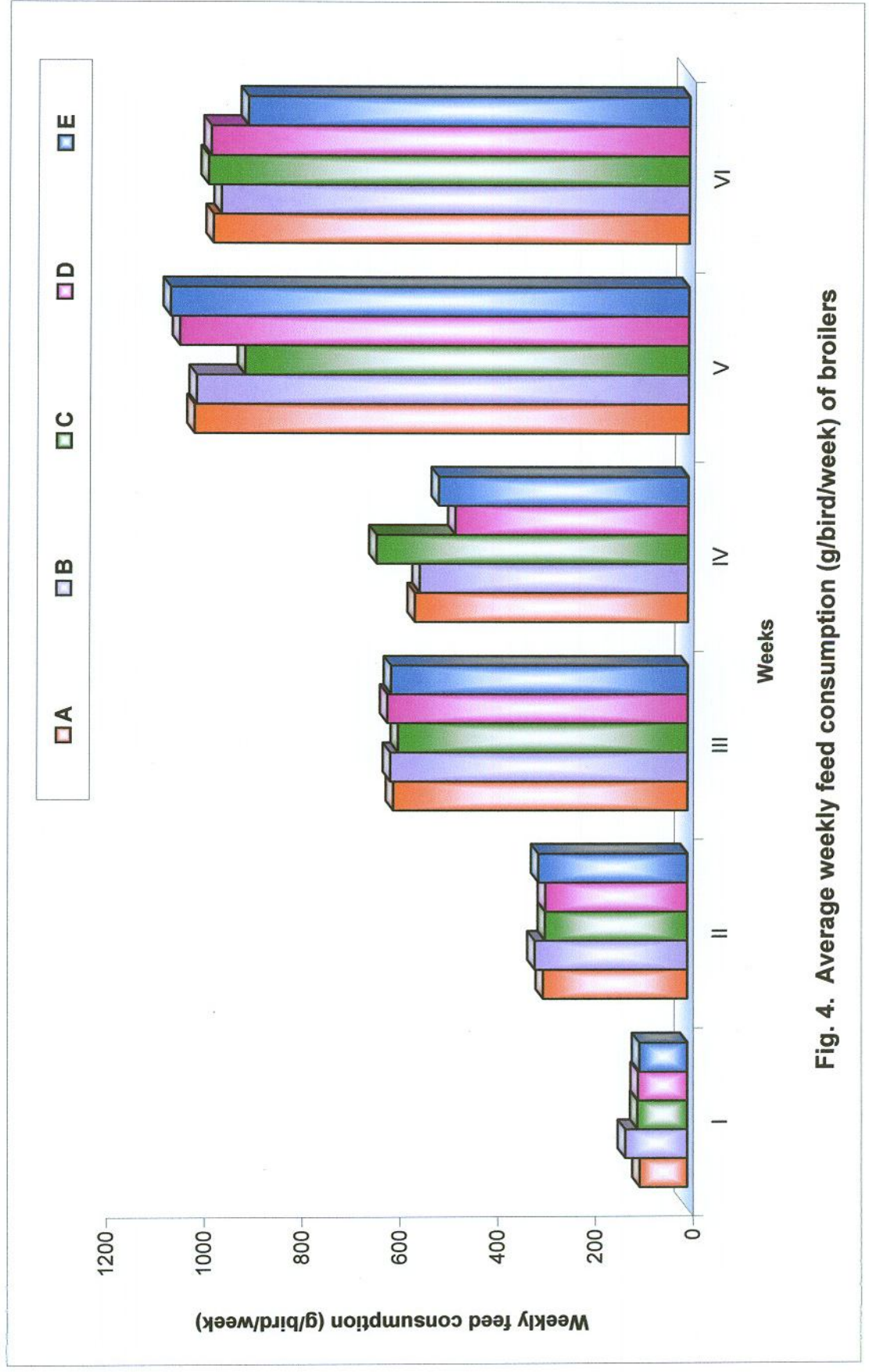


Fig. 4. Average weekly feed consumption (g/bird/week) of broilers

**Table 9. Average cumulative feed consumption (g/bird) of broilers**

Treatment \ Weeks	I	II	III	IV	V	VI	Treatment mean
A	97.34 ± 1.85	390.50 <sup>a</sup> ± 4.77	997.88 <sup>c</sup> ± 4.47	1560.98 <sup>f</sup> ± 15.60	2546.91 <sup>h</sup> ± 10.61	3512.61 <sup>k</sup> ± 43.18	1517.70 ± 71.18
B	126.91 ± 3.86	436.44 <sup>b</sup> ± 3.96	1045.10 <sup>d</sup> ± 3.88	1580.30 <sup>fg</sup> ± 17.85	2590.19 <sup>i</sup> ± 17.51	3495.00 <sup>k</sup> ± 34.60	1545.22 ± 70.18
C	102.00 ± 1.93	391.02 <sup>a</sup> ± 2.93	1013.81 <sup>dc</sup> ± 24.60	1608.38 <sup>g</sup> ± 20.81	2516.51 <sup>h</sup> ± 25.44	3480.43 <sup>k</sup> ± 43.72	1518.69 ± 70.56
D	101.02 ± 1.86	389.83 <sup>a</sup> ± 4.07	1054.52 <sup>d</sup> ± 30.89	1471.60 <sup>e</sup> ± 16.41	2576.90 <sup>i</sup> ± 33.68	3471.48 <sup>j</sup> ± 48.16	1511.23 ± 70.95
E	98.02 ± 1.82	401.23 <sup>ab</sup> ± 2.78	1008.31 <sup>c</sup> ± 3.25	1513.38 <sup>e</sup> ± 20.55	2548.96 <sup>hi</sup> ± 20.24	3436.94 <sup>j</sup> ± 46.16	1501.33 ± 69.93
Week mean	105.06 <sup>a</sup> ± 1.30	401.80 <sup>b</sup> ± 2.03	1023.93 <sup>c</sup> ± 8.07	1546.93 <sup>d</sup> ± 8.73	2555.89 <sup>e</sup> ± 10.27	3479.29 <sup>f</sup> ± 19.32	

Mean values bearing the common alphabet as a superscript within column do not differ significantly (P<0.05)

CD for treatment (A) = 44.10

CD for week (B) = 36.75

CD for interaction (A x B) = 45.50

At the end of 6<sup>th</sup> week the cumulative feed consumption observed in different treatments viz., A, B, C, D and E were 3512.61 ± 43.18, 3495.00 ± 34.60, 3480.43 ± 43.72, 3471.48 ± 48.16 and 3436.94 ± 46.16 g respectively. The highest feed consumption noted in group A (3512.61 ± 43.18 g) while lowest in group E (3436.94 ± 46.16 g).

The weekly cumulative feed consumption for the various treatment mean ranged between 1501.33 ± 69.93 to 1545.22 ± 70.18 g. No significant difference was found in cumulative feed consumption within treatment mean.

The average cumulative feed consumption for the week mean were in the range of 105.06 ± 1.30 to 3479.29 ± 19.32 g, where the difference among all the week mean were found statistically significant. The cumulative feed consumption between treatment and weeks, interaction were significantly varied from 2<sup>nd</sup> weeks onward upto 6<sup>th</sup> weeks (P<0.05).

