BEHAVIOURAL CHARACTERISTICS OF DIFFERENT GENOTYPES OF PIG

Thesis

submitted to

NAGALAND UNIVERSITY

in partial fulfilment of requirements for the degree

of

Doctor of Philosophy (Agriculture)

in

LIVESTOCK PRODUCTION AND MANAGEMENT

by

S. SARENDI WALLING

Admn. No. Ph-236/17 Regn. No. AC/Ph.D./LPM/00147

Department of Livestock Production and Management,
School of Agricultural Sciences and Rural Development,
Nagaland University, Medziphema Campus-797106
Nagaland

2021

DECLARATION

I, S. Sarendi Walling, hereby declare that the subject matter of this thesis is the record of work done by me, that the contents of this thesis did not form the basis of the award of any previous degree awarded to me or to the best of my knowledge to anybody else, and that the thesis has not been submitted by me for any research degree in any other university/institute.

This is being submitted to Nagaland University for the degree of Doctor of Philosophy (Agriculture) in Livestock Production and Management.

Date: S. SARENDI WALLING

Place:

Dr. M. Catherine Rutsa
Supervisor

NAGALAND UNIVERSITY
Medziphema Campus
School of Agricultural Sciences and Rural Development
Medziphema - 797106, Nagaland

Dr. M. Catherine Rutsa
Associate Professor
Department of Livestock Production and Management

CERTIFICATE- I

This is to certify that the thesis entitled "**Behavioural Characteristics of Different Genotypes of Pig**" submitted to Nagaland University in partial fulfilment of the requirements for the award of degree of Doctor of Philosophy (Agriculture) in Livestock Production and Management is record of research work carried out by Mr. S. Sarendi Walling, Registration No. AC/Ph.D./LPM/00147 under my personal supervision and guidance.

The result of the investigation reported in the thesis has not been submitted for any other degree or diploma. The assistance of all kinds received by the student has been duly acknowledged.

Date:
Place: Dr. M. Catherine Rutsa
Supervisor

NAGALAND UNIVERSITY
Medziphema Campus
School of Agricultural Sciences and Rural Development
Medziphema – 797 106, Nagaland

CERTIFICATE – II

VIVA VOCE ON THESIS OF DOCTOR OF PHILOSOPHY IN LIVESTOCK PRODUCTION AND MANAGEMENT

This is to certify that the thesis entitled "**Behavioural Characteristics of Different Genotypes of Pig**" submitted by S. Sarendi Walling, Admission No. Ph.-236/17, Registration number **AC/Ph.D./LPM/00147** of 2017 batch to the NAGALAND UNIVERSITY in partial fulfillment of the requirements for the award of degree of Doctor of Philosophy (Agriculture) in Livestock Production and Management has been examined by the Advisory Board and External examiner on ………………..........

The performance of the student has been found **Satisfactory/Unsatisfactory.**

Member		**Signature**
1. Dr. M. Catherine Rutsa	Supervisor	……………….
2. Dr. Adib Haque	External Examiner	……………….
3. Pro Vice Chancellor nominee	Dean, SASRD	……………….
4. Prof. V.K. Vidyarthi	Member	……………….
5. Dr. R. Zuyie	Member	……………….
6. Prof. J. Longkumer	Member	……………….
7. Prof. R. Nakhro	Member	……………….
8. Head (LPM)	Ex-officio member	……………….

Head
Department of Livestock Production
and Management

Dean
School of Agricultural Sciences
and Rural Development

ACKNOWLEDGEMENTS

Firstly, I thank God, Almighty for his endless blessings throughout my life and blessing me good health to be able to work tirelessly and patiently.

I profoundly express my sincere gratitude to my supervisor **Dr. M. Catherine Rutsa,** Associate Professor, Department of Livestock Production and Management, who has endlessly supported and guided me throughout my research work. It was a privilege to work under her guidance and constant supervision. I fell lost of words to express more gratitude to her; nevertheless, I wish her good health to deal with her everyday task.

I profoundly express my utmost gratitude to my advisory committee member **Prof. V.K. Vidyarthi**, the then former HoD, Department of Livestock Production and Management, for his constant encouragement, constructive criticism and motivation in every possible way. I also sincerely thank **Mrs. Sushma Vidyarthi** for her encouragement throughout my research works.

I express my gratitude to **Prof. Nizamuddin** and **Dr. N. Savino**, Associate Professor of the Department of Livestock Production and Management for their encouragement and moral support during my study period.

I am also thankful to my Advisory Committee members **Dr. R. Zuyie**, Associate Professor, Department of Livestock Production and Management, **Prof. J. Longkumer**, Department of Agriculture Extension and **Prof. R. Nakhro**, Department of Agricultural Economics for their valuable suggestions, critical inputs and constructive criticism. I am thankful to my advisory committee member **Dr. A.K. Sahu**, Assistant Professor, Department of Agricultural Economics for his valuable service in analyzing my data.

I am also thankful to ICAR-AICRP on pig, Nagaland centre, Department of livestock Production and Management, NU:SASRD, Medziphema for allowing me to use the infrastructure and the live animals in the farm and the cooperation of the project staff of both the technical (JRF and veterinary assistants) and non-technical staffs members for rendering their service selflessly during the course of my research work are duly acknowledged.

I wish to express my sincere thanks and gratitude to ICAR-NRC on Mithun, Medziphema, Nagaland for allowing me to use their laboratories and the assistance and cooperation from the institute staffs are duly acknowledged.

I feel profound joy to express thanks to my colleagues Miss Homseng, Miss Adelene, Miss Tsarila and Miss Diana for their valuable suggestion during the course of my research works. I wish every one of them a good luck in their endeavors.

I am very thankful to my family members for their constant prayers and support towards achieving my goal. I thank my mother for her constant love and prayers for me to have good health to go through my rough days. I also thank my wife for her constant support and encouragement throughout my entire study period.

Last but not the least, I thank Almighty God for all the blessings that he has bestowed upon me and I also fervently pray to God to grand a peaceful life to all those who has helped me throughout my study period.

Date :

Place: S.SARENDI WALLING

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

ABBREVIATION	FULL FORM
%	per cent
ad libitum	free choice
ANOVA	analysis of variance
BW	body weight
Cctv	close circuit television
CD	critical difference
cm	centimetre
df	degree of freedom
et al.	and co-workers
Fig	Figure
FLD	frequency of lying down
FOD	frequency of drinking
FOF	frequency of feeding
ft	feet
g	gram
Hb	Haemoglobin
i.e.	that is

Kg	kilogram
m	metre
min	minutes
ml	millilitre
mm	millimetre
MMS	mean sum of square
Mov	movement
MSL	meter above the sea level
no	number
NS	non significant
ºC	degree Celsius
ºF	degree Fahrenheit
P.I.	Performance Index
PCV	packed cell volume
PR	pulse rate
RBC	red blood cell
Rep	replication
RR	respiration rate
RT	rectal temperature
Sec	seconds

SEM	Standard Error Mean
SOV	Source of Variation
sq.	Square
SS	Sum of Square
TSD	time spent on drinking
TSF	time spent on feeding
TSL	time spent on lying
viz.	such as
WBC	white blood cell

ABSTRACT

The study entitled "Behavioural characteristics of different genotypes of pig" was carried out using three different genotypes of pigs namely *Tenyivo*, Upgraded *Tenyivo* and *Hampshire* pigs as group one, two and three respectively, seven animals in each group. The experimental animals were reared under similar feeding regime and standard housing system. The physical characteristics, physiological behaviours, ethological behaviour, some blood parameters and growth performance were recorded. The physical measurements, T_3 has the highest face length (21.46 cm) and highest face breadth (9.60 cm) in $T_{1.}$ The T_3 group recorded higher values of body length, heart girth, abdominal girth, height on withers as 78.37 cm, 72.77 cm, 83.80 cm and 45.17 cm, respectively. The physiological value of pulse rate at 60 and 180 days were 132.27, 125.14, 78.27 and 94.00, 79.43, 72.71 beats per minute, respectively. The value of respiration at 60 and 180 days were 38.14, 28.85, 33.89 and 32.68, 29.02, 30.45 movements per minute, respectively. The value of rectal temperature at 60 and 180 days were 38.20, 38.50, 38.20 ºC and 38.90, 38.90, 38.90 ºC, respectively. The value of time spent on feeding at 60 and 180 days were 87.60, 93.47, 168.63 and 82.34, 151.59, 166.42 minutes, respectively. The value of time spent on drinking at 60 and 180 days were 229.87, 268.80, 247.13 and 225.60, 253.20, 273.90 seconds, respectively. The blood analysis for red blood cells, white blood cells, haemoglobin, packed cell volume, glucose and cholesterol did not show any significant difference ($P > 0.05$) between the three treatment groups. The body weight at 60 and 180 days were 4.494, 7.487 and 8.996 and 16.199, 27.770 and 30.772 kg per pig, respectively. The values for average body weight was significantly ($P < 0.05$) higher in T_3 group followed by T_2 and in T_1 groups irrespective of the periods of observations.

Keywords: genotypes, physical characteristics, physiological behaviours, ethological behaviours, blood studies, growth performance

CHAPTER I

INTRODUCTION

INTRODUCTION

The pig is one of the most common and important livestock reared by the tribal mass of the North East (NE) India. Traditional practice of rearing pig is seen even today both in the rural and urban population. In Nagaland, the Naga people have very few written materials about their livestock history except through oral and verbal communication from the elders which were passed down from generation to generation. Thus, basing on oral records, it was known that pigs were associated with the local Naga inhabitants since time immemorial.

According to the 20th Livestock Census of India (2019), pig population is estimated to be 9.06 million. NE region has 38.42% of the total pig population of India with a total population of 57, 56,306 numbers. In Nagaland, the state pig population is 5, 03,688 of which 75.99% are crossbreds and 24.41% are indigenous.

The challenges faced by India towards quantity and safety of food as well as nutritional security for the fast growing population require an integrated approach towards livestock and agricultural farming. Among the various livestock species, piggery is most potential source of meat production with efficient feed converters next to the broiler birds. Apart from providing meat, it is also a source of bristles and manure. Pig farming will provide employment opportunities to seasonally employed rural farmers and supplementary income to improve their living standards.

The study of behavioural pattern is important in swine production because every individual at different ages behave differently due to the effects and interaction of stimuli which may be genetical or non-genetical variations and which finally affects the performance traits of animal. Therefore, the behavioural study of different pig breeds and variety reared under the present location and environmental climatic condition can add value towards better management to achieve higher production, reducing diseases condition and result in faster growth, efficient production and higher profitability. As stated by Saxena and Saxena (2003) the animal behavioural characteristic requires an accurate description, understanding of the control of behaviour and quantitative assessment of how behaviour can be accommodated and affect good husbandry for optimum production.

According to Onyimonyi *et al.* (2010), linear body measurement such as chest girth, height at withers and body length were used to relate body dimensions to an animal overall body size or weight. These measurements were frequently used in studies of an animal growth. Sulabo *et al.* (2006) established that there was a positive correlation between linear measurement and body weight in pigs. Brown *et al.* (1973) observed that linear body measurements could be used in assessing growth rate, weight, feed utilization and carcass characteristic in farm animals. According to Tegbe and Olurunju (1998) and Oke *et al.* (2006), changes in linear measurements were an indication of tissue growth evidenced in the muscle and tissues. These parameters could tend to increase as the animals grew over time. Linear body measurement could provide good information on performances, productivity and carcass characteristics of animals (Ige *et al.*, 2006). The phenotypic morphometric parameters between males and females of local pigs are also important (Banik *et al*., 2012; Borkotoky *et al*., 2014; Boro *et al*., 2016 and Kalita *et al*., 2017) The study of physical characters being a part of standardization of measurement could be an essential and integral part of farm operations.

The study of physiological parameters such as heart rate, respiration rate and body temperature is an important procedures followed in modern day farming. Pereira *et al*. (2019) states that to provide the best animal welfare, measureable indicators of stress, such as heart rate and respiratory rate, body temperature or behavioural indicators should be recorded in animal trails. Von Borell *et al.* (2007) derived a conclusion from the measurement of Heart Rate Variability (HRV) in pigs, cattle, horses, sheep, goats and poultry from which they found that HRV is a promising approach for evaluating stress and emotional states in animals. According to Chakraborty *et al.* (2018) diagnosing illness in animals represents one of the main duties of veterinarian's clinical examination which consists of the measurement of rectal temperature as well as the evaluation of pulse and respiration.

The animal drinking and feeding behaviour is determined by variables such as the number of visits to the drinker, duration of each visits and intake per unit of time (Nielsen, 1999) which is the central variables in the study of individual drinking behaviour. In feeding behaviour, complex interactions exist between different factors and the central behavioural variables. Social competition for feed decreases the number of visits to the feeder and increased the feed intake per minute (De Haer and De Vries, 1992; Nielsen *et al.* 1995) and on the other hand increase in temperature decrease the number of visits to feeder but did not affect the feed intake per minute (Quiniou *et al.* 2000).

The growth performance of the pigs and the variation in the growth rate starts from conception, with pigs of the same litter often vary considerably in birth weight (Milligann *et al*. 2001). This variation in pig growth performance both within and between litters continues throughout their lifetime (Kennedy, 1984).

The present research work is aimed to find out the best genotype suitable for Nagaland agro-climatic condition which will help the farmers to identify the breeds suitable for their backyard rearing. The study on physical parameters will provide information on growth performance and thereby help in selection and identification of breed for rearing and which one to be culled. The physical studies on linear measurement are indication of tissue growth and therefore will provide information on performance, productivity and carcass characteristics. Physiological studies are done to record the stress such as heart rate, respiratory rate and body temperature to provide animal welfare. The study of physiological behaviours will help in better management of animals by identifying the sick animals and thereby timely management of the animals in general. The study on ethological behaviour will help in identifying feed management as it will provide information on the feeding behaviour of the three different genotypes and thereby, identifying on which breed performs better in terms of feed intake and growth of the animals. The haematological study will provide information on the blood profile of the three different genotypes which can be used as base line information for similar type of works in future. The growth performance of the study will provide information on the best performing breed for selection and breeding program. In general, behavioural studies of different pig breeds and variety reared under the present location and environmental climatic condition can add value towards better management to achieve higher production, reducing disease condition and result in faster growth, efficient production and higher profitability.

Keeping above points in mind the present experimental research work entitled "Behavioural characteristics of different genotypes of pigs" was carried out using three genotypes of pig namely: *Hampshire*, *Tenyivo* and Upgraded *Tenyivo* (75%) with the following objectives:

1. To study the physical characteristics of the three genotypes of pig.
2. To study the physiological characteristics of the three genotypes of pig.

3. To study the ethological characteristics of the three genotypes of pig.
4. To study the haematological and biochemical parameters of blood from the three pig populations.
5. To study the growth performance of the three pig populations.

CHAPTER II

REVIEW OF LITERATURE

REVIEW OF LITERATURE

2.1 Physical Characteristic

Oke *et al.* (2006) investigated the effect of breed sire on growth characteristics of exotic crossbred pigs in a humid tropical environment where measurement like body length, height at withers, heart girth and rear girth were taken from crossbred progeny of Large white sow mated with sire of Large white, *Hampshire* and *Duroc* in the ratio of 1:4. The results showed significant ($P < 0.05$) difference among the breeds of sire for body weight, heart girth and rear girth at different ages. *Hampshire* sire progeny were superior to the progeny of the breeds for most of the traits measured post weaning. *Hampshire* sired progeny were superior in 70 per cent of all traits while those of Large white sired showed superiority in 30 per cent of the traits in post weaning phase.

Banik *et al*. (2012) studied the effect of different body measurement on body weight in Ghungroo pigs and observed that sex of the animals did not show any significant difference in body measurement traits. The correlation coefficient of different body measurement traits showed high correlation among themselves for male, female and overall observation.

Morenikeji *et al.* (2013) made their work on genetic correlation and heritability of performance traits among three pig genotypes. They found that the correlation of body weight and linear measurements was positive. The chest girth and height at withers had the highest and strongest relationship with body weight among other linear measurement.

Khargharia *et al.* (2014) reported that the conformation traits *viz.* Body length, height at withers, hearth girth and neck girth were significantly ($P < 0.05$) higher in Doom pigs as compared to Niang Megha at birth, weaning and at adult age.

Borkotoky *et al.* (2014) reported that there was no significant difference in the phenotypic morphometric parameters between male and female pigs of Naga local pigs. Moreover, the female pigs have non-significantly higher morphometric value than male animals.

Oluwole *et al.* (2014) made their studies on hybrid progenies from crossbreeding between the Nigerian indigenous pig and Large white pigs and found that the correlation between the reproductive parameters and growth performance of hybrid pigs were established with good management practices. The male were heavier in weight and morphometric traits such as body length, heart girth and rump circumference, while the female were high in morphometric traits such as snout length, ear length and body height.

Boro *et al.* (2016) studied the phenotypic attributes of Desi pigs of Bareilly district in Utter Pradesh and found that head was elongated with triangle shaped face with long and short snout. Majority of them had erect leaf shaped ears (82.98%) with upward or horizontal orientation, 70% have narrow straight and curled tails with a wild looks and small in size.

Kalita *et al*. (2017) reported that there was no significant difference in the phenotypic morphometric parameters between male and female pigs of local pigs of Mizoram.

Morenikeji *et al*. (2019) investigated the effects of genotypes, sex and their interaction on the performance characteristics of three pig genotypes. They found that body weight, length, trunk length, height at withers, chest girth, tail length and shoulder to tail were significantly ($P < 0.05$) influenced by genotype and sex.

Panda *et al.* (2020) made an investigation to derive fewer independent common factors trough principal component analysis to characterize 75% *Landrace* crossbreds *i.e.* 75% *Landrace* x 25% Bareilly local piglets. They observed high correlation coefficients among most of the morphometric and growth traits.

Govindasamy *et al.* (2020) conducted a study in four states of North Eastern India *viz.* Mizoram, Manipur, Nagaland and Meghalaya to study the phenotypic characters of the Burmese pig. They reported that the average body length, height at withers, hearth girth and neck girth at adult age were 84.86 ± 1.76, 69.94 ± 1.52, 87.06 ± 2.41. and 78.27 ± 1.98 cm in male and 81.66 ± 1.70, 60.15 ± 1.60, 83.05 ± 2.10. and 75.02 ± 1.81 cm, respectively.

2.2 Physiological Behaviour

2.2.1 Pulse rate

Von Borell *et al.* (2007) derived a conclusion from the measurement of Heart Rate Variability (HRV) in pigs, cattle, horses, sheep, goats and poultry from which they found that HRV is a promising approach for evaluating stress and emotional states in animals. It has the potential to contribute much to own understanding and assessment of the underlying neuro physiological processes of stress responses and different welfare states in farm animals.

Swindle *et al.* (2012) reported that swine occupies an important place in preclinical toxicological testing of pharmaceutical as they share a unique similarity with humans in anatomic and physiologic characters that involves the cardiovascular, urinary, integumentary and digestive systems. They found that hemodynamically there were differences between breeds of pigs and between pigs of different ages within the same breed, like heart rates were much higher in young swine than in adults. They concluded that the usefulness of pigs in experimental research that pigs and minipigs would continue to be useful tools for the investigator, toxicologist and research pathologist.

Sipos *et al.* (2013) made a study on the physiological changes of rectal temperature, pulse rate and respiratory rate of pigs at different ages including the critical peripartal period and found that specific trends could be found for pulse rate where the study revealed some major differences to historic reference value.

Zupan *et al*. (2016) studied the behaviour, heart rate and heart rate variability in pigs exposed to novelty and found that there is a complex and often contradictory nature of relationship between behaviour and cardiac responses to novelty in pigs of different breeds and sexes.

Pereira *et al.* (2019) made a study on contactless motion-based approach for monitoring cardiorespiratory signals (heart rate and respiratory rate) in anesthetized pigs using infrared thermography and found that the mean absolute error averaged 3.43 ± 3.05 beat per minute for heart rate.

Chavez *et al.* (2020) made a study on the use of computer vision technology and thermal infrared imagery to detect changes in animal physiology like heart rate and respiration rate in pigs and to obtain data from animals that shared some signs of illness with data from animals that showed no signs of ill health. Highly significant differences ($P < 0.05$) were observed between sick and healthy pigs in heart rate with higher heart rate and higher temperatures in sick pigs, suggesting that possible uses of this technology for on farm monitoring and management.

2.2.2 Respiration rate

Huynh *et al.* (2005b) studied