ORGANIC CHROMIUM SUPPLEMENTATION ON GROWTH OF CROSS BRED PIGS

ANN NISA THOMAS

Thesis submitted in partial fulfilment of the requirement for the degree of

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University, Thrissur

2007

Department of Animal Nutrition
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
MANNUTHY, THRISSUR-680651
KERALA, INDIA

DECLARATION

I hereby declare that this thesis entitled **"ORGANIC CHROMIUM SUPPLEMENATION ON GROWTH OF CROSS BRED PIGS"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis of the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Mannuthy,

30-06-07

Ann Nisa Thomas

CERTIFICATE

Certified that this thesis, entitled **"ORGANIC CHROMIUM SUPPLEMENATION ON GROWTH OF CROSS BRED PIGS"** is a record of research work done independently by **Ann Nisa Thomas** under my guidance and supervision and it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.

Mercy M

Dr. A. D. Mercy

(Chairperson, Advisory Committee)
Associate Professor and Head
Department of Animal Nutrition
College of Veterinary and Animal Sciences, Mannuthy.

Mannuthy,
30-06-07.

CERTIFICATE

We, the undersigned members of the Advisory Committee of **Ann Nisa Thomas**, a candidate for the degree of Master of Veterinary Science in Animal Nutrition, agree that this thesis entitled **"ORGANIC CHROMIUM SUPPLEMENATION ON GROWTH OF CROSS BRED PIGS"** may be submitted by Ann Nisa Thomas, in partial fulfilment of the requirement for the degree.

30.6.07
Dr. A. D. Mercy
(Chairperson, Advisory Committee)
Associate Professor and Head
Department of Animal Nutrition
College of Veterinary and Animal sciences
Mannuthy.

30.6.07
Dr. P. Gangadevi

Associate Professor
Department of Animal Nutrition
College of Veterinary and
Animal Sciences, Mannuthy.
Thrissur-680 651.
(Member)

30.6.07
Dr. K. Shyama

Assistant Professor
Department of Animal Nutrition,
College of Veterinary and
Animal Sciences, Mannuthy.
Thrissur-680 651.
(Member)

30.6.07
Dr. A. Kannan,
Assistant Professor,
Department of Livestock Production
Management, College of Veterinary and
Animal Sciences, Mannuthy,
Thrissur-680 651.
(Member)

30.6.07
Dr. George T. Oommen,
Associate Professor,
Department of Livestock Products
Technology, College of Veterinary
and Animal Sciences, Mannuthy,
Thrissur-680 651.
(Member)

5.9.07
External Examiner
DR. M. R. PURUSHOTHAMAN
ASSOCIATE PROFESSOR
DEPARTMENT OF ANIMAL NUTRITION
VETERINARY COLLEGE AND RESEARCH INSTITUTE
NAMAKKAL

ACKNOWEDGEMENT

With great respect, I place on record my most sincere and heartfelt gratitude to the Chairperson of the Advisory Committee, ***Dr. A. D. Mercy,*** *Associate Professor and Head, Department of Animal Nutrition, for her meticulous guidance, valuable suggestions, personal attention, evaluation and correction of my incapacities and whole-hearted support rendered in all possible ways, which was the major factor that led me to accomplish this task. I am touched by the genuine warmth of her affection.*

I am indebted to ***Dr. P. Gangadevi,*** *Associate Professor, Department of Animal Nutrition, as a member of the Advisory Committee and wish to put on record my sincere thanks to her for the valuable suggestions, constant encouragement and help rendered during the entire period of research work.*

I am in short of words to express my gratitude to ***Dr. Shyama K.,*** *Assistant Professor, Department of Animal Nutrition, member of the Advisory Committee, for her personal care and encouragement rendered through out the course of study.*

I am cordially obliged to, ***Dr. George T. Oommen,*** *Associate Professor, Department of Livestock Products Technology and a member of Advisory Committee for his helpful suggestions and co-operation rendered from time to time.*

I owe my sincere gratitude to ***Dr. A. Kannan.,*** *Assistant Professor, Department of Livestock Production Management and a member of the Advisory Committee for his valuable suggestions and timely help extended throughout the course of study.*

I wish to express my sincere thanks to ***Dr. M. R. Rajan,*** *Associate Professor and Head, University Pig Breeding Farm for timely help and wholehearted co-operation.*

I am thankful for the wholehearted help rendered for statistical analysis of data by ***Smt. Sujatha*** *and* ***Smt. K.A. Mercy,*** *Assistant Professors, Department of Statistics.*

*I gratefully acknowledge **Mr. Chandrasekharan**, Associate Professor and Instrumentation Engineer, **Mrs. Sangeetha and Mrs. Reji**, Research Assistants, Central Instrumentation Laboratory for their timely help and cooperation.*

*I sincerely thank **Dr. Hareesh,** my colleague for moral support and constant encouragement through out my studies.*

*The help given by my senior **Dr. Jasmine Rani**, and junior colleague **Dr. Ruby** is greatly acknowledged. I sincerely thank **Dr. Sekar** for the invaluable help rendered throughout the course of the study.*

*I take pleasure in thanking **Drs. Jabeena, Sheena, Chitra, Remya, Ranjini and Deepa and Sony, Aron, Reshma and Dhanya** and all other friends of my batch for their lots of help, friendliness, co-operation and moral support.*

*I take this opportunity to express my thanks to **Julie, Rekha, Sujitha** and all other the non teaching staff in the Department of Animal Nutrition who have helped me a lot in the successful completion of the work*

*I remember and acknowledge **Mr. Haridas, Mr. Varghese** and other staffs and laborers of the University Pig Breeding Farm, Mannuthy and all others who have helped to carry out the research work.*

*Words cannot express my deep sense of gratitude and love towards **Ammachi, Ichachan, Tony, Manoj chettan, Chriss chechi, Benny chettan, Manjechi, Tony Chettan, Kunjechi and kids- Sonu, Monu, John and Andrea** for their moral support, prayers and affection towards me during the busiest part of my studies*

*I also take this opportunity to express my love and obligation to **Daddy** (Rtd. Prof. and Head, Department of Animal Nutrition) and **Mummy** for unstinted support, valuable guidance and consistent encouragement showered upon me through out my experiment. No phrase or words in any language can ever express my deep sense of love and gratitude to my beloved **Achan and Amma** without their love, support and encouragement it would not have been possible to complete this study successfully.*

Words are inadequate to express my profound gratitude to my beloved husband ***Manesh****, who always supported me by extending his heart to see me fly.*

The prayer support and affectionate care of ***team members of the White cross*** *is acknowledged.*

Above all, I venerate my heavenly mother ***Holy Mary and St. Joseph*** *for their love and care and thank my* ***Guardian Angel*** *for his protection and prayers.*

Hereby I submit the essence of my effort to my eternal father ***The Most Holy Trinity through the Immaculate Heart of Mother Mary***

Ann Nisa Thomas

CONTENTS

LIST OF TABLES

LIST OF FIGURES

Dedicated to the Immaculate Heart
Of Mother Mary

Introduction

1. INTRODUCTION

Food and Agricultural Organization of the United Nations recommends that one third of the total protein requirement of man must be met from animal protein sources to correct the amino acid deficiencies of vegetable and cereal protein especially in developing countries. Among the farm animals, pigs are the most prolific with shorter gestation period, higher litter size, higher growth rate and better feed efficiency. They attain market weight as early as six months of age. Therefore increasing pork production will help to meet the animal protein demand of the ever increasing human population.

Reproduction and growth performance are the key factors that affect the economics of swine industry. Improving conception rates, weaning weight and animal health by nutritional means may increase profitability as well as enhance animal well being. Supplemental chromium had shown to improve growth performance (Page *et al.*, 1993 and Boleman *et al.*, 1995) and enhance immune response (Van-de-Ligt *et al.*, 2002). Supplementation with chromium was found to increase litter size (Lindeman *et al.*, 1995) in breeding sows and improve carcass quality (Page *et al.*, 1993 and Lindeman *et al.*, 1995).

Chromium supplementation also had been reported to have an effect on plasma metabolites. Researches showed that chromium supplementation will decrease serum cholesterol (Page *et al.*, 1993), triglycerides (Lemme, 1999 and Lien *et al.*, 2001), increase HDL cholesterol, (Lien *et al.*, 2001), blood urea (Lemme, 1999), total protein (Yildiz *et al.*, 2004) and a decrease in serum glucose (Lien *et al.*, 2001). Thus chromium was proved to increase carbohydrate, protein and fat metabolism.

The researches on chromium supplementation to swine diets had been primarily conducted with chromium picolinate, chromium nicotinate or chromium chloride. Research with chromium propionate was limited in literature.

Therefore, the objective of this experiment is to determine the effect of chromium as chromium propionate on the growth and to evaluate the economics of organic chromium supplementation in crossbred pigs.

Review of Literature

2. REVIEW OF LITERATURE

2.1 EFFECT OF CHROMIUM SUPPLEMENTATION IN DIET

2.1.1 Growth

Page *et al.* (1993) observed an increased average daily gain in growing-finishing pigs when fed 50 and 200 ppb of chromium (Cr) as chromium picolinate (CrP). Similarly, Boleman *et al.* (1995) also observed increased average daily gain in pigs when 200 ppb of CrP was added to basal diet through out the growth and finishing period.

Mooney and Cromwell (1995) when fed 0 or 200 μg/kg of Cr from CrP to pigs, observed an increase in the average daily gain. Similar result was obtained in an experiment conducted by Mooney and Cromwell (1997) where they found greater final body weight in pigs that consumed 200μg/kg of CrP in diet or 5000 or 25000 μg /kg of chromium from chromium chloride.

Van-Hengten and Spear (1997) observed that 0.2ppm of supplemental Cr from Cr chloride, CrP or Cr nicotinic acid increased daily gain during 16 to 32 days in control pigs but not in pigs challenged with *Escherichia coli* lipopolysaccharide. Lemme (1999) also observed an improved daily gain in pigs receiving diet supplemented with 200 μg / kg Cr, especially in the second phase of fattening. Similar result was reported by Lien *et al.* (2001) when pigs were supplemented with 200 ppb Cr in the form of CrP.

Krolieczewska *et al.* (2005) when conducted a study to evaluate the performance and carcass characteristics of broilers after Cr supplementation with Cr enriched yeast in doses of 300 or 500 μg /kg , obtained an increased body weight with the supplementation of 500 μg /kg Cr. Similar result was obtained by Toghyani *et al.*

(2006) in broiler chicks supplemented with 0 (control), 500, 1000 or 1500 ppb of Cr in the form of CrP where body weight and body weight gain of broilers fed supplemental Cr for 21 and 42 days increased significantly.

Amoikon *et al.* (1995) observed that average daily gain and gain: feed ratio were not affected by dietary treatment when pigs were fed a control diet or a diet supplemented with 200 µg of Cr/kg of diet as CrP. Similarly Ward *et al.* (1997) could not find any effect when 400 ppb of Cr as chromium picolinate was fed to pigs in grower phase. Matthews *et al.* (2003) also found that chromium propionate had no consistent effect on growth in pigs. Shelton *et al.* (2003) conducted two experiments in pigs with graded levels of Cr as Cr propionate and found no effect on overall growth performance. Matthews *et al.* (2005) observed that average daily gain and gain : feed ratio were not affected when supplemented with 0 or 200 ppb Cr as Cr propionate. Chromium chelated to glycine and nicotinamide (CrCh) supplemented at 0, 200 or 400 ppb did not affect average daily gain of growing and finishing pigs (Khajarern *et al.*, 2006). On the other hand Matthews *et al.* (2001) reported that both CrP and Cr propionate decreased average daily gain without affecting gain: feed ratio in pigs.

2.1.2 FEED INTAKE

Page *et al.* (1993) observed no effect on feed intake in growing–finishing pigs when Cr was supplemented at 50, 100 or 200 ppb as CrP. Similarly Amoikon *et al.* (1995) and Ward *et al.* (1997) also could not observe any effect on feed intake when Cr was supplemented at 200 and 400 ppb, respectively. No effect on feed intake was also reported by Matthews *et al.* (2005) when Cr was supplemented at 200 ppb as CrP.

Lien *et al.* (2001) on the other hand obtained increased feed consumption in pigs fed diet supplemented with 200 ppb Cr as CrP.

Reduced feed intake was reported in pigs by Boleman *et al.* (1995) when 200 ppb of CrP was supplemented and by Matthews *et al.* (2001) when CrP and Cr propionate were supplemented in the diet.

2.1.3 FEED CONVERSION EFFICIENCY

Lindemann *et al.* (1995) observed an overall trend for improvement in gain:feed ratio when Cr was added to the diet as CrP at various levels (0, 250 or 500 ppb). Similar result was obtained by Lemme (1999) when pigs were supplemented with 0, 200, 400 or 800 μg/kg Cr, on a restricted feeding scale basis. He observed that pigs receiving diet containing 200 μg/kg Cr showed improved feed conversion ratio compared to the group receiving 0 μg/kg Cr for the total treatment, especially in the second phase of fattening. Yildiz *et al.* (2004) observed an improved feed conversion ratio with increasing organic Cr supplementation at 0, 250, 500, 750 and 1000 ppb of Cr supplied from CrP. Similarly Krolieczewska *et al.* (2005) also observed that supplementation of 500 μ/kg Cr, increased feed conversion ratio compared to those fed with 300 μg/kg and to those fed the control diet. However, Khajarern *et al.* (2006) observed that feed conversion efficiency was not affected by dietary treatment involving a basal grower and finisher feed supplemented with 0, 200 or 400 ppb of supplemental Cr chelated to glycine and nicotinamide.

2.1.4. SERUM TRAITS

2.1.4.1 Cholesterol

In an experiment conducted by Page *et al.* (1993) in growing finishing pigs, serum cholesterol was reduced when fed 100 and 200 ppb of Cr. Similarly, Bunting *et al.* (1994) also observed that 370 pg/kg of CrP supplementation reduced plasma cholesterol and enhanced glucose clearance from the blood of growing calves.

Lien *et al.* (2001) in an experiment when growing finishing pigs were supplemented with 0, 200 or 400 ppb Cr in the form of CrP, observed a marked decrease in serum total cholesterol and very low density lipoprotein (VLDL). Low-density lipoprotein (LDL) increased in Cr supplemented group. High-density lipoprotein (HDL) cholesterol and VLDL cholesterol were markedly increased while LDL cholesterol was significantly diminished in the 200 ppb Cr group. Decreased blood cholesterol concentration was reported by Yildiz *et al.* (2004) when they fed basal diet with 0, 250, 500, 750 and 1000 ppb Cr supplied from CrP. However, Sahin *et al.* (1999) and Matthews *et al.* (2001) did not observe any effect on serum cholesterol when Cr was supplemented as Cr propionate or CrP.

A study was conducted by Sands and Smith (2002) to investigate the effects of supplemental CrP or manganese proteinate on heat-stressed broiler chicken. They observed that serum concentrations of non-esterified fatty acids was lower in high manganese supplemented group, but triglycerides, total cholesterol, HDL cholesterol, and HDL: total cholesterol ratio were not affected by dietary treatment. Heat stressed birds receiving no manganese supplementation had lower HDL: total cholesterol ratios while heat stress reduced serum triglyceride concentration.

Shelton *et al.* (2003) observed that total cholesterol was increased due to an increase in HDL cholesterol in pigs fed 100 and 200ppb of Cr in diet.

2.1.4.2 Triglycerides

Lemme (1999) observed that the triglyceride concentrations reduced linearly in plasma after 24 h fasting in Swiss Large pigs when fed 0, 200, 400 or 800 μg/kg Cr on a restricted feeding scale basis. Similar result was obtained when Cr was supplemented at 0, 200 or 400 ppb levels in form of CrP in the serum of growing finishing pigs (Lien *et al.* 2001).

No effect on serum triglycerides was reported by Page *et al.* (1993) and Mooney and Cromwell (1997) in pigs, while Sahin *et al.* (1999) also observed no effect on serum triglycerides supplementation of 200 or 400 ppb of Cr on serum triglycerides in rabbits. Shelton *et al.* (2003) fed 0, 100, 200 or 300 ppb Cr as Cr propionate to pigs and observed that serum triglyceride level was not affected by the treatment.

2.1.4.3 Blood Urea Nitrogen

A numerical increase in blood urea nitrogen (BUN) concentration at 24 h with incremental amount of dietary chromium was reported in Swiss Large pigs when fed 0, 200, 400 or 800 μg/kg Cr on a restricted feeding scale basis (Lemme, 1999), while Lien *et al.* (2001), observed a marked decrease in urea concentration in serum of pigs when supplemented with 0, 200 or 400 ppb chromium in form of CrP. Similarly Shelton *et al.* (2003) observed that plasma urea nitrogen concentration was linearly decreased in pigs as Cr increased in the diets.

No effect on BUN was observed by Page *et al.* (1993), Kitchalong *et al.* (1995) and Matthews *et al.* (2001) in pigs supplemented with different levels of Cr. Sahin *et al.* (1999) also did not observe any effect on BUN as a result of Cr supplementation in rabbits.

2.1.4.4 Glucose and other Blood Parameters

Yildiz*et al.* (2004) conducted an experiment where they fed basal diet with 0, 250, 500, 750 and 1000 ppb Cr supplied from CrP and found that the serum glucose was decreased, while insulin and total protein concentrations increased linearly as dietary Cr level increased.

Lien *et al.* (2001) observed that serum insulin was significantly decreased in 400 ppb group while serum glucose was decreased in 200 ppb of Cr supplemented group of pigs.

Supplementation of Cr had no effect in pigs on total protein, inorganic phosphorus, calcium and glucose levels in blood of pigs (Page *et al.*, 1993), glucose, albumin, total protein, insulin, glucagon, triiodothyronine, or thyroxine levels in Sufflok lambs, (Kitchalong *et al.*, 1995), on serum total protein (Sahin *et al.*, 1999) and on plasma glucose and insulin concentration in pigs (Matthews *et al.*, 2001).

2.1.5 CARCASS TRAITS

Page *et al.* (1993) observed that longissimus muscle area and percentage muscling were increased and 10th rib fat decreased by addition 0, 100, 200, 400 or 800 ppb of Cr from CrP. Similarly, Lindemann *et al.* (1995) observed that addition of 200 ppb of Cr as CrP reduced back fat thickness and increased longissimus muscle area. Shelton *et al.* (2003) observed that longissimus muscle area, ham weight, ham fat free lean and total carcass lean were increased in pigs fed 200 ppb in positive control diets but decreased in pigs fed 200 ppb Cr in low NE diet. In the same way, Khajarern *et al.* (2006), observed that dressing percentage increased in pigs receiving Cr chelated to glycine and nicotinamide (CrCh) and longissimus muscle area and percentage of muscling were significantly increased in pigs receiving CrCh compared to pigs fed on the control diets. Also Toghyani *et. al.* (2006) observed that Cr supplementation increased carcass yield and decreased abdominal fat contents.

In an experiment conducted by Lien *et al.* (2001) it was found that the carcass of pigs that received the Cr supplemented ration contained less oleic acid and total unsaturated fatty acids. On the other hand, the total saturated fatty acid content was higher than that of the control. Similarly Krolieczewska *et al.* (2005) observed that addition of 300 or 500 µg /kg Cr yeast in diet of chickens caused a decrease of cholesterol level and content in muscle.

Mooney and Cromwell (1995) and Mooney and Cromwell (1997) observed that back fat measurements and longissimus muscle area were not affected by Cr supplementation in pigs. The percentage of muscling, fat, bone and skin from right ham and percentage of water, protein, lipid and ash from the left carcass were also not altered by Cr supplementation.

Matthews *et al.* (2005) conducted an experiment in crossbred finishing gilts fed 0 or 200 ppb of Cr. They observed that carcass length was increased while overall shrink, loin muscle area, 10th rib fat thickness, average back fat thickness, dressing percentage, muscle score, fat fresh lean and percent lean were not affected by Cr propionate. However, increased first rib fat thickness was reported by Boleman *et al.* (1995) in pigs supplemented with Cr.

2.1.6 IMMUNITY

Van-de-Ligt *et al.* (2002) conducted an experiment in gilts to assess the effect of supplementation of Cr tripicolinate to lactating sows on performance and immune status of the offspring during the first 42 days after weaning. They observed that Cr did not affect total IgG on day 0 and 7 but by day 28, total IgG was higher. Total IgM followed a similar pattern and was lowest on day 7.

Kegley and Spears (1995) conducted an experiment in steers where treatment group was supplemented with 0.4 mg of supplemental Cr/kg of DM. On d 52, steers supplemented with high Cr yeast had a greater response to an intra dermal injection of phyto-haemagglutinin (PHA) for 8 h after injection than that of control steers or those supplemented with $CrCl_3$ or Cr nicotinic acid. Peripheral lymphocytes from steers supplemented with Cr nicotinic acid had a greater blastogenic response to 12.5 microgram PHA/ml than lymphocytes from steers supplemented with $CrCl_3$. Similarly Kegley *et al.* (1996) observed that calves supplemented with Cr-nicotinic acid complex had a greater response to an intra dermal injection of PHA than did the controls at 6, 12, 24 and 48 h after injection where as calves supplemented with $CrCl_3$ had a greater response than that of controls at 24 and 48 h after injection. Following a disease challenge with an intra nasal dose of infectious bovine rhinotracheitis on d 75, body temperature tended to be lower for calves supplemented with Cr nicotinic acid complex than that for control calves. Calves supplemented with either source had lower serum cortisol concentration at d 5 after challenge. However no effect was reported when Angus crossbred steers were supplemented with Cr (0.4 mg /kg of DM) as Cr nicotinic acid complex on any of the immune responses (Kegley *et al.*, 1997).

2.1.7 GLUCOSE AND LIPID METABOLISM

Riales and Aibrink (1981) observed that 200 pg trivalent Cr injection increased HDL cholesterol and improved insulin sensitivity than plain water (W) injection in a double blind 12-wk study of 23 healthy adult men aged 31 to 60 years. Liu and Abernathy (1982) observed that the relative Cr response was significantly higher in lower insulin secretors (LI) than that in higher insulin secretors (HI) and the ratio of the total insulin to the total glucose was significantly lower in LI than that in HI.

Chromium supplementation did not affect glucose removal rate (GRR) or plasma insulin in the first 48 hr of life in 22 full-term newborns (Saner *et al*., 1980). Uusitupa *et al.* (1983) also did not find any significant difference between Cr supplementation and placebo periods in glucose tolerance and in fasting or 2-h post glucose serum insulin levels but the 1-h post glucose serum insulin level was slightly lower on chromium supplementation than on the placebo. This is in agreement with the findings of Offenbacher *et al.* (1985) who observed no significant changes in glucose tolerance or insulin level after Cr supplementation.

Kitchalong *et al.* (1995) found that half-life during the glucose tolerance test and glucose clearance rate did not differ between control and CrP supplemented groups; however, on wk 2, plasma insulin was elevated and glucose reduced in the lambs fed CrP. Similarly in a study conducted by Sands and Smith (2002) to investigate the effects of supplemental CrP or manganese proteinate on heat-stressed broiler chickens it was observed that glucagon concentration, insulin :glucagon ratio and glucose were not affected by dietary treatment regimen.

2.1.8 DIGESTIBILITY OF NUTRIENTS

Sahin and Sahin (2001) conducted an experiment in which two levels of vitamin C (125 and 250 mg/kg of diet) and three levels of CrP (200, 400 or 800 µg/kg of the diet) were fed to 32–wk old laying hen. The highest performance was obtained when 250 mg/kg of vitamin C was supplemented with either 400 or 800 µg Cr /kg of diet. Digestibility of dry matter, organic matter, crude protein and ether extract were higher with dietary vitamin C and with higher Cr.

Materials and Methods

3. MATERIALS AND METHODS

3.1 EXPERIMENTAL ANIMALS

The investigation was carried out for a period of 67 days on cross-bred (Large white Yorkshire X Desi) piglets. Twenty four weaned piglets (12 male and 12 female) with an average body weight of 18 kg belonging to the Centre for Pig Production and Research (CPPR), Mannuthy were used as experimental animals. Male piglets were castrated before the start of the experiment.

The piglets were randomly divided into two groups with six replicates of two piglets in each group. The two groups of piglets were randomly allotted to two dietary treatments (Tl and T2). All the animals were dewormed before the commencement of the experiment.

3.2 HOUSING AND MANAGEMENT

Each replicate was housed in separate pen in the same shed with facilities for feeding and watering. All the animals were maintained under identical management conditions. The animals were washed every day in the morning before 10 AM and stalls were cleaned twice daily before feeding in the morning and afternoon.

3.3 EXPERIMENTAL DIETS

The animals were fed with standard grower ration formulated to contain 16 percent crude protein and 3000 kcal of digestible energy /kg of feed on dry matter (ICAR, 1985).

The two dietary treatments were

I) T1- (Control)- Standard grower ration.

II) T2-Control ration plus 200 ppb of chromium as chromium propionate

The ingredient composition of the ration is presented in Table 1.

3.4 FEEDING TRIAL

The experimental animals of the two dietary treatments T1 and T2 were maintained on their respective feeding regimes from the time of weaning to 67 days of growing period. The pigs of each pen were group fed two times a day (10.00AM and 2.30 PM) and were allowed to consume as much feed as they could within a period of one hour. Record of daily feed intake was maintained through out the experimental period. Clean drinking water was provided at all times in all the pens throughout the experimental period of 67 days. The pigs were weighed at the beginning of the experiment and later on at fortnightly intervals.

3.5 HAEMATOLOGICAL PARAMETERS

Blood samples were collected at the beginning of the experiment and subsequently at the end of the experiment using heparin as anticoagulant in clean dry test tubes. Blood samples were centrifuged at 3000 rpm for 10 minutes to separate the plasma which is used for estimating plasma cholesterol (CHOD-PAP method), high density lipoprotein cholesterol (PT.MG.Acetate method), triglycerides (GPO-PAP-ESPAS method), total protein (Biuret method), albumin (BCC method), albumin: globulin ratio, phosphorus (Phosphomolybdate method), glucose (GOD–PAP method) and blood urea nitrogen (Modified Berthelot method) using the kits supplied by Agappe diagnostics. Plasma calcium was estimated by Atomic Absorption Spectrophotometer using hollow cathode tube.

3.6 DIGESTION TRIAL

Digestion trial was conducted at the end of the experiment to determine the digestibility coefficient of the nutrients of the experimental diets. Acid insoluble ash was considered as the internal indicator for measuring the digestibility coefficient of nutrients.

Before the commencement of the actual collection period, animals were subjected to a preliminary period of three days when they were fed the same quantity of the feed. Faecal grab samples uncontaminated with urine, water, feed or dirt were collected manually from different places of the pen thrice daily during the collection period of three days. Samples that were collected on each day were placed in double lined polythene bags, labelled and kept in deep freezer until further analysis. The representative samples of feed offered were also taken for the proximate analysis.

The calcium content was determined using Atomic Absorption Spectrophotometer (Perkin Elmer 3110). Phosphorus content of the feed and faecal samples were analysed by colorimetry using Spectrophotometer (Spectronic 1001 plus, Milton Roy; USA). The digestibility of the nutrients was calculated using appropriate formulae (Maynard *et al.,* 1979).

3.7 STATISTICAL ANALYSIS

Data on body weight was analysed by analysis of variance as per Snedecor and Cochran (1994). For other parameters such as average daily gain, feed conversion efficiency, total feed intake, average cumulative body weight gain, calcium, phosphorus, magnesium, cholesterol, triglycerides, HDL, total protein, albumin, globulin, albumin:globulin ratio, blood urea nitrogen and glucose were analysed by 't' test using MSTATC.

INCIDENCE OF DISEASE OUTBREAK

There was a sudden outbreak of swine fever in the farm and therefore the experiment was terminated on 67th day.

Table 1. Ingredient composition of grower ration

Ingredients	Composition (per cent)
Yellow Maize	54.75
Soya bean Meal	6.5
Wheat Bran	28.0
Fish Meal	9.0
Salt	0.5
Dicalcium phosphate[a]	1.0
Calcite	0.25
Calculated CP	16.01
DE (kcal/kg)	3073
Calcium	1.06
Phosphorus	0.81
Lysine	0.87
Methionine	0.33

Chromium propionate (Kemin Nutritional Technologies, India Pvt. Ltd.) containing 0.4 % chromium was added @ 0.005 % to the ration T2.

[a]Dicalcium Phosphate (Kerala Chemicals and Protein Ltd., Kochi) containing 23% Ca and 18% P.

Indomix A, B2, D3, K (Nicholas Piramal India Ltd, Mumbai) containing Vitamin A-40,000 IU, VitaminB2-20mg, Vitamin D3-5000 IU, per gram was mixed @25gm/100kg feed and Vitamin K-50mg.

Indomix B, E (Nicholas Piramal India Ltd, Mumbai) containing Vitamin B1-4mg, Vitamin B6-8mg, Vitamin B12-40mg, Niacin-60mg, Calcium Panthothinate-40mg, Vitamin E-40mg per gram was mixed @ 25gm/100kg feed.

ZnO (Nice chemicals Pvt. Ltd., Kochi) containing 80.26% Zinc was mixed @75gm/100kg feed.

Herbolysine (Indian Herbs Research and Supplyco Ltd., Daara Shivpuri, UP, India) 100 % Lysine was mixed @ 80 g/100 kg in feed.

Herbomethionine (Indian Herbs Research and Supplyco Ltd., Daara Shivpuri, UP, India) 100 % methionine was mixed @ 160 g/100 kg in feed.

Results

4. RESULTS

4.1 CHEMICAL COMPOSITION OF THE RATION

The percentage chemical composition of the grower ration is presented in Table 2. The dry matter, crude protein, ether extract, crude fibre, total ash, NFE, acid insoluble ash, calcium and phosphorus contents were 89.48, 18.67, 2.66 10.23, 8.33, 60.11, 3.51, 1.64 and 0.95 per cent, respectively.

4.2 BODY WEIGHT AND BODY WEIGHT GAIN

The results of body weight of pigs under the two dietary treatments T1 and T2 recorded at fortnightly intervals are presented in Table 3. Average final body weight of pigs of the two dietary treatments was 40.25 and 39.71, kg, respectively. Average cumulative body weight gain of animals belonging to groups T1 and T2 are presented in Table 4 and are graphically represented in Fig. 1. Average body weight gain of animals belonging to groups T1 and T2 was 21.75 and 21.87 kg, respectively.

4.3 AVERAGE DAILY GAIN

Data on average daily body weight gain of pigs under the two dietary treatments T1 and T2 are presented in Table 5 and are graphically represented in Fig. 2. For the two dietary treatments T1 and T2, the values for average daily gain were 324.62 and 326.48 g, respectively.

4.4 FEED CONVERSION EFFICIENCY

The cumulative feed conversion efficiency of pigs of T1 and T2 are presented in Table 5and the data is presented in Fig. 3. Pigs of group T1 and T2 registered a feed conversion efficiency of 3.77 and 3.74, respectively.

4.5. APPARENT DIGESTIBILITY COEFFICIENT OF NUTRIENTS

Chemical composition of faeces of pigs fed with different experimental diets is shown in Table 6. Data on apparent digestibility coefficient of nutrients is presented in Table 7 and is graphically represented in Fig 4. The digestibility coefficient of the two dietary rations T1 and T2 were 0.58 and 0.62 for dry matter, 0.69 and 0.65, for crude protein, 0.35 and 0.28 for ether extract, 0.16 and 0.52 for crude fibre and 0.71 and 0.70 for NFE, respectively.

4.6 BLOOD PARAMETERS

Initially plasma biochemical parameters were calcium-7.70 mg/dl, phosphorus-3.90 mg/dl, magnesium- 2.40 mg/dl, glucose- 124 mg/dl, total protein- 5.13 g/dl, globulin-2.01 g/dl, albumin- 3.12 g/dl, albumin: globulin- 0.55, blood urea nitrogen- 29.60 mg /dl and the lipid profile were triglycerides- 9.20mg /dl total cholesterol- 92.80 mg /dl and HDL cholesterol- 83.11 mg/dl. Data on various plasma biochemical parameters of blood collected towards the end of the experiment (65 th day) from pigs maintained on the two experimental treatments were 11.71 and 11.66 mg/dl of calcium, 6.52 and 4.15 mg/dl of phosphorus, 2.37 and 2.51 mg/dl of magnesium, 130.23 and 138.43 mg/dl of glucose, 6.0 and 5.62 g/dl of total protein, 3.5 and 3.6 g /dl of albumin, 1.16 and 1.34 mg/dl of globulin, 2.01 and 1.62of albumin: globulin ratio 32.68 and 45.11 mg/dl of blood urea nitrogen (Table 8). The plasma lipid profile of pigs maintained on the two experimental diets T1 and T2 are depicted in Table 9. The blood serum contained 57.62 and 35.85 mg /dl of triglycerides, 120.00 and 113.67 mg /dl of total cholesterol and 43.8 and 57.24mg/dl of HDL cholesterol.

4.7 ECONOMICS OF GAIN

Data on body weight gain, total feed intake, total feed cost and cost of feed per kg body weight gain of pigs maintained on the two dietary treatments are presented in Table 10. Total feed intake of the pigs of the two treatments were79.92 and 79.27 kg, respectively. The cost of ingredients used for the study was as per the rate contract fixed by the College of Veterinary and Animal Sciences Mannuthy, for the year 2006-07. Since organic chromium was supplied free of cost, cost of feed of the two ration was Rs.8.48. The total feed cost was Rs. 677.72 and 672.21 for T1 and T2, respectively and cost of feed per kg body weight gain of pigs were Rs.31.16 and 30.7, respectively (Fig. 5).

Table 2. Chemical composition of the ration*

Item	Composition, %
Dry Matter	89.48
Crude protein	18.67
Ether extract	2.66
Crude fibre	10.23
Total ash	8.33
Nitrogen free extract	60.11
Acid insoluble ash	3.51
Calcium	1.64
Phosphorus	0.95

*On dry matter basis

Table 3. Fortnightly average body weight of pigs maintained on two dietary treatments

Fortnight	Average body weight (kg)[1]		P value
	T1	T2	
0	18.5±2.90	17.83±3.00	- (NS)
1	23.63±3.71	21.67±3.40	0.124 (NS)
2	27.83±4.46	26.21±0.65	0.137 (NS)
3	33.96±5.59	32.12±2.00	0.120 (NS)
4	40.25±6.68	39.71±1.60	- (NS)

[1] Mean of six values
NS - Non significant (P>0.05)

Table 4. Fortnightly average of cumulative body weight gain of pigs maintained on two dietary treatments

Fortnight	Average cumulative gain (kg)		P value
	T1	T2	
1	5.31 ± 0.25	3.92 ± 0.41	0.307 (NS)
2	9.56 ± 0.36	8.37 ± 0.49	0.538 (NS)
3	15.66 ± 0.47	14.29 ± 0.41	0.801 (NS)
4	21.75 ± 1.71	21.87 ± 1.73	0.982 (NS)

[1]Mean of six values
NS - Non significant (P>0.05)

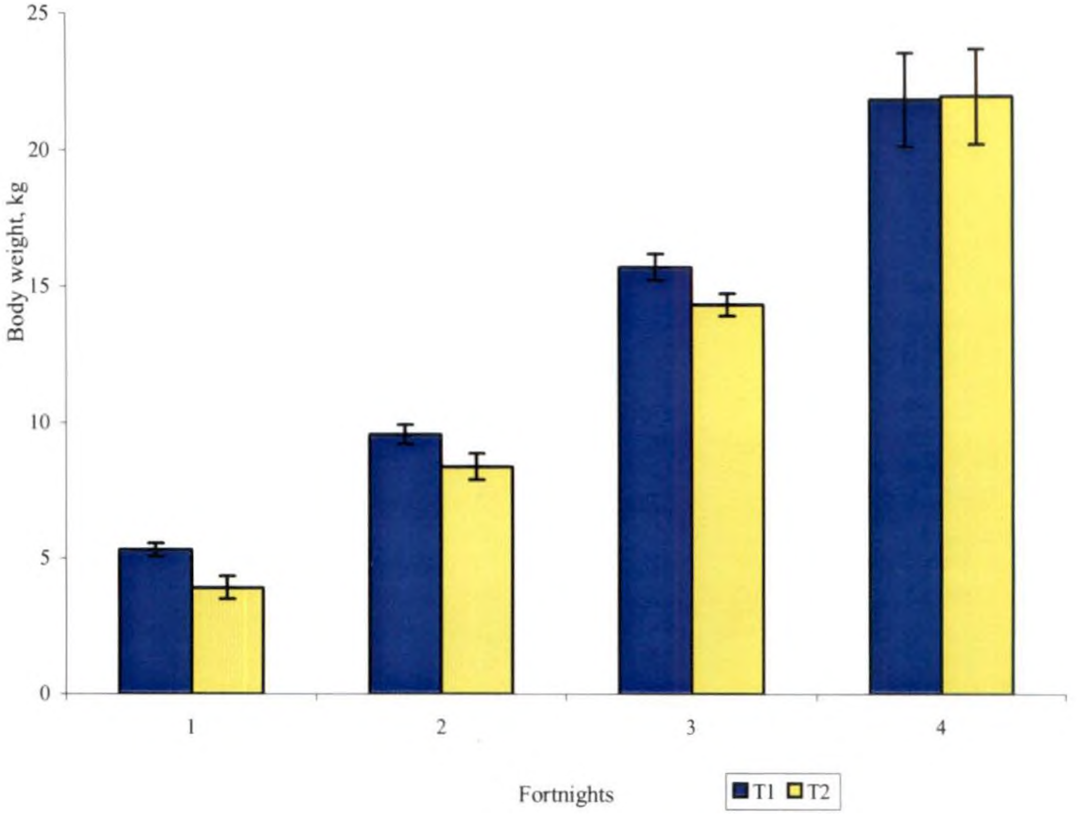

Fig. 1. Fortnightly average of cumulative body weight gain

Table 5. Average daily gain and feed conversion efficiency of pigs maintained on two dietary treatments

Item	Treatments[1]		P value
	T1	T2	
Initial body weight (kg)	18.50±1.23	17.83±1.24	(NS)
Final body weight (kg)	40.25 ±1.25	39.71±1.65	(NS)
Body weight gain (kg)	21.75±1.7	21.87 ±1.73	0.959 (NS)
Total feed intake (kg)	79.92±0.83	79.27±0.76	0.845 (NS)
Average daily gain (g)	324.62 ±25.37	326.48±25.82	0.970 (NS)
Feed conversion efficiency (kg feed/kg weight gain)	3.77±0.30	3.74± 0.31	0.949 (NS)

[1]Mean of six values
NS - Non significant (P>0.05)

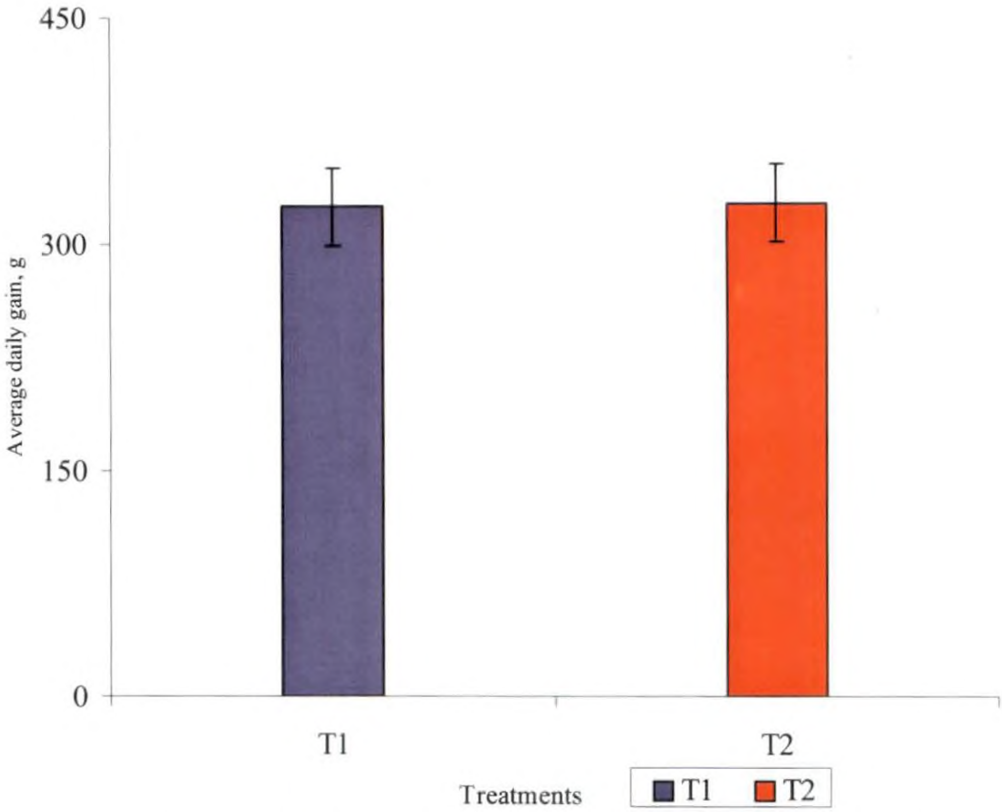

Fig. 2. Average daily gain of pigs maintained on two dietary treatment

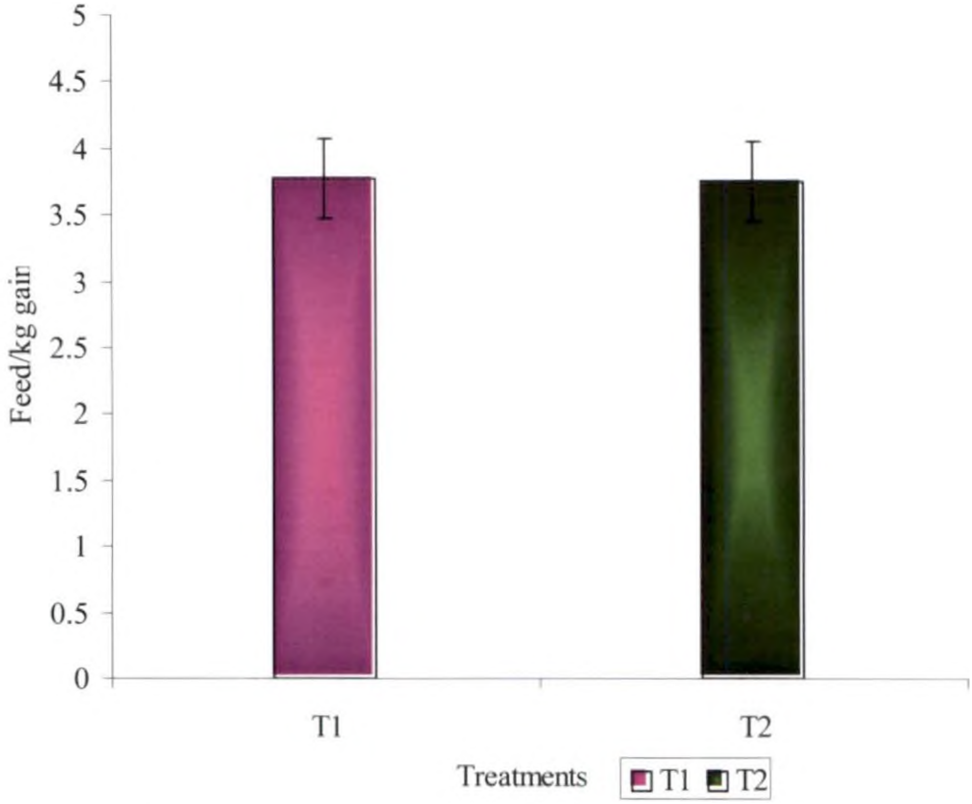

Fig. 3. Feed conversion effciency of pigs maintained on two dietary treatments

Table 6. Chemical composition of faeces of pigs maintained on two dietary treatments*

Item	Chemical composition of the faeces, %	
	T1	T2
Dry matter	32.67	25.83
Crude protein	15.38	17.32
Ether extract	4.18	5.30
Crude fibre	19.6	12.79
Total ash	23.05	19.03
NFE	37.79	45.56
Acid insoluble ash	7.63	9.31
Calcium	1.39	1.99
Phosphorus	1.33	1.68

* On dry matter basis

Table 7. Average digestibility coefficient of nutrients of two experimental rations*

Item	Digestibility coefficient	
	T1	T2
Dry matter	0.58±0.06	0.62± 0.03
Crude protein	0.69± 0.10	0.65±0.12
Ether extract	0.35±0.12	0.28±0.06
Crude fibre	0.16±0.05	0.52±0.02
Nitrogen free extract	0.71±0.04	0.70±0.02

*Mean of 3 values

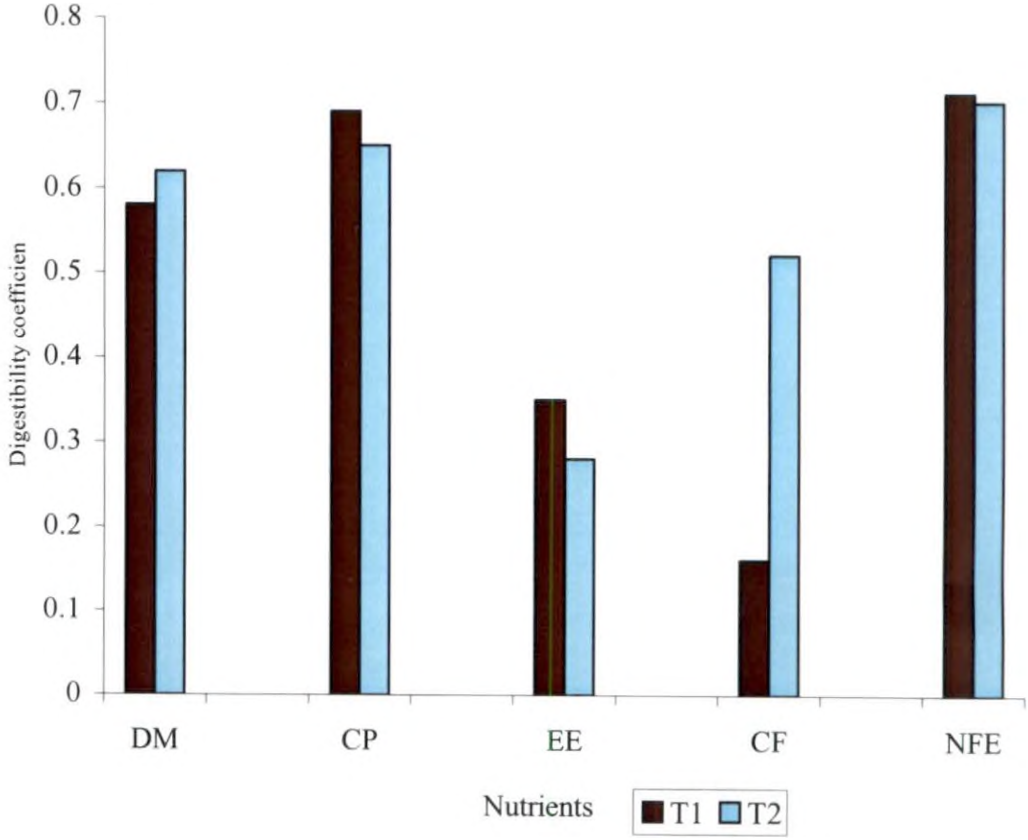

Fig. 4. Average digestibility coefficient of nutrients of two experimental rations

Table 8. Blood biochemical parameters of pigs maintained on two dietary treatments

Blood parameters	Treatments [1]		P value
	T1	T2	
Plasma calcium (mg/dl)	11.71±0.95	11.66±0.20	0.956 (NS)
Phosphorus (mg/dl)*	6.52±0.81	4.15±0.44	0.028
Magnesium (mg/dl)	2.37±0.17	2.51±0.06	0.446 (NS)
Glucose (mg/dl)	130.23±7.54	138.43±6.78	0.438 (NS)
Total protein (g/dl)	6.0±0.39	5.62±0.55	0.581 (NS)
Globulin(g/dl)	1.16±0.47	1.34±0.54	- (NS)
Albumin (g/dl)	3.47±0.18	3.58±0.17	0.654 (NS)
Albumin: Globulin	2.01±0.68	1.62±0.33	0.616 (NS)
Blood urea nitrogen (mg/dl)	32.68±3.66	45.11±5.72	0.348 (NS)

[1]Mean of six values

*Significant (P<0.05)

NS- Non significant (P>0.05)

Table 9. Blood lipid profile of pigs maintained on two dietary treatments

Lipid profile	Treatments[1]		P value
	T1	T2	
Plasma triglycerides (mg%)	57.62±12.69	35.85±11.19	0.154 (NS)
Total cholesterol (mg%)*	120.00±31.00	113.67±6.80	0.005
HDL cholesterol (mg%)	43.80±13.72	57.24±15.15	0.527(NS)

[1]Mean of six values

* Significant (P<0.01)

NS- Non significant (P>0.05)

Table 10. Cost of feed per kg body weight gain of pigs maintained on two dietary treatments

Item	Treatments	
	T1	T2
Body weight gain (kg)	21.75	21.87
Total feed intake (kg)	79.92	79.27
Cost /kg of ration (Rs)	8.48	8.48
Total cost of feed	677.72	672.21
Cost of feed per kg body weight gain (Rs)	31.16	30.74

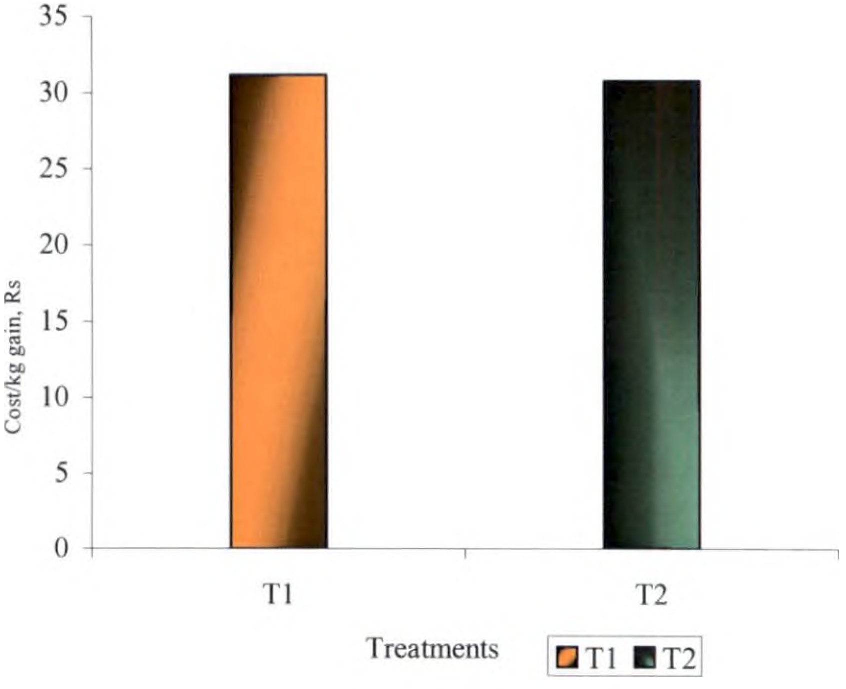

Fig. 5. Cost of feed per kg body weight gain

Discussion

5. DISCUSSION

5.1 CHEMICAL COMPOSITION OF THE RATION

From the data on chemical composition of the experimental ration given in Table 2 it could be seen that it contained 18.67 per cent protein on dry matter basis. The crude protein requirement of grower ration is 18 per cent as per ICAR (1985) and IS:7472 (1986).

The metabolizable energy content of the ration calculated from the chemical composition using the formula (ME MJ/kg DM = 0.018 crude protein + 0315 fat + 0.0163NFE + 0.0149 crude fibre, where, crude protein, fat, NFE and CF in g/kg feed) given by European Association for Animal Production (McDonald *et al.*, 2002) was 2.98 kcal / g on dry matter basis.

5.2 BODY WEIGHT

The initial body weight of pigs of T1 and T2 groups were 18.5 and 17.83 kg, respectively (Table 3). Statistical analysis did not show any significance. The body weight of pigs were similar ($p>0.05$) in all fortnights. The average body weight of animals in the dietary treatments T1 during 1st, 2nd and 3rd fortnights were 23.63, 27.83 and 33.96 kg, while those in T2 were 21.67, 26.21 and 32.12 kg, respectively. Statistical analysis of the data showed that there was no significant difference ($p>0.05$) between animals in the two dietary treatments T1 and T2 in regard to their average body weights during 1st, 2nd and 3rd fortnights. The body weight at the end of the experiment was 40.25 and 39.71 kg, respectively for the two groups, T1 and T2.

Vasudevan (2000) obtained 35.3, 36.5 and 37.4 kg body weight after 2 months of feeding trial in cross bred (Large white Yorkshire X Desi) pigs fed diets containing maize of different particle size. Similar body weights were recorded by Sekar (2003) in cross bred pigs (Large white Yorkshire X Desi) of similar age group.

5.3 BODY WEIGHT GAIN

It could be seen from the data presented in Table 4 that, while animals in dietary treatment T1 had average cumulative weight gain of 5.31, 9.56, 15.66 and 21.75, kg, respectively during 1st, 2nd, 3rd or 4th fortnights, those in dietary treatment T2 had 3.92, 8.37, 14.29 and 21.87 kg, respectively. There was however no statistical significance (P>0.05) between animals in the two dietary treatments in respect of their average weight gain during any of the fortnights.

Total body weight gain of pigs observed in present experiment was lower than that reported by Vasudevan (2000), Rekha (2001) and Sekar (2003). This may be because of shorter experimental duration of the present study. The experiment had to be concluded abruptly due to the outbreak of swine fever in the University Pig Breeding Farm, Mannuthy.

The average daily gains (g) of animals fed diets supplemented with 0 and 200 ppb of chromium as chromium propionate were 324.62 and 326.48 g, respectively (Table 5). There was no significant difference (P>0.05) between animals in the two dietary treatments in regard to their average daily gain.

Similar average daily gain was recorded in cross bred pigs by Vasudevan (2000) when diets containing maize of different particle size were fed and Rekha (2001) when different levels of energy was fed. Sekar (2003), on other hand reported higher average daily gain of 352, 382 and 405g, in cross bred pigs when fed baker's yeast at 0, 0.25 and 0.5 per cent levels, respectively.

Thus the results of the present study indicate that incorporation of 200 ppb of Cr as Cr propionate in the ration for growing pigs did not affect average cumulative weight gain and the average daily weight gain. This is in agreement with the report of Ward *et al.* (1997) who could not find any effect on growth when 400 ppb of Cr as CrP was fed to pigs in grower phase. Amoikon *et al.* (1995), Matthews *et al.* (2003), Shelton *et al.* (2003), Matthews *et al.* (2005), and Khajarern *et al.* (2006) also could not observe any difference in average daily gain in pigs supplemented with 0 or 200 ppb of Cr as Cr propionate.

Page *et al.* (1993), Boleman *et al.* (1995) and Mooney and Cromwell (1995) observed increased average daily gain in growing finishing pigs fed 200 ppb of Cr as CrP. Similarly Mooney and Cromwell (1997) also found greater final body weight in pigs fed 200μg/kg of CrP in diet or 5000 or 25000 μg /kg of chromium from chromium chloride. Van-Hengten and Spear (1997) reported increased daily gain in pigs fed 0.2 ppm of supplemental Cr as Cr chloride, Cr picolinate or Cr nicotinic acid. Increased average daily gain was also reported by Lemme (1999) and Lien *et al.* (2001) in growing finishing pigs fed Cr as CrP

5.4 FEED INTAKE

From the summarized data presented in Table 5, it could be observed that the animals in dietary treatments T1 and T2 consumed 79.92 and 79.27 kg feed, respectively. Analysis of the data revealed that there was no significant difference (P>0.05) in feed intake in the two treatments.

This result obtained in present study with regard to feed intake was in accordance with the findings of Page *et al.* (1993) who observed no effect on feed intake in growing–finishing pigs when Cr was supplemented at 50, 100 or 200 ppb as CrP. Similarly Amoikon *et al.* (1995), Ward *et al.* (1997) and Matthews *et al.* (2005) also could not observe any effect on feed intake when Cr was supplemented at 200 and 400 ppb, respectively.

Lien *et al.* (2001) observed increased feed intake in pigs fed diet supplemented with 200 ppb Cr as CrP. On the other hand reduced feed intake was reported in pigs by Boleman *et al.* (1995) when 200 ppb of CrP was supplemented and by Matthews *et al.* (2001) when CrP and Cr propionate were supplemented in the diet.

5.5 FEED CONVERSION EFFICIENCY

The data on the feed conversion efficiency of pigs maintained on two dietary treatments T1 and T2 presented in Table 5 were 3.77 and 3.74 respectively. Statistical analysis of the data using 't' test revealed that there was no significant difference between the unsupplemented and the supplemented group.

Khajarern *et al.* (2006) observed that feed conversion efficiency was not affected by dietary treatment involving a basal grower and finisher feed supplemented with 0, 200 or 400 ppb of supplemental Cr which agree well with the results of present study.

In contrast to the present finding, Lindemann *et al.* (1995) observed an overall trend for improvement in gain:feed ratio when Cr was added to the diet as chromium picolinate at various levels (0, 250 or 500 ppb). Similarly Lemme (1999), Yildiz *et al.*

(2004) and Kroliczewska *et al.* (2005) observed higher feed conversion efficiency for pigs when chromium was supplemented to the diets.

5.6 DIGESTIBILITY OF NUTRIENTS

5.6.1 Dry matter

The digestibility coefficient of the two rations T1 and T2 were 0.58 and 0.62 for dry matter (Table 7). The values obtained in the present experiment are in accordance with those reported in Large White Yorkshire pigs X Desi pigs by Vasudevan (2000) when fed diet containing maize of different particle size, Rekha (2001) when fed diet with different levels of energy, and Madhukumar (2002) when protein of ration was replaced at 0, 25 and 50 per cent level from prawn waste and Sekar (2003) when fed diet supplemented with baker's yeast.

There is a numerical increase in dry matter digestibility of Cr supplemented ration. Similar increase in dry matter digestibility was also observed by Sahin and Sahin (2001) with higher chromium supplementation when fed various levels of chromium to 32–wk old laying hen.

Ramamoorthy (1999) on other hand, obtained slightly lower dry matter digestibility (53.1, 48.8 and 46.3) when 50 and 100 per cent of protein of control diet was replaced with protein of silkworm pupae meal.

5.6.2 Crude protein

The digestibility coefficient of crude protein presented in Table 7 for the dietary rations T1 and T2 were 0.69 and 0.65, respectively Ramamoorthy (1999), Madhukumar (2002) and Sekar (2003) obtained almost similar values in Large White Yorkshire X Desi cross bred pigs in various experiments.

5.6.3 Ether extract

The digestibility coefficient of ether extract of the rations T1 and T2 were 0.35 and 0.28 respectively (Table 7). Madhukumar (2002) obtained similar digestibility of ether extract (33.64, 37.95 and 33.27 per cent) in cross bred pigs when replaced 25 per cent and 50 percent of protein in control diet with prawn waste.

5.6.4 Crude fibre

The digestibility coefficient of crude fibre obtained for the rations in the two treatments were 0.16 and 0.52 respectively. There was a higher digestibility of crude protein of the diet supplemented with chromium. Sahin and Sahin (2001) also reported higher crude fibre digestibility in 32 week old laying hen when fed Cr supplemented diet.

Crude fibre digestibility reported in cross bred pigs (Ramamoorthi, 1999; Vasudevan, 2000; Rekha, 2001; and Sekar, 2003) fed different diets agree well with the digestibility obtained for the control rations in the present study.

5.6.5 Nitrogen free extract

The digestibility coefficient of NFE of the diets T1 and T2 were 0.71and 0.70 respectively (Table 7) indicating that Cr supplementation did not affect the NFE digestibility. This study is in contrast to the findings of Sahin and Sahin (2001) who observed higher digestibility for NFE for higher chromium supplemented groups in hens. Similar NFE digestibility values were reported by Sekar (2003) in cross bred pigs supplemented with baker's yeast at 0, 0.25 and 0.5 per cent levels.

5.4 BLOOD BIOCHEMICAL PARAMETERS

5.4.1 Blood Glucose

Results of blood analysis presented in Table 8 shows that the plasma glucose value for the animals in group T1 and T2 were 130.23 and 138.43 mg/dl, respectively. Statistical analysis showed that there was no significant difference ($p>0.05$) between the two treatments. Similar finding was also observed by Kitchalong *et al.* (1995), Page *et al.* (1999), and Mathews *et al.* (2001). However Lien *et al.* (2001) observed that serum glucose was decreased in 200 ppb of Cr supplemented group of pigs.

Nath *et al.* (1979) reported decreased blood sugar level when diabetic patients were fed 500 μg of Cr/ day and Mossop (1983) reported a decrease in fasting glucose from 14.4 mmol/L to 6.6mmol/L following 16 to 32 weeks of daily supplementation with 600 μg of Cr as Cr chloride in diabetic men.

Pechova and Pavlatha (2007) in their review article had explained the mode of action of Cr. Chromium activity in animals is associated with a compound called chromodulin, which is a low molecular weight chromium binding protein. The molecular weight of chromodulin is 1500 Da and it is formed by 4 types of amino acid residues (glycine, cysteine, glutamate and aspartate). On decomposition of chromodulin, a product-glucose tolerance factor (GTF) is formed which is the true biologically active form of chromium. It is assumed that increased glucose concentration leads to the fast release of insulin in to blood. Insulin binds to an external α subunit of the transmembrane protein insulin receptor, causing its conformation change. The receptor autophosphorylates tyrosine residues on the internal portion of its β subunit, turning the receptor into an active kinase. It is reported that chromodulin is stored in the apo form in the cytosol and in the nucleus of insulin sensitive cells Increase in plasma insulin concentrations have been found to result in a movement of chromium from insulin dependent cells. Four Cr^{3+} are bound upon the entry of chromium into the cell, producing holochromodium. A newly formed compound is bound to insulin stimulated receptors, hence maintaining their active conformation and enhances insulin signaling. When the level of insulin in blood decreases and receptive signaling must be interrupted, chromodulin is eliminated from cells.

5.4.2. Blood Urea Nitrogen

Analysis of data on blood urea nitrogen (BUN) shows that there was no significant difference (p>0.05) between the animals in two groups for the plasma blood urea nitrogen. The values were 32.68 and 45.11mg/dl for animals in dietary treatment T1 and T2 respectively. There was a numerical increase in the BUN value for the T2 group. Similar numerical increase in BUN concentration at 24 hour with incremental amount of dietary chromium was reported by Lemme (1999) in Swiss Large pigs when fed 0, 200, 400 or 800 μg/kg Cr. Numerical but not significant increase in blood urea nitrogen suggest a tendency for increased metabolic rate resulting in increased amino acid metabolism with the chromium supplementation.

This is in contrast to the findings of Shelton *et al.* (2003) who observed that plasma urea nitrogen concentration was linearly decreased in pigs as chromium level increased in the diets

5.4.3 Total protein, Albumin and Globulin

Results of blood analysis presented in Table 8 show that plasma total protein, albumin, globulin and albumin:globulin values for the group T1 and T2 were 6.00 and 5.62 g /dl, 3.47 and 3.58 g/dl, 1.16 and 1.34 g /dl and 2.01 and 1.62 respectively. None of these parameters was significantly different ($p>0.05$) for the two treatment groups. Page *et al.* (1993) and Sahin *et al.* (1999) reported that supplementation of Cr has no effect in pigs on total protein. Kitchalong *et al.* (1995) also reported that Cr supplementation had no effect on serum albumin in Sufflok lambs. However Yildiz *et al.* (2004) conducted an experiment where they fed basal diet with 0, 250, 500, 750 and 1000 ppb Cr supplied from CrP and found that the total protein concentrations increased linearly as dietary Cr level increased.

5.4.4 Mineral Status

Statistical analysis of data presented in Table 8 suggest that while there is no significant difference between the two groups for the plasma calcium and magnesium, the value of phosphorus is significantly different ($p<0.05$) between the two groups. Plasma calcium value for pigs under the two dietary treatments T1 and T2 were 11.71 and 11.66 mg/dl, respectively. Plasma calcium values obtained by Devi (1981) in cross bred pigs when supplemented diet with different levels of tapioca chips were slightly higher while the phosphorus values were similar to that of the present values obtained.

Interactions of Cr with calcium and magnesium have been reported by Shageer and Mowat (1993) who found an increased calcium and magnesium concentration with Cr supplementation on day 7 of the trial. Page *et al.* (1993) who reported that supplemental Cr had no effect on inorganic phosphorus.

5.5 BLOOD LIPID PROFILE

5.5.1 Cholesterol

Plasma cholesterol values presented in Table 9 for the animals in group T1 and T2 were 120.00 and 113.67 mg/dl, respectively. Statistical analysis of the result showed that cholesterol content of T2 pigs was lower ($p<0.01$) than that of T2. Several studies on chromium supplementation in pigs have shown to decrease the serum cholesterol level (Page *et al.*, 1993, Bunting *et al.*, 1994, Lien *et al.*, 2001 and Yildiz *et al.*, 2004). Cholesterol values obtained by Page *et al.* (1993) were 101.8 and 87.7, mg/dl when supplemented with 0 and 200 ppb of Cr as CrP.

Increased total cholesterol was reported by Shelton *et al.* (2003) observed in pigs fed 100 and 200 ppb of chromium in diet, while Sands and Smith (2002) observed that serum concentrations of total cholesterol, was not affected by dietary treatment of CrP or manganese proteinate in heat-distressed broiler chickens.

5.5.2 Triglycerides

Plasma triglyceride value for the groups T1 and T2 were 57.62 and 35.85 mg/dl. Though there was no significant difference ($p>0.05$) between the two groups, triglyceride value of T2 was numerically lower than that of T1. Chromium supplementation had no effect on serum triglycerides was also reported by Page *et al.* (1993) and Mooney and Cromwell (1997) in pigs and Sahin *et al.* (1999) in rabbits.

Lemme (1999) and Lien *et al.* (2001) observed that the triglyceride concentrations were reduced in pigs supplemented with various levels of chromium.

5.5.3 High Density Lipoprotein Cholesterol

The data for HDL cholesterol presented in Table 9 for the animals in treatment group T1 and T2 were 43.80 and 57.24 mg/dl, respectively. There was numerical increase in T2 but no significant difference (p>0.05) between the animals of the two treatments. This was in accordance with the findings of Sands and Smith (2002) who observed that HDL-cholesterol was not affected by the dietary treatment of chromium.

5.5.4 Economics of Gain

Data on cost of feed per kg body weight gain of pigs maintained on the two dietary treatments are presented in Table 9. The values were Rs.31.16 and 30.74 for T1 and T2, respectively. Similar cost of feed per kg body weight was obtained by Sekar (2003) in cross bred (LWY X Desi) pigs fed baker's yeast and Suresh (2003) in Large White Yorkshire pigs when supplemented diet with potassium diformate. However Sinthiya (1998) obtained higher cost of feed when dried fish was replaced with different levels of carcass meal.

The overall critical evaluation of the results obtained in the present study indicates that chromium propionate did not affect the growth or feed conversion efficiency of growing (Large White Yorkshire X Desi) cross bred pigs. But supplementation of chromium from chromium propionate significantly reduced total cholesterol in blood. There was a trend for lower triglyceride level and higher HDL cholesterol level in plasma of animals supplemented with chromium. Thus it can be concluded that chromium supplementation can be beneficially used to improve the lipid profile of the cross bred pigs.

Summary

6. SUMMARY

An investigation was carried out for a period of 67 days on twenty four weaned (12 male and 12 female) cross bred (Large white Yorkshire X Desi) piglets weighing on an average of 18 kg to find out the effect of supplementation of chromium propionate on growth. The piglets were randomly divided into two groups with six replicates of two piglets in each group. The two groups of piglets were randomly allotted to the two dietary treatments, T1 (Control- Standard grower ration, containing 16 percent crude protein and 3000 kcal of digestible energy/kg feed) and T2 (Control ration plus 200 ppb of chromium as chromium propionate). The pigs were weighed at the beginning of the experiment and later on at fortnightly intervals. Blood samples were collected in the beginning and at the end of the experiment using heparin as anticoagulant for the analyses of various biochemical parameters including plasma cholesterol, high density lipoprotein cholesterol, triglycerides, total protein, albumin, albumin: globulin ratio, glucose, blood urea nitrogen, calcium, phosphorus and magnesium. Digestion trial was conducted at the end of the experiment to determine the digestibility coefficient of the nutrients of the experimental diets.

The initial body weight of pigs of T1 and T2 groups were 18.5 and 17.83 kg, respectively. There was no significant difference (P>0.05) between animals in the two dietary treatments T1 and T2 with regard to their average body weights during all fortnights. The body weight at the end of the experiment was 40.25 and 39.75 kg, respectively for the two groups, T1 and T2. The average daily gain of animals fed diets supplemented with 0 and 200 ppb of chromium as chromium propionate were 324.62 and 326.48 g, respectively. There was no significant difference (P>0.05) between animals in the two dietary treatments with regard to their average daily gain. The data on the feed conversion efficiency of pigs maintained on two dietary treatments T1 and T2 were 3.77 and 3.74 respectively and were statistically similar.

The digestibility coefficients of nutrients of the two rations T1 and T2 were 0.58 and 0.62 for dry matter, 0.69 and 0.65, for crude protein, 0.35 and 0.28 for ether extract, 0.16 and 0.52 for crude fibre and 0.71 and 0.70 for NFE, respectively. There is a numerical increase in dry matter and crude fibre digestibility for Cr supplemented ration.

Data on various plasma biochemical parameters of blood collected towards the end of the experiment from pigs maintained on the two experimental treatments T1 and T2 were 11.71 and 11.66 mg/dl of calcium, 6.52 and 4.15 mg/dl of phosphorus, 2.37 and 2.51 mg/dl of magnesium, 130.23 and 138.43 mg/dl of glucose, 6.0 and 5.62 g/dl of total protein, 3.47 and 3.58 g /dl of albumin, 1.16 and 1.34 g/dl of globulin, 2.01 and 1.6 of albumin: globulin ratio and 32.68 and 45.11 mg/dl of blood urea nitrogen respectively. The blood contained 57.62 and 35.85 mg /dl of triglycerides, 120.00 and 113.67 mg /dl of total cholesterol and 43.8 and 57.24 mg/dl of HDL cholesterol. Plasma phosphorus and plasma cholesterol values of treatment group were significantly lower than that of the control group.

Data on cost of feed per kg body weight gain of pigs maintained on the two dietary treatments were Rs.31.16 and 30.74, for T1 and T2, respectively.

The overall critical evaluation of the results obtained in the present study indicates that chromium propionate did not affect the growth or feed conversion efficiency of growing cross bred (Large White Yorkshire X Desi) pigs. But supplementation of chromium as chromium propionate significantly reduced total cholesterol in blood. There was a trend for lower triglyceride level and higher HDL cholesterol level in plasma of animals supplemented with chromium. Thus it can be concluded that chromium supplementation can be beneficially used to improve the lipid profile of the cross bred pigs.

References

REFERENCES

Amoikon, E. K., Fernandez, J. M., Southern, L. L., Thompson, D. L., Ward, T. L and Olcott, B. M. 1995. Effect of chromium tripicolinate on growth, glucose tolerence, insulin sensitivity, plasma metabolites and growth hormone in pigs. *J. Anim. Sci.* 73: 1123-1130

Boleman, S. L., Boleman, S. J., Bidner, T. D. and Southern, L. L. 1995. Effect of chromium picolinate on growth, body composition and tissue accretion in pigs. *J. Anim. Sci.* 73: 2033-2042

Bunting, L. D., Fernandez, J. M.,. Thompson, Jr. D. L and Southern, L. L. 1994. Influence of chromium picolinate on glucose usage and metabolic criteria in growing holstein calves. *J. Anim. Sci.* 72: 1591-1599

Devi, S. K. A. 1981. Growth and carcass characteristics of pigs maintained on ration containing different levels of dried tapioca chips. MVSc thesis, Kerala Agricultural University, Thrissur, Kerala, India. p. 129

Indian Council of Agricultural Research. 1985. *Nutrient Requirements of Livestock and Poultry*. Publications and Information Division, ICAR, New Delhi, p. 12

IS: 7472. 1986. Cited by Reddy, D. V. 2001. *Applied Nutrition*. Oxford and IBH publishing Co. PVT. LTD. Kolkota. p. 300

Kegley, E. B. and Spears, J. W. 1995. Immune response,glucose metabolism and performance of stressed feeder calves fed inorganic or organic chromium. *J. Anim. Sci.* 73: 2721-2726

Kegley, E. B., Spears, J. W. and Brown, T. T. Jr. 1996. Immune response and disease resistance of calves fed chromium nicotinic acid complex or chromium chloride. *J. Dairy. Sci.* 79:1278-1283

Kegley, E. B., Spears, J. W. and Brown, T. T. Jr. 1997. Effect of shipping and chromium supplementation on performance, immune response and disease resistance of steers. *J. Anim. Sci.* 75: 1956-1964

Khajarern, J., Khajarern, S., Ashmead, H. D. W. and Ashmead, S. D. 2006. The effect of chromium bisglycinate-nicotinamide chelate supplementation on growth and carcass quality in growing and finishing pigs. *Intern. J. Appl. Res. Vet. Med.* 4 (3): 193-199

Kitchalong, L., Fernandez, J. M., Bunting, L. D., Southern, L. L., and Bidner, T. D. 1995. Influence of chromium tripicolinate on glucose metabolism and nutrient partitioning in growing lambs. *J. Anim. Sci.* 73: 2694-2705

Krolieczewska, B., Zawadzki, W., Skiba, T. and Mestaz, D. 2005. Effects of chromium supplementation on chicken broiler growth and carcass characteristics. *Acta. Vet. Brno.* 74: 543-549

Lien, T. F., Wu, C. P., Wang, B. J., Sheao, M. S., Shiao, T. Y., Lin, B. H., Lu, J. J. and Hu, C. Y. 2001. Effect of supplemental levels of chromium picolinate on the .growth performance, serum traits, carcass characteristics and lipid metabolism of growing finishing pigs. *J. Anim. Sci.* 72: 289-296

Lemme, A. 1999. The efficacy of dietary trivalent chromium on energy and nitrogen metabolism, growth performance and carcass characteristics of growing-finishing pigs under various nutritional conditions. Dissertation submitted to Swiss Federal institute of Technology Zurich. p. 77

Lindemann, M. D., Wood, C. M., Harper, A. F. Kornegey, E. T. and Anderson, R. A. 1995. Dietary chromium picolinate additions improve gain:feed and carcass characteristics in growing-finishing pigs and increase litter size in reproducing sows. *J. Anim. Sci*.73: 457-465

Liu, V. J. K. and Abernathy, R. P. 1982. Chromium and insulin in young subjects normal glucose tolerance. *Am. J. Clin. Nutr.* 35: 661-667

Madhukumar, U. 2002. Nutritive evaluation of carcass meal for growth and carcass characteristics in Large White Yorkshire pigs. MVSc thesis, Kerala Agricultural University, Thrissur, Kerala, India. p. 83

Matthews, J. O., Southern, L. L., Fernandez, J. M., Pontif, J. E., Bidner, J. D and Odzaard, R. L. 2001. Effect of chromium picolinate and chromium propionate on glucose and insulin kinetics of growing barrows and on growth and carcass traits of growing – finishing barrows. *J. Anim. Sci.* 79:2172-2178

Matthews, J. O., Higbie, A. D., Southern, L. L., Coombs, D. F., Bidner,T. D. and Odgaard, R. L. 2003. Effect of chromium propionate and metabolisable energy on growth, carcass traits and pork quality of growing–finishing pigs. *J. Anim. Sci.* 81:191-196

Matthews, J. O., Guzik, A. C., LeMieux, F. M., Southern, L. L. and Bidner, T. D. 2005. Effect of chromium propionate on growth, carcass traits and pork quality of growing finishing pigs. *J. Anim. Sci.* 83:858-862

Maynard, L. A., Loosli, J. K. Hintz, H. F. and Warner, R. G. 1979. *Animal Nutrition.* Sixth edition. Tata McGraw Hill Publishing Company Ltd., New Delhi. p. 613

McDonald, P., Edwards, R. A., Greenhalgh, J. F. D. and Morgan, C. A. 2002. *Animal Nutrition.* Sixth edition. Pearson Education (Singapore) Pte.Ltd. Patpargang, Delhi, India. p. 693

Mooney, K. W. and Cromwell, G. 1995. Effect of dietary chromium picolinate supplementation on growth, carcass characteristics and accretion rates of carcass tissues in growing- finishing swine. *J. Anim. Sci.* 1995. 72: 3351-3357

Mooney, K. W. and Cromwell, G. 1997. Efficacy of chromium picolinate and chromium chloride as potential carcass modifiers in swine. *J. Anim. Sci.* 75:2661-2671

Mossop, R. T. 1983. Effects of chromium (III) on fasting glucose, cholesterol and cholesterol HDL levels in diabetics. *Cent. Afr. J. Med.* 29: 80-82 cited by Anderson, R. A. 1998. Chromium, glucose intolerance and diabetes. *J. Am. Col. Nutr.* 17(6): 548- 555

Nath, R., Minocha, J., Lyall, V., Sunder, S., Kumar, V., Kapoor, S. and Dhar., K. L. 1979. Assessment of chromium metabolism in maturity onset and juvenile diabetics using chromium-51 and therapeutic response of chromium administration on plasma lipids, glucose tolerance and insulin levels. In Shapcott, D. and Hubert, J. (eds): chromium in Nutrition and Metabolism. Amsterdam: Elsvier/North Holland. pp 213-222 cited in Anderson, R. A. 1998. Chromium,glucose intolerance and diabetes. *J. Am. Col. Nutr.* 17(6): 548- 555

Offenbacher, E. G., Rinko, C. J. and Pi-Sunyer, F. X. 1985. The effects of inorganic chromium and brewer's yeast on glucose tolerance, plasma lipids, and plasma chromium in elderly subjects. *Am. J. Clin. Nutr.* 42: 454- 461

Page, T. G., Southern, L. L., Ward, T. L. and Thompson, D. L. 1993. Effect of chromium propionate on growth, serum and carcass traits of growing finishing pigs. *J. Anim. Sci.* 71: 656-662

Pechova, A. and Pavlata, L. 2007. Chromium as an essential nutrient : a review. *Veterinarni Medicana.* 52 (1): 1-18

Rammoorthi, S. 1999. Evaluation of silk worm pupae meal on growth performance in Large White Yorkshire pigs. MVSc thesis, Kerala Agricultural University, Thrissur, Kerala, India. p. 90

Rekha, P. 2001. Influence of different levels of energy on growth performance of cross bred pigs. MVSc thesis, Kerala Agricultural University, Thrissur, Kerala, India. p. 73

Riales, R. and Aibrink, M. J. 1981. Effect of chromium chloride supplementation on glucose tolerance and serum lipids including high-density lipoprotein of adult men. *Am. J. Clin. Nutr.* 34: 2670-2678

Sahin, N and Sahin, K. 2001. Optimal dietary concentration of vitamin C and chromium picolinate for allevating the effect of low ambient temperature (2-6°C) on egg production, some egg characteristics and nutrient digestibility in laying hen. *Vet. Med. Czech.* 46: 229-236

Sahin, K., Guler, T., Sahin, N., Ertas, O. N. and Erkal, N. 1999. The effect of chromium added into basal diet on serum total protein, urea. triglyceride, cholesterol and serum and tissue chromium, zinc, copper levels in rabbits. *Tr. J. Vet. Anim. Sci.* 23:109-113

Sands, J. S. and Smith, M. O. 2002. Effects of dietary manganese proteinate or chromium picolinate supplementation on plasma insulin, glucagon, glucose and serum lipids in broiler chickens reared under thermoneutral or heat stress conditions. *Int. J. Poult. Sci.* 1 (5): 145-149

Saner, G., Yuksel, T., Cihad T. and Gursan, 1980. Effect of chromium on insulin secretion and glucose removal rate in the newborn. *Am. J. Clin. Nuir.* 33: 232-235

Sekar, M. 2003. Effect of baker's yeast on growth and nutrient utilization in cross bred (Large White Yorkshire X Desi) pigs. MVSc thesis, Kerala Agricultural University, Thrissur, Kerala, India. p. 67

Shageer, M. S. and Mowat, D. N. 1993. Effects of level of supplemental chromium on performance, serum constituents, and immune status of stressed feeder calves. *J. Anim. Sci.* 71: 232-238

Shelton, J. L., Payne, R. L., Johnston, S. L., Bidner, T. D., Southern, L. L, Odgard, R. L. and Page, T. G . 2003. Effect of chromium propionate on growth, carcass traits, pork quality and plasma metabolites in growing finishing pigs. *J. Anim. Sci.* 81: 2515-2524

Sinthiya, M. V. 1998. Nutritive evaluation of carcass meal for growth and carcass characteristics in Large White Yorkshire pigs. MVSc thesis, Kerala Agricultural University, Thrissur, Kerala, India. p. 77

Snedecor, G. W. and Cochran, W. G. 1994. *Statistical Methods*. Eighth edition. The Iowa State University Press, Ames, Iowa, USA. p. 313

Suresh, M. 2003. Effect of dietary potassium diformate on growth performance in large white Yorkshire pigs. MVSc thesis, Kerala Agricultural University, Thrissur, Kerala, India. p. 66

Toghyani , M ., Shivazad , M., Gheisari, A. A. and Zarkesh , S. 2006. Performance, carcass traits and hematological parameters of heat-stressed broiler chicks in response to dietary levels of chromium picolinate. *Int. J. Poult. Sci.* 5 (1): 65-69

Uusitupa, M. U., Kumpulainen, J. T., Voutilainen, E., Hersio, K., Sarlund, H., Pyorala, K. P., Koivistoinen, P. E., and Lehto, J. T. 1983. Effect of inorganic chromium supplementation on glucose tolerance, insulin response, and serum lipids in noninsulin-dependent diabetics. *Am. J. Clin. Nutr.* 38:404-410

Van- de- ligt, J. L. G., Lindemann, M. D., Harmon, R. J. and Monegue, H. J. 2002. Effect of chromium picolinate supplementation on porcine immune response during the post weaning period. *J. Anim. Sci.* 80: 449-455

Van- Heugten, E. and Spear, J. W. 1997. Immune response and growth of stressed weanling pigs fed diets supplemented with organic or inorganic forms of chromium. *J. Anim. Sci.* 75: 409-416

Vasudevan, G. 2000. Effect of particle size of maize on the growth performance and digestibility of nutrients in cross bred (Large white Yorkshire) pigs. MVSc thesis, Kerala Agricultural University, Thrissur, Kerala, India. p. 71

Ward, T. L., Southern, L. L and Bidner, T. D. 1997. Interactive effects of dietary chromium tripicolinate and crude protein level in growing-finishing pigs provided inadequate and adequate pen space. *J. Anim. Sci.* 75:1001-1008

Yildiz, A. O., Parlat, S. and Yazgan, O. 2004. The effects of organic chromium supplementation on production traits and some serum parameters of laying quails. *Revue. Méd. Vét,* 155(12): 642-646

ORGANIC CHROMIUM SUPPLEMENTATION ON GROWTH OF CROSS BRED PIGS

ANN NISA THOMAS

Abstract of the thesis submitted in partial fulfilment of the requirement for the degree of

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University, Thrissur

2007

Department of Animal Nutrition
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
MANNUTHY, THRISSUR-680651
KERALA, INDIA

ABSTRACT

An investigation was carried out with the objective to determine the effect of chromium as chromium propionate on the growth of cross bred pigs and to evaluate the economics of organic chromium supplementation in the ration of cross bred pigs. Twenty four weaned piglets (12 male and 12 female) with an average body weight of 18 kg were used as experimental animals. The piglets were randomly divided into two groups with six replicates of two piglets in each group and were randomly allotted to two dietary treatments T1 (control diet) and T2 (control + 200 ppb chromium). The pigs were weighed at the beginning of the experiment and later on at fortnightly intervals. Blood samples were collected in the beginning and at the end of the experiment for the analysis of various biochemical parameters. Digestion trial was conducted at the end of the experiment to determine the digestibility coefficients of the nutrients of the experimental diets.

Animals in the two dietary treatments showed similar ($p>0.05$) body weight gain, average daily body weight gain and feed conversion efficiency. There was a numerical increase in dry matter and crude protein digestibility of Cr supplemented ration. There was no significant difference ($p>0.05$) between the animals in the two groups for all the blood parameters studied except phosphorus and cholesterol, which were significantly lower ($p<0.05$) for T2 group. There was non-significant decrease in triglycerides and increase in HDL cholesterol level. The overall critical evaluation of the results obtained in the present study indicate that though supplementation of chromium propionate did not affect the growth or feed conversion efficiency of growing (Large White Yorkshire X Desi) cross bred pigs, it can be beneficially used to improve the lipid profile of the cross bred pigs.