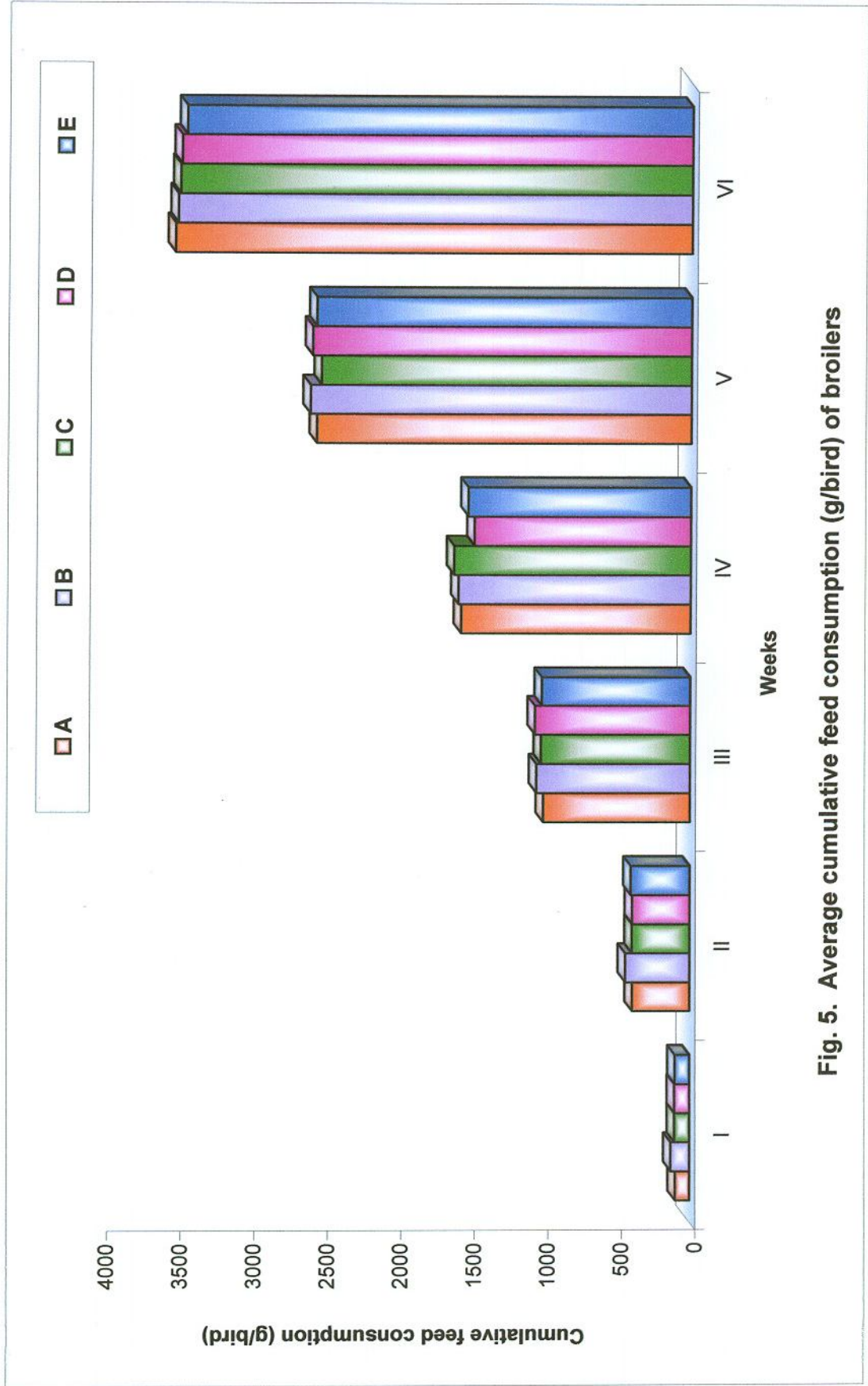


Fig. 5. Average cumulative feed consumption (g/bird) of broilers

Broiler birds receiving the 10 per cent level of orange pomace consumed less feed compared to other experimental groups. The reason for lower feed intake might be due to the high level of orange pomace which caused slight decreased the feed appetite.

D-limonene an appetite depressing factor, reported to be present in citrus rind (Jong-kyu *et al.*, 1996) which may have caused the depressed feed intake. Similarly slight drop in feed intake were observed as the level of orange pomace increased in diet could be an indication that the diet became quite less palatable due to bitter taste of pomace.

#### 4.6 Weekly Feed Efficiency

The average weekly feed efficiency in terms of feed intake per unit gain in weight for different dietary treatment groups from first to sixth weeks of age is presented in Table 10 and the same has been graphically depicted in Fig. 6. The analysis of variance of average weekly feed efficiency are presented in Appendix-VI.

**Table 10. Average weekly feed efficiency of broilers (0-6 weeks)**

Weeks Treatment	I	II	III	IV	V	VI	Treatment mean
A	1.28 ± 0.13	1.80 ± 0.06	1.79 ± 0.03	1.99 ± 0.12	2.08 ± 0.07	2.65 ± 0.17	1.93 ± 0.05
B	1.50 ± 0.11	1.74 ± 0.04	2.07 ± 0.25	1.67 ± 0.07	2.67 ± 0.20	2.43 ± 0.10	2.01 ± 0.07
C	1.19 ± 0.05	1.90 ± 0.11	1.65 ± 0.11	2.48 ± 0.39	2.26 ± 0.12	2.35 ± 0.12	2.00 ± 0.08
D	1.22 ± 0.02	1.71 ± 0.04	1.84 ± 0.04	2.02 ± 0.23	2.58 ± 0.21	2.38 ± 0.06	2.01 ± 0.06
E	1.14 ± 0.02	2.06 ± 0.23	1.89 ± 0.18	2.02 ± 0.21	2.18 ± 0.08	2.37 ± 0.11	2.04 ± 0.07
Week mean	1.28 <sup>a</sup> ± 0.04	1.89 <sup>b</sup> ± 0.05	1.99 <sup>b</sup> ± 0.07	2.18 <sup>b</sup> ± 0.10	2.27 <sup>c</sup> ± 0.07	2.47 <sup>c</sup> ± 0.05	

Mean values bearing the common alphabet as a superscript within column do not differ significantly (P<0.05)

CD for treatment (A) = 0.16

CD for week (B) = 0.23

CD for interaction (A x B) = 0.40

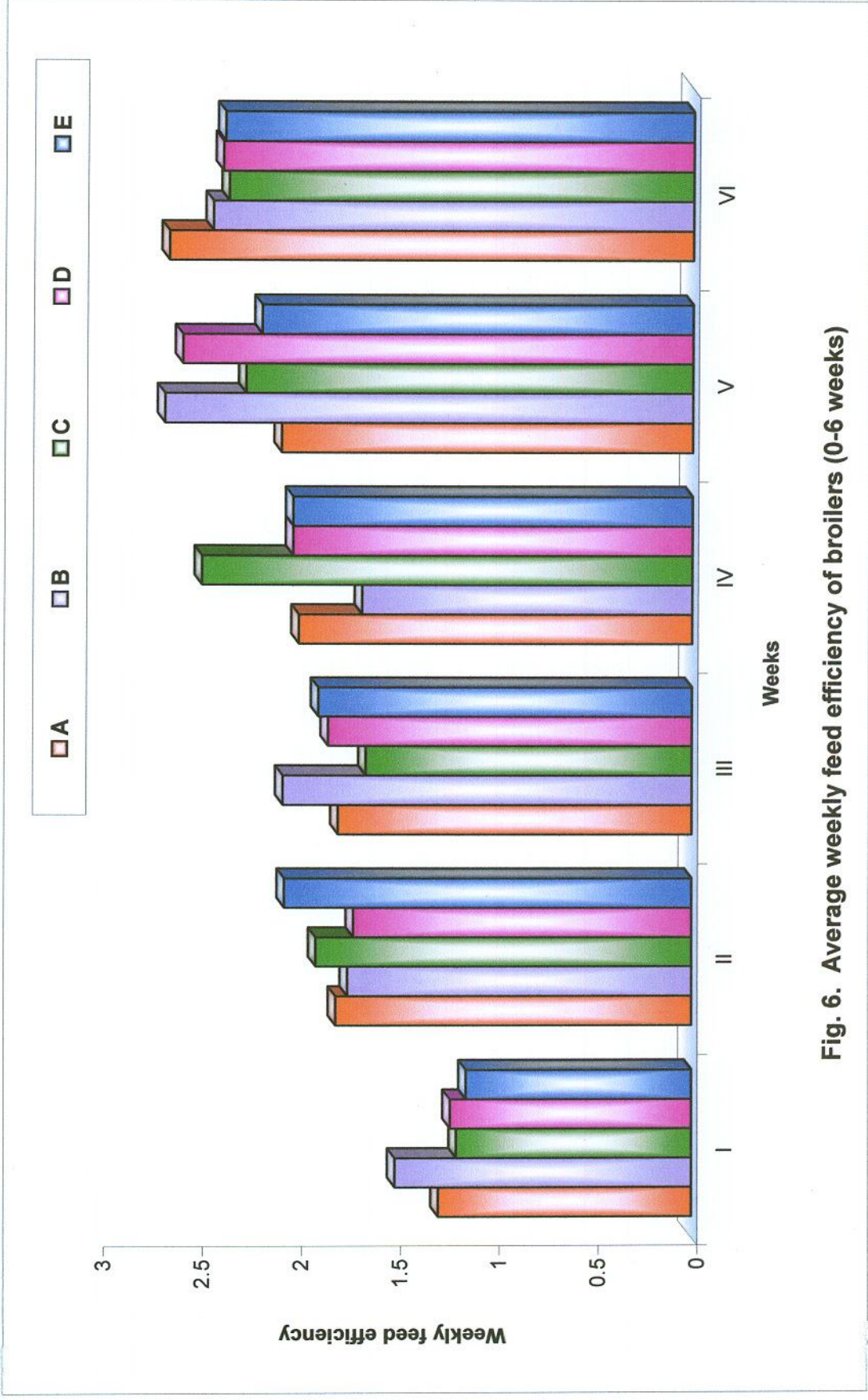


Fig. 6. Average weekly feed efficiency of broilers (0-6 weeks)

The feed efficiency at the end of 6<sup>th</sup> week for treatment A, B, C, D and E were  $2.65 \pm 0.17$ ,  $2.43 \pm 0.10$ ,  $2.35 \pm 0.12$ ,  $2.38 \pm 0.06$  and  $2.37 \pm 0.11$ , respectively.

The weekly feed efficiency of the treatment mean for A, B, C, D, and E were  $1.93 \pm 0.05$ ,  $2.01 \pm 0.07$ ,  $2.00 \pm 0.08$ ,  $2.01 \pm 0.06$  and  $2.04 \pm 0.07$  respectively. The weekly feed efficiency was found to be non significant within treatment mean. It was evident from the treatment mean that lowest FCR was in control group. It also seen that the FCR in all the experimental groups were similar.

The weekly feed efficiency of week mean ranged between  $1.28 \pm 0.04$  to  $2.47 \pm 0.05$  showing significant difference to each other.

The feed efficiency was statistically same in all treatment, but lower feed efficiency was observed in the chicks receiving the highest orange pomace level. The treatment mean value of efficiency indicated that orange pomace can be added to the broiler diets upto 10 per cent levels without any negative effect on feed efficiencies. A higher level than 10 per cent of orange pomace may creates a problem of wet litter and depressed feed efficiency perhaps due to high fibre content.

#### **4.7 Cumulative Feed Efficiency**

The average cumulative feed efficiency for different dietary treatment groups from first to sixth week of age is presented in Table 11 and the same has been graphically depicted in Fig. 7. The analysis of variance of average cumulative feed efficiency are presented in Appendix-VII.

At the 6<sup>th</sup> week, the cumulative feed efficiency of different treatments such as A, B, C, D and E were  $1.98 \pm 0.03$ ,  $2.00 \pm 0.05$ ,  $2.00 \pm 0.03$ ,  $1.95 \pm 0.02$  and  $2.00 \pm 0.09$ , respectively.

**Table 11. Average cumulative feed efficiency of broilers (0-6 weeks)**

Treatment \ Weeks	I	II	III	IV	V	VI	Treatment mean
A	1.28 <sup>ab</sup> ± 0.13	1.58 <sup>c</sup> ± 0.04	1.68 <sup>c</sup> ± 0.01	1.77 ± 0.03	1.83 <sup>d</sup> ± 0.02	1.98 ± 0.03	1.69 ± 0.02
B	1.50 <sup>bc</sup> ± 0.11	1.61 <sup>c</sup> ± 0.02	1.70 <sup>cd</sup> ± 0.01	1.75 ± 0.02	1.98 <sup>e</sup> ± 0.09	2.00 ± 0.05	1.76 ± 0.02
C	1.19 <sup>a</sup> ± 0.05	1.76 <sup>d</sup> ± 0.09	1.80 <sup>d</sup> ± 0.08	1.81 ± 0.03	1.91 <sup>de</sup> ± 0.03	2.00 ± 0.03	1.75 ± 0.03
D	1.22 <sup>a</sup> ± 0.04	1.55 <sup>c</sup> ± 0.03	1.70 <sup>c</sup> ± 0.05	1.77 ± 0.04	1.86 <sup>d</sup> ± 0.02	1.95 ± 0.02	1.76 ± 0.02
E	1.14 <sup>a</sup> ± 0.02	1.60 <sup>c</sup> ± 0.03	1.75 <sup>d</sup> ± 0.04	1.83 ± 0.04	1.87 <sup>d</sup> ± 0.03	2.00 ± 0.09	1.77 ± 0.03
Week mean	1.30 <sup>a</sup> ± 0.04	1.67 <sup>b</sup> ± 0.02	1.74 <sup>bc</sup> ± 0.02	1.77 <sup>c</sup> ± 0.02	1.94 <sup>d</sup> ± 0.02	2.03 <sup>d</sup> ± 0.02	

Mean values bearing the common alphabet as a superscript within column do not differ significantly ( $P < 0.05$ )

CD for treatment (A) = 0.09

CD for week (B) = 0.10

CD for interaction (A x B) = 0.23

The cumulative feed efficiency of broilers for the treatment mean ranged between  $1.69 \pm 0.02$  to  $1.77 \pm 0.03$ . However, better feed efficiency was noted for A ( $1.69 \pm 0.02$ ). The weekly cumulative feed efficiency for broilers was found to be non-significant within treatment groups.

The cumulative feed efficiency for the week mean ranged from  $1.30 \pm 0.04$  to  $2.03 \pm 0.02$ . It is revealed that average cumulative feed efficiency for weeks differs significantly. The interaction between treatment and weeks for weekly cumulative feed efficiency of broilers was statistically significant from 1<sup>st</sup> to 5<sup>th</sup> week ( $P < 0.05$ ) except 4<sup>th</sup> week.

The observation of feed consumption and feed efficiency in the present experiment are in agreement with Oluremi *et al.* (2006) who reported non significant effect ( $P > 0.05$ ) on feed intake, feed conversion ratio when broiler chickens fed with sun dried sweet orange (citrus sinensis) rind (SOR) at 0,5,10,15 and 20% levels in both starter and finisher diets.

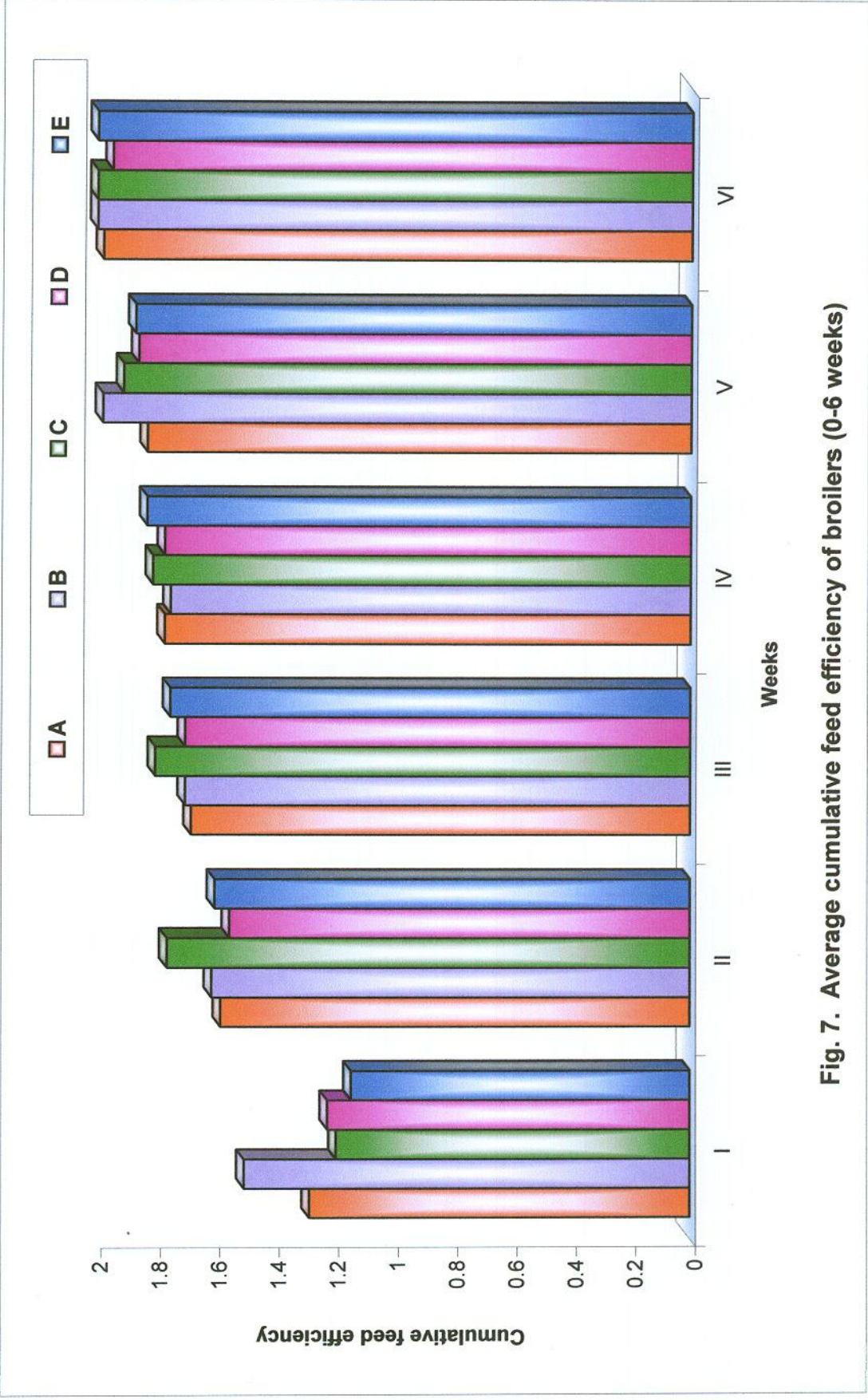


Fig. 7. Average cumulative feed efficiency of broilers (0-6 weeks)

These observations are also in accordance with Kang and Chol (1984) who reported broiler chicks fed 2 per cent and 4 per cent of citrus peel gained numerically more weight and consumed more feed than those fed the basal diets without citrus peel. Citrus peel at 6 per cent level showed slight decreased weight gain and feed intake. Similarly Yang and Chung (1984) reported that weight gain and feed intake tended to fall as the level of citrus increased. Patel *et al.* (2001) observed non-significant difference when 5, 10, 15, 20 per cent of orange pomace was utilized as a replacement to maize in broiler diet.

Meena Kumari *et al.* (2008) reported non significant difference on FCR during starter phase when orange pomace fed to the broilers at different levels as energy source. Similar observations was reported by Wadhawa *et al.* (2008) when dried ground orange skin was fed to broilers instead of maize.

Kumar *et al.* (2008) reported the non significant difference on feed consumption, feed efficiency when mango seed kernel were fed to broiler starter from 0-4 weeks of age.

#### **4.8 Mortality Percentage**

The overall mortality in the broilers during the experimental period was 2.06 per cent which was due to the unabsorbed yolk and heat stress because of hot climatic condition of region. Mortality did not shown any resemblance with feeding of orange pomace.

#### **4.9 Dressing Percentage**

Dressing percentage for all the treatment groups was calculated by slaughtering three birds from each treatment groups comprising of one bird from each replicates. The analysis of variance was carried out after transforming the percent value into Arc sin values. The details of mean

dressing percentage and Arc sin values are given in Table 12. ANOVA for the same is given in Appendix-VIII.

**Table 12. Mean values of dressing percentage of broilers**

Treatments	Mean dressing percentage	Arc sin values
A	71.33 ± 0.56	57.61 ± 0.46
B	72.31 ± 0.60	58.24 ± 0.55
C	72.09 ± 0.52	58.05 ± 0.43
D	71.40 ± 0.58	57.67 ± 0.44
E	71.26 ± 0.55	57.48 ± 0.42

The average dressing percentage among the different treatment groups varied between 71.26 ± 0.55 to 72.31 ± 0.60 per cent. The difference among all the treatment groups were found to be non significant. Highest dressing percentage was recorded in treatment B. (72.31 ± 0.60). The dressing percentage seems to be very little influenced by the dietary treatments.

#### 4.9.1 Edible meat percentage

The edible meat percentage for all the treatment groups was calculated by slaughtering three birds from each treatment groups comprising of one bird from each replicates. The analysis of variance was carried out after transforming the percent value into Arc sin values. The details of mean edible meat percentage and Arc sin values are given in Table 13. ANOVA for the same is given in Appendix-IX.

**Table 13. Edible meat percentage of broilers**

Treatment	Mean Edible meat (%)	Arc sin value
A – Corn Soya (Basal diet)	62.86 ± 0.50	52.42 ± 0.37
B – Corn Soya diet +3% orange pomace	63.14 ± 0.54	52.59 ± 0.40
C – Corn Soya diet + 5% orange pomace	63.08 ± 0.55	52.53 ± 0.40
D – Corn Soya diet + 7% orange pomace	63.00 ± 0.45	52.53 ± 0.31
E –Corn Soya diet +10% orange pomace	62.71 ± 0.46	52.36 ± 0.36

The average edible meat percentage among different treatments varied between  $62.71 \pm 0.46$  and  $63.14 \pm 0.54$ . Non-significant difference was found between all treatment groups. The maximum edible meat percentage i.e.  $63.14 \pm 0.54$  was found in group B, followed by group C, group D, group A, the lowest average edible meat percentage i.e.  $62.71 \pm 0.46$  was observed in group E. From the table it is revealed that, utilization of orange pomace in broiler diet did not have any negative effect on dressing edible meat percent when compared with control diet.

The present results of experiment are in agreement with Patel *et al.* (2001) who reported non-significant difference on dressing percentage and edible meat percentage and it seems to be little influenced by the dietary treatments. Oluremi *et al.* (2007) reported non-significant difference ( $P > 0.05$ ) among the treatment mean when broiler received sweet orange peel meal based diet.

#### **4.10 Economics of Broiler Production**

The economics of broiler production under trial was worked out by considering the prevailing prices of inputs at the time of experiment in the market. Input consisted of day old chicks, cost of feed, Cost of orange pomace (labour charges, transportation etc.) medicines, vaccines and overhead expenses. The broilers were sold @ Rs. 60 per kg live weight and other expenses like labour, electricity and miscellaneous were also considered as uniform for all the treatment groups. The details of the same are presented in Table 14

**Table 14. Economics of broiler production (Rs.)**

Treatments		A	B	C	D	E
Expenses						
A	Chick cost, Rs	17.50	17.50	17.50	17.50	17.50
1	Feed cost /kg	19.00	14.15	13.87	11.88	9.00
2	Cost of orange pomace/kg (labour charge, transportation etc.)	0	5	5	5	5
3	Total feed cost, Rs/kg	19	19.15	18.87	16.88	14.00
4	Feed intake, kg/ bird	3.512	3.495	3.480	3.471	3.436
B	Total feed cost, Rs/kg	66.72	66.92	65.66	58.59	48.02
C	Labour charge, Rs/bird	5	5	5	5	5
D	Electricity and water, Rs/bird	2	2	2	2	2
E	Vaccination and medication, Rs/bird	2	2	2	2	2
F	Miscellaneous, Rs/bird	1	1	1	1	1
I	Total Rs. (A + B + C + D+ E+ F)	94.22	94.42	93.16	86.09	75.52
	Receipt					
	Live body weight, kg/bird	1.825	1.831	1.817	1.815	1.807
II	Sale of bird @ Rs. 60/kg	109.50	109.86	109.02	108.90	108.42
	Total profit /bird (II-I) Rs	15.28	15.44	15.86	22.81	30.90
	Profit, Rs/kg	8.37	8.43	8.72	12.56	17.00

From Table 14 it is noticed that the cost of feed reduced when 10% orange pomace included in broiler diet.

Total profit per kg was ranged between Rs. 8.37/- to Rs. 17.00/- whereas, it was found highest in group E with 10 per cent orange pomace as Rs. 17.00/- and lowest in group A.



Chapter V  
*Summary and Conclusions*

## CHAPTER VI

### SUMMARY AND CONCLUSIONS

The present investigation entitled "Utilization of orange pomace at different levels in broiler diet" was conducted at Poultry Research Centre, in the Department of Poultry Science, Post Graduate Institute of Veterinary and Animal Sciences, Akola. The study was conducted to utilize orange pomace at different levels and its effect on growth performance and economics of broiler production.

An experiment was conducted on 240, day old commercial straightrun broiler chicks, randomly distributed in to five groups having three replication with 16 chicks in each. The different dietary treatments were A Control (Basal diet), B (Basal diet+ 3% orange pomace), C (Basal diet+5% orange pomace), D (Basal diet+ 7% orange pomace) and E (Basal diet +10% orange pomace). Uniform managerial practices were followed for all the treatment groups. The basal diet i.e. Corn Soya diet was prepared as per National Standard.

At the end of 6<sup>th</sup> week the live body weights of broilers for group A, B, C, D and E were  $1825.27 \pm 15.85$ ,  $1831.21 \pm 18.03$ ,  $1817.35 \pm 15.71$ ,  $1815.75 \pm 47.36$  and  $1807.10 \pm 17.03$  g respectively. The treatment mean were found to be non significant. The higher body weight was found in group B ( $1831.21 \pm 18.03$  g) while the lowest in group E ( $18.07 \pm 17.03$  g).

The average cumulative body weight gain of broilers at sixth week for various groups i.e. A, B, C, D and E were  $1781.85 \pm 15.53$ ,  $1788.06 \pm 17.89$ ,  $1773.71 \pm 15.80$ ,  $1773.50 \pm 48.31$  and  $1767.13 \pm 16.14$ g respectively. The cumulative body weight gain were found to be non significant within treatment mean.

At the end of 6<sup>th</sup> week the cumulative feed consumption observed in different treatment groups viz., A, B, C, D and E were  $3512.61 \pm 43.18$ ,  $3495.00 \pm 34.60$ ,  $3480.43 \pm 43.72$ ,  $3471.48 \pm 48.16$  and  $3436.94$

±46.16 g respectively. The highest feed consumption noted in group A (3512.61 ± 43.18 g) while lowest in group E (3436.94 ± 46.16 g). The average cumulative feed consumption was found to be non-significant within treatments.

Cumulative feed efficiency of different treatment mean such as A, B, C, D and E were 1.69 ± 0.02, 1.76 ± 0.02, 1.75 ± 0.03, 1.76 ± 0.02 and 1.77 ± 0.03, respectively. The average cumulative feed efficiency was found to be non-significant within treatments.

The average dressing percentage among the different treatment groups varied between 71.26 ± 0.55 to 72.31 ± 0.60 per cent. The difference among all the treatment groups were found to be non significant. Highest dressing percentage was recorded in treatment B. (72.31 ± 0.60). The dressing percentage seems to be little influenced by the dietary treatments.

The average edible meat percentage among different treatments varied between 62.71 ± 0.46 and 63.14 ± 0.54. Non-significant difference was found between all the treatment groups. The maximum edible meat percentage i.e. 63.14 ± 0.54 was found in group B, followed by group C, group D, group A, the lowest average edible meat percentage i.e. 62.71 ± 0.46 was observed in group E. The cost of feed reduced when 10 per cent orange pomace included in broiler diet. Total profit per kg was ranged between Rs. 8.37/- to Rs. 17.00/- whereas, it was found highest in group E with 10 per cent orange pomace as Rs. 17.00/- and lowest in group A.

## **Conclusions**

From the present experiment, it is concluded that:

- 1) Orange pomace could be replaced effectively as an energy source up to 10% level without adversely affecting the performance of broilers. Its inclusion in poultry feed would help to reduce the cost of feed.
- 2) Feed consumption as well as feed efficiency was not affected by utilization of orange pomace up to 10 per cent level in broiler diet.
- 3) Dressing percentage and Edible meat percentage was found to be non-significant effect on utilization of orange pomace at different levels in broiler diet.
- 4) Utilization of unconventional feed ingredient such as orange pomace upto 10 per cent levels found to be more economical.



*Bibliography*

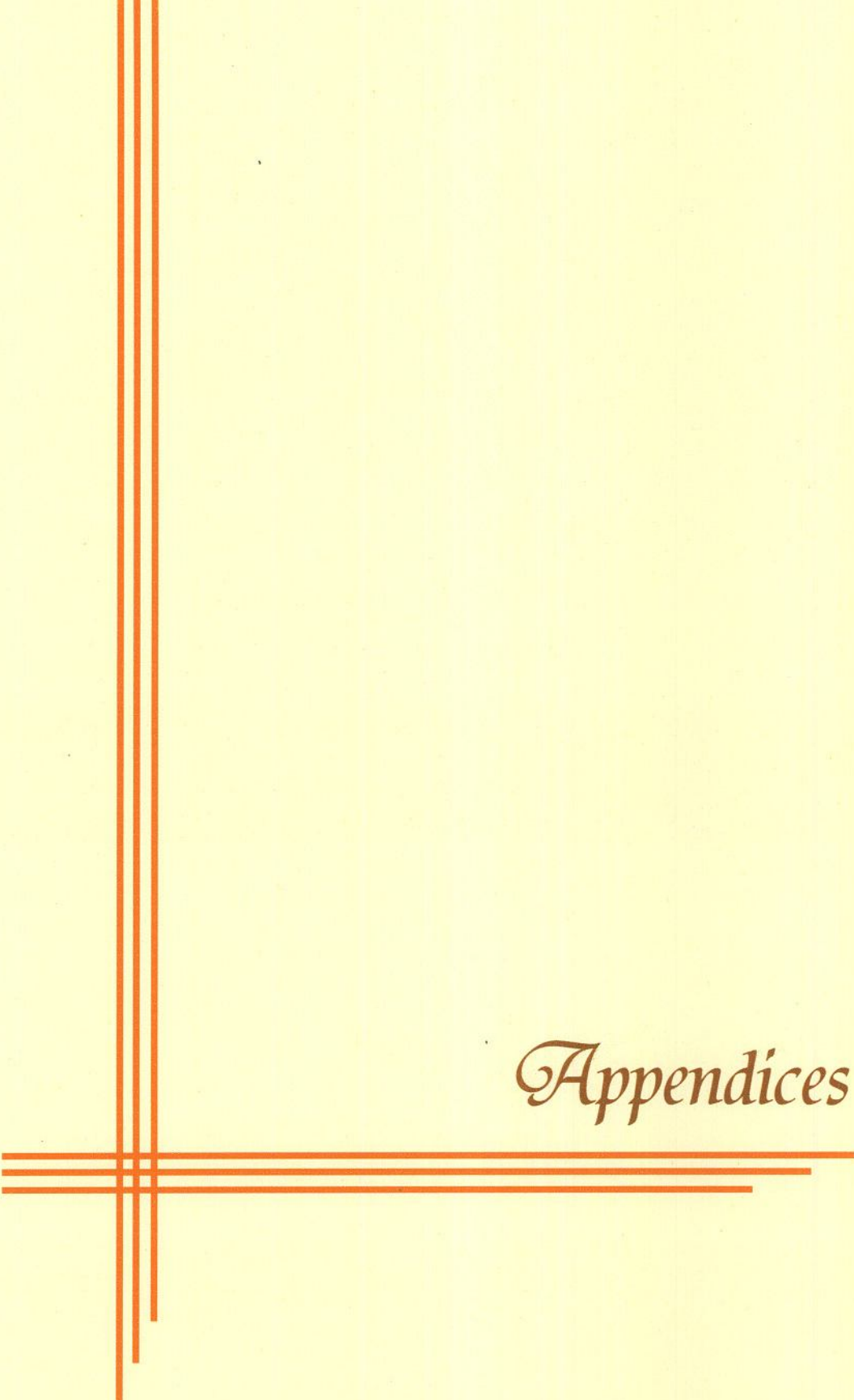
## BIBLIOGRAPHY

- A.O.A.C. (1990) Official method of analysis 15<sup>th</sup> Edn., Association of Official Analytical Chemists, Washington, D.C. pp 945.
- Accardi, F., G. Leto, M. L. Alicata and P. Giaccous (1977)<sup>3</sup> Digestibility of dried orange and lemon pup and calculation of their nutritive value. *Nutr. Abstr. and Rev. (series-B)*, **47**(10) : 682.
- Adegbola, A. A. (1976) Utilization of agro industrial by product in Africa. New Feed Resources. Chap. 10 in proceeding of technical consulting held Nov. 22-24, Rome Italy.
- Ammerman, C. B., D. A. Hansen, F. G. Martin and L. R. Arrington (1976) Nutrient composition of dried citrus Pulp as influenced by season of production and production source. *Proc. Fla. State Hort. Soc.* **89** : 168-170.
- Anonymous (1981) Tropical feeds, Information Summaries, Animal Production and Health Paper, **12** : 293.
- Anonymous (2000) Note on citrus fruits and its export, publication by Deputy Director of Agriculture, Nagpur division, Nagpur.
- Antongiovanni, M., A. Buccioni, F. Petacchi, A. Agnoletti (2005). Use of a citrus by-product in broilers diets. *Intr. J. Anim. Sci.* **4**(2): 501-503.
- Banerjee, G. C. (1998) Feed and principle of animal nutrition. Oxford and IBH Publication Co. Pvt. Ltd., New Delhi.
- Bhat, G. A., F. A. Mattoo, M. T. Banday and A. A. Khan (2005) Effect of feeding different levels of apple pomace in the ration with or without enzyme supplementation on the performance of pullets. IPSACON 2005 on Indian Poultry Production in Changed Global Scenario: Challenges and Opportunities. 78.
- Bhattacharya, A. N. and M. Harb (1973) Dried citrus pulp as a grain replacement for Awasi lambs. *J. Anim. Sci.* **36**(6) : 1175-1180.
- Cottyn, B. G. and C. V. Bouncque (1970) Digestibility and feeding value of pellets of dried citrus pulp. *Nutr. Abstr. and Rev.* **40** : 1434.
- Driggers, J., Clyde, Davis, K. George and N. R. Mehrhof (1951) Toxic factor in citrus seed meal. Gainesville, Florida-agriculture Experiment Station, Technical Bulletin **476** : 36.
- El-Deek, A. A., M. A. Asar, S. M. Hamdy, and A. A. Abdalla (2009) Utilization of Guava By-product in Broiler Finisher Diets. *Egypt. Poult. Sci.* **29**(1): 53-75.
- Gohl, B. O. (1975) Tropical feeds, food and agriculture organization of the United Nations, Rome. pp 290-297.

- Jadhao, S. B., P. P. Nemade and R. J. Kukade (1994) Potential use of citrus by products in livestock feed in central Provinces and Berar of India. *Asian livestock*, **19** : 70-72.
- Jawale, M. R., A. A. Zanzad, R. J. Kukade (2005) Effect of partial replacement of maize by orange pomace supplemented with enzyme in broilers. *The Journal of Bombay Veterinary College*. **13**(1-2).
- Jong-kyu, H. A., S. W. Kim and W. Y. Kim (1996) Use of Agro-industrial By-products as Animal feed in Korea. Animal Science and Technology College of Agriculture and Life Sciences, Soul National University, pp 441-744.
- Kang, S. L. and J. H. Chol (1984) Feeding value of dried citrus peel in broiler diets. *Nutr. Abstr. and Rev. (series-B)* **54**(5) : 164.
- Keithly, James H. and Taggart, Thomas (2004) Commercial poultry breeder citrus byproduct feed supplement and method, United States Patent 20040219279.
- Keithly, James H. and Taggart, Thomas (2006) Dried citrus peel supplement for use in commercial poultry feed United States Patent 7115298.
- Kukde, R. J. (1990) Replacement of maize by orange pomace meal in broiler mash. Agresco Report, Dr. PDKV, Akola.
- Kumar, D., A. Prasad and Chandramoni (2008) Effect of feeding mango seed kernel as a replacer of rice polish on the performance of broiler starter. IPSACON 2008 on Poultry production in India: threats and opportunities. 413.
- Kunjukutty, N., T. R. Sanknny and Maggle Menachery (1966) Studied on the chemical composition and feeding value of lime (*Citrus aurantifolia swingle*) and lemon (*Citrus lemon* Linn.). *Indian Vet. J.* **43**(6) : 453.
- Lanza, A. (1986) Dried citrus pulp in animal feeding. *Nutr. Abstr. And Rev. (Series -B)* **56**(9) : 613.
- Lanza, M., V. Fasone, V. Galofaro, D. Barbagallo, M. Bella and P. Pennisi (2004) Citrus pulp as an ingredient in ostrich diet : effects on meat quality, *Meat Science*. **68**(2) : 269-275.
- Lodhi, G. N., D. Singh and J. S. Ischponani (1976) Variation in nutrient content in feeding stuff rich in protein and reassessment of chemical method for metabolizable energy estimation for poultry. 1. *Agric. Sci.*, **86** : 293.
- Mahadeveswamy, M. and L. V. Venkataraman (1990) Integrated utilization of fruit processing waste for biogas and fish production, *Biological waste*, **32** : 243-251.
- Martinez Pascuala, J. Fernandez and J. Carmona (1981) Composition of citrus pulp. *Animal Feed Sci and Tech*. **5**(1) : 1-10.

- Matoo, F. A., G. A. Bhat, M. T. Banday, T. A. S. Ganaie (2001) Performance of broiler fed on apple pomace diets supplemented with enzyme(s). *Indian J. Anim. Nutr.* **18**(4) : 349-352.
- Meena Kumari, D. Wadhwa, K. S. Sharma and J. S. Chauhan (2008) Evaluation of orange pomace as energy source in broiler feeds. IPSACON 2008 on Poultry production in India: threats and Opportunities 424.
- Mohamed Mohmound Abdel- Rahman and Saad Z. A. EL-Naggar (1979) Chemical composition and feeding value of 'Bladi' and 'Navel' orange meal in poultry ration. *Indian J. Anim. Sci.* **50**(6) : 493-495.
- Mohapatra, S. C. and S. C. Misra (2008) Poultry production in India : Threats and Opportunities. IPSACON 2008 on Poultry production in India: threats and Opportunities. 3-8.
- Mourao, J. L., V. M. Pinheiro, J. A. Prates, R. J. Bessa, L. M. Ferreira, C. M. Fontes and P. L. Ponte (2008) Effect of dietary dehydrated pasture and citrus pulp on the performance and meat quality of broiler chickens. *Poult. Sci.* **87**(4) : 733-743.
- Odunsi, A. A., (2005) Response of Laying Hens and Growing Broilers to the Dietary Inclusion of Mango (*Mangifera indica* L.) Seed Kernel Meal Tropical animal health and production. **37**(2) : 139-150.
- Oluremi, O. I. A., V. O. Ojighen and E. H. Ejembi (2006) The nutritive potentials of sweet orange (*Citrus sinensis*) rind in broiler production. *International J. Poult. Sci.* **5**(7) : 613-617.
- Oluremi, O. I. A., P. M. Mou and A. Y. Adenkola (2007) Effect of formation of sweet Orange (*Citrus sinensis*) Fruit peel on its Maize Replacement Value in broiler Diets. *Journal of Animal and Veterinary Advances.* **6**(8) : 1017-1021.
- Patel, S. B., A. A. Zanzad, and R. J. Kukade (2001) Effect of orange pomace on performance of broiler by partial replacement of maize. Dept. of Animal Nutrition M.V.Sc thesis submitted to Maharashtra Animal and Fishery Sciences University, Nagpur.
- Perez Buriel, J., M. Lugo Criollo, and O. Mata Rivera (1976) Note on citrus meal in diets for grilling chickens. *Nutr. Abstr. and Rev.* (Series-B) **4**(3) : 137.
- Rabayaa, E., J. M. Abo Omar and R. A. Othman (2001) Utilization of Olive Pulp in Broiler Rations. *An. Najah Univ. J. Res.*, **15** : 133-144.
- Rao, V. S. and M. S. Ladaniya (1989) Studies on processing and waste utilization of Nagpur mandarin, Annual Report published by N.R.C. for Citrus, I.C.A.R., Nagpur : 2.
- Sharma, K. S. and B. S. Katoch (1981) Evaluation of some horticultural by-product in chick starter rations. *Indian J. Poultry Sci.* **16** : 147-149.

- Singh, H. P. and R. M. Pandey (1993) Quest for higher production and productivity of fruits. A coordinated approach souvenir, Golden Jubilee Symposium. Hort. Society of India. Bangalore, 4.
- Snedecor, G. W. and W. G. Cochran (1994) Statistical method 8<sup>th</sup> Edn. Iowa State University Press, Ames, USA.
- Squires, M. W., E. C. Naber and V. D. Toelle (1992) The effects of heat, water, acid, and alkali treatment of tomato cannery wastes on growth, metabolizable energy value, and nitrogen utilization of broiler chicks. *Poultry Science*. **71**(3) : 522-529.
- Suh, I. J., K. T. Nam and T. S. Koh (1985) Utilization of citrus pulp and its effect on the cholesterol metabolism in chicks. *Korean Journal of Animal Sciences*. **27**(10) : 673-678.
- Velloso, L. (1988) Use of citrus pulp in animal feeding. *Nutr. Abstr. and Rev.* (Series B) **58**(2) : 96.
- Wadhwa, D., Meena Kumari and V. K. Sharma (2008) Orange skin can partially replace maize (energy source) in broiler feeds. IPSACON 2008 on Poultry Production in India : threats and Opportunities 428.
- Yang, S. J. and C. C. Chung (1984) Studies on the utilization of citrus by-products as livestock feeds. II. A study on the feeding value of the citrus by-products for broiler chicks. *Korean Journal of Animal Science* **26** : 244-250.
- Yang, S. J. and C. C. Chung (1986) Studied on utilization of citrus by-products on livestock feeds. Feeding value of dried citrus by-products fed to layers. *Nutr. Abstr. And Rev.* (Series B) **56**(6) : 400.
- Yang, Seung-ju., Jung, In Chul., Moon, Yoon-Hee (2008) Effects of Feeding Citrus Byproducts on Nutritional Properties of Korean Native Chicken Eggs. *Journal of the Korean Society of Food Science and Nutrition*. **37**(7) : 841-846.
- Zafar, F, M. Idrees and Z. Ahmed (2005) Use of Apple by-product in poultry rations of broiler chicks in Karachi. *Pakistan J. Physiol.* **1** : 1-2.
- Zinjarde, R. M. (1998) Preservation of orange pomace by ensiling with paddy straw and its utilization in the ration of cattle. Ph.D. thesis submitted to Dr. PDKV, Akola : 4.



*Appendices*

## APPENDIX-I

Table for analysis of variance of weekly body weights

SV	DF	SS	MSS	F Cal.
Treatments 'A'	4	100010.24	25002.55	2.35 <sup>NS</sup>
Weeks 'B'	6	647077727.54	107846287.92	10158.87*
Interaction (A x B)	24	6852348.10	285514.50	26.89*
Error	1630	17463275.47	10615.97	
<b>Total</b>	<b>1664</b>	<b>671493361.31</b>		

\* - Significant at (P&lt;0.05)

NS - Non-significant

## APPENDIX-II

Table for analysis of variance of weekly weight gain

SV	DF	SS	MSS	F Cal.
Treatments 'A'	4	1708.7837	427.1959	0.04 <sup>NS</sup>
Weeks 'B'	5	25599858.18	5119971.63	470.74*
Interaction (A x B)	20	431960.7732	21598.038	1.99*
Error	1395	15172726.78	10876.5066	
<b>Total</b>	<b>1424</b>	<b>41206254.52</b>		

\* - Significant at (P&lt;0.05)

NS - Non-significant

## APPENDIX-III

Table for analysis of variance of cumulative weight gain

SV	DF	SS	MSS	F Cal.
Treatments 'A'	4	119969.42	29992.35	2.36 <sup>NS</sup>
Weeks 'B'	5	507329913	101465982.6	7931.20*
Interaction (A x B)	20	6391684.32	319584.21	24.98*
Error	1395	17846606.35	12793.266	
<b>Total</b>	<b>1424</b>	<b>531688173.083</b>		

\* - Significant at (P&lt;0.05)

NS - Non-significant

## APPENDIX-IV

Table for analysis of variance of weekly feed consumption

SV	DF	SS	MSS	F Cal.
Treatments 'A'	4	27888.75	6972.19	1.58 <sup>NS</sup>
Weeks 'B'	5	149641851.95	29928370.39	6788.33*
Interaction (A x B)	20	1589485.77	79474.29	18.03*
Error	1395	6150274.48	4408.80	
<b>Total</b>	<b>1424</b>	<b>157409500.95</b>		

\* - Significant at (P&lt;0.05)

NS - Non-significant

## APPENDIX-V

Table for analysis of variance of cumulative weekly feed consumption

<sup>3</sup> SV	DF	SS	MSS	F Cal.
Treatments 'A'	4	236568.73	59142.18	2.369 <sup>NS</sup>
Weeks 'B'	5	1988366505	397673301	15930.11*
Interaction (A x B)	20	<sup>3</sup> 23020715.39	1151035769	46.11*
Error	1395	34824259.84	24963.62	
<b>Total</b>	<b>1424</b>	<b>2046448048.75</b>		

\* - Significant at (P&lt;0.05)

NS - Non-significant

## APPENDIX-VI

Table for analysis of variance of weekly feed efficiency

SV	DF	SS	MSS	F Cal.
Treatments 'A'	4	1.90	0.47	0.40 <sup>NS</sup>
Weeks 'B'	5	208.01	41.60	35.28*
Interaction (A x B)	20	52.22	2.16	2.21*
Error	1395	1644.90	1.18	
<b>Total</b>	<b>1424</b>	<b>1907.04</b>		

\* - Significant at (P&lt;0.05)

NS - Non-significant

## APPENDIX-VII

Table for analysis of variance of cumulative feed efficiency

SV	DF	SS	MSS	F Cal.
Treatments 'A'	4	1.37	0.34	1.62 <sup>NS</sup>
Weeks 'B'	5	60.00	12.00	56.64*
Interaction (A x B)	20	25.78	1.28	6.08*
Error	1410	298.75	0.21	
<b>Total</b>	<b>1439</b>	<b>385.911</b>		

\* - Significant at (P&lt;0.05)

NS - Non-significant

## APPENDIX-VIII

Table for analysis of variance for dressing percentage of broilers

SV	DF	SS	MSS	F Cal.
Treatments 'A'	4	1.89616	0.47404	0.74328 <sup>NS</sup>
Error	10	6.3776	0.63776	
<b>Total</b>	<b>14</b>	<b>8.27376</b>		

NS - Non-significant

## APPENDIX-IX

Table for analysis of variance for edible meat percentage of broilers

SV	DF	SS	MSS	F Cal.
Treatments 'A'	4	0.54024	0.13506	0.32217 <sup>NS</sup>
Error	10	4.1923	0.41923	
<b>Total</b>	<b>14</b>	<b>4.73254</b>		

NS - Non-significant



*Vita*

**VITA**

The author, **Awesh Murlidhar Mehare** was born on 12<sup>th</sup> April, 1983 at Daryapur, Tal. Daryapur, District Amravati in Maharashtra State. He passed his S.S.C. and H.S.S.C examination with English medium from Shivaji Junior College, Amravati.



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After graduation with excellent performance in academic as well as extra curricular activity, he joined Post Graduate Institute of Veterinary and Animal Sciences, Akola, Maharashtra Animal and Fishery Sciences, University, Nagpur for his master degree Programme in the discipline of Poultry Science in the year 2007.

A decorative graphic consisting of two sets of three parallel orange lines. One set is vertical, extending from the top of the page down to the bottom. The other set is horizontal, extending from the left side of the page towards the right. The two sets of lines intersect to form a cross shape. The text 'Thesis Abstract' is positioned to the right of the intersection point.

*Thesis Abstract*

## THESIS ABSTRACT

- a) Title of the thesis (in Capital letters) : UTILIZATION OF ORANGE POMACE AT DIFFERENT LEVELS IN BROILER DIET
- b) Full name of student : MEHARE AWESH MURLIDHAR
- c) Name and address of Major Advisor : Dr. A. N. Sarag  
Associate Professor,  
Department of Poultry Science,  
PGIVAS, Akola.
- d) Degree to be awarded : M.V.Sc. (Poultry Science)
- e) Year of award of degree : 2009
- f) Major subject : Poultry Science
- g) Total number of pages in the thesis : 43
- h) Number of words in the abstract : 481
- i) Signature of Student : 
- j) Signature, Name and address of forwarding authority. : 

(Dr. B. S. Barmase)  
Professor & Head,  
Department of Poultry Science,  
PGIVAS, Akola.

---

### ABSTRACT

The present study entitled "Utilization of orange pomace at different levels in broiler diet" was conducted at Poultry Research Centre in the Department of Poultry Science, Post Graduate Institute of Veterinary and Animal Sciences, Akola. The study was conducted to utilize orange pomace at different levels and its effect on growth performance and economics of broiler production.

Two hundred and forty, day old commercial straightrun broiler chicks were equally and randomly distributed into five treatment groups with three replicates having 16 chicks in each replicates. Uniform managerial practices were followed for all the treatment groups. The diets for all the treatment groups were maintained isocaloric and isonitrogenous. Orange

pomace was incorporated at the levels of 0, 3, 5, 7 and 10 per cent at the expense of maize. The experiment was conducted on deep litter system for six weeks period. Data collected during the experimental period was analyzed by factorial completely randomized design.

The average weekly live body weight of day old chicks at day old stage were  $43.42 \pm 1.48$ ,  $43.15 \pm 1.51$ ,  $43.65 \pm 0.46$ ,  $42.25 \pm 1.25$  and  $41.21 \pm 1.24$  g respectively, in A, B, C, D, and E treatments groups. The corresponding average live weights at the end of 6th weeks were  $1825.27 \pm 15.85$ ,  $1831.21 \pm 18.03$ ,  $1817.35 \pm 15.71$ ,  $1815.75 \pm 47.36$  and  $1807.10 \pm 17.03$  g respectively in A to E treatment groups. Results showed that at the end of 6th week highest body weights ( $1831.21 \pm 18.03$ g) were observed in birds receiving the diet containing 3 per cent orange pomace (B) group followed by 5,7,10 per cent orange pomace (C, D, E) groups respectively, as compared to control group.

The cumulative feed consumption in A, B, C, D and E treatment groups were  $3512.61 \pm 43.18$ ,  $3495.00 \pm 34.60$ ,  $3480.43 \pm 43.72$ ,  $3471.48 \pm 48.16$  and  $3436.94 \pm 46.16$  g respectively. The mean weekly cumulative feed consumption for treatments week wise, found significant ( $P < 0.05$ ).

The cumulative feed efficiencies at the end of 6th week of age were  $1.98 \pm 0.03$ ,  $2.00 \pm 0.05$ ,  $2.00 \pm 0.03$ ,  $1.95 \pm 0.02$  and  $2.00 \pm 0.09$ , respectively for the treatment A, B, C, D, and E groups. The cumulative feed efficiencies treatment wise found non significant ( $P < 0.05$ ). The average cumulative FCR for the weeks differ significantly week wise.



The dressing percentage among different treatment groups varied between  $71.26 \pm 0.92$  and  $72.31 \pm 0.94$ . A non-significant difference was found among all treatment groups. The maximum dressing per cent was observed in group B ( $72.31 \pm 0.94$ ) and lowest dressing percentage i.e.  $71.26 \pm 0.92$  was found in group E. The edible meat percentage among different treatments varied between  $62.71 \pm 0.46$  and  $63.14 \pm 0.54$ . Non-significant difference was found between all treatment groups.

The cost of feed reduced when 10 per cent orange pomace included in broiler diet, whereas, profit was found to highest in group E with 10 per cent orange pomace.



प्रबंध सारांश

## प्रबंध सारांश

- १) प्रबंधाचे शिर्षक : “विविध पातळीनुसार संत्रा चोथ्याचा मांसल कोंबड्यांच्या खाद्यात उपयोग करणे”
- २) विद्यार्थ्यांचे पूर्ण नांव : मेहरे आवेश मुरलीधर
- ३) मुख्य मार्गदर्शकाचे नांव व पत्ता : डॉ. ए.एन. सराग  
सहयोगी प्राध्यापक,  
कुक्कुट पालन शास्त्र विभाग  
स्नातकोत्तर पशुवैद्यक व  
पशुविज्ञान संस्था, अकोला.
- ४) प्रदान केली जाणारी पदवी : एम.व्ही.एस्सी. (कुक्कुट पालन शास्त्र)
- ५) पदवी प्रदान करण्याचे वर्ष : २००९
- ६) मुख्य विषय : कुक्कुट पालन शास्त्र
- ७) प्रबंधामधील एकूण पाने : ४३
- ८) प्रबंध सारांशामधील एकूण शब्द : ३२७
- ९) विद्यार्थ्यांची सही : 
- १०) प्रबंध कार्यवाहीस्तव पाठविणाऱ्या अधिकाऱ्याची सही, नांव व पत्ता : 

(बी. एस. बारमारे)  
प्राध्यापक आणि विभागप्रमुख  
कुक्कुट पालन शास्त्र विभाग,  
स्नातकोत्तर पशुवैद्यक  
व पशुविज्ञान संस्था, अकोला.

## परिच्छेद

विविध पातळीनुसार संत्रा चोथ्याचा मांसल कोंबड्यांच्या खाद्यात उपयोग करण्याच्या दृष्टीने तसेच संत्रा चोथ्याचा मांसल कोंबड्यांच्या वाढीवर व आर्थिक दृष्ट्या अभ्यासाच्या उद्देशाने सदर प्रयोग कुक्कुट संशोधन केंद्र, स्नातकोत्तर पशुवैद्यक व पशुविज्ञान संस्था, अकोला येथे करण्यात आला.

एक दिवस वयाच्या दोनशे चाळीस कोंबड्यांच्या पिलांना प्रत्येकी तिन उपगट असलेल्या पाच गटात अठ्ठेचाळीस व प्रत्येक उपगटात सोळा पिल्ले असे विभागले. गट दोन, तिन, चार व पाच यामध्ये क्रमाने संत्रा चौथ्याच्या ३,५,७ आणि १० टक्के प्रति १०० किलो प्रमाणे खाद्यात उपयोग करण्यात आला. गट एक मधील खाद्यात संत्रा चौथ्याचा अंतर्भाव नव्हता. सदर प्रयोग सहा आठवड्यांच्या कालावधीसाठी करण्यात आला व पक्षांचे संगोपन गादी पध्दतीवर करण्यात आले.

एक दिवस वयाच्या सरासरी शारिरीक वजन गट एक मध्ये ४३.४२ ± १.४८, गट दोन मध्ये ४३.१५ ± १.५१ गट तिन मध्ये ४३.६५ ± ०.४६, गट चार मध्ये ४२.२५ ± १.२५ व गट पाच मध्ये ४१.२७ ± १.२४ ग्रॅम होते. सहाव्या आठवड्याला सरासरी शारिरीक वजन हे फायदेशीर होते. व ते गट एकसाठी १८२५.२७ ± १५.८५ गट दोन १८३१.२१ ± १८.०३ गट तिन १८१७.३५ ± १५.७१ गटचार मध्ये १८१५.७५ ± ४७.३६ व गट पाच १८०७.१० ± १७.०३ ग्रॅम होते सर्वात जास्त सरासरी शारिरीक वजन गट दोन मध्ये होते.

एकत्रीत खाद्य वापर गट एक, दोन, तिन, चार आणि पाच मध्ये क्रमाने ३५१२.६१ ± ४३.१८, ३४९५.०० ± ३४.६०, ३४८०.४३ ± ४३.७२, ३४७१.४८ ± ४८.१६, ३४३६.९४ ± ४६.१६ ग्रॅम होते.

खाद्याची मांसात रुपांतर करण्याची क्षमता गट एक, दोन तिन, चार आणि पाच मध्ये क्रमाने १.९३ ± ०.०५, २.०१ ± ०.०७, २.०० ± ०.०८, २.०१ ± ०.०६ आणि २.०४ ± ०.०७ होती. संत्रा चौथा वापरामुळे खाद्याची मांसात रुपांतर करण्याच्या क्षमतेवर कोणताही विपरीत परिणाम दिसून आला नाही. ड्रेसिंगची टक्केवारी गट दोन मध्ये सर्वात जास्त (७२.२६ ± ०.५५) होती.

सर्व गटामध्ये मांसल कोंबड्यांच्या अर्थशास्त्राच्या बाबतीत असे निदर्शनास आले की, जास्त नफा प्रति एक किलो जिवंत शारीरिक वजन हा गट पाच मध्ये दिसून आला.

सदर प्रयोगांती असे निदर्शनास आले की, १० टक्के पर्यंत संत्रा चौथ्याचा मांसल कोंबड्यांच्या खाद्यांत उपयोग करता येऊ शकतो व संत्रा चौथ्याचा १० टक्के पातळीपर्यंत मांसल कोंबड्यांच्या वाढीवर कोणताही विपरीत परिणाम होत नाही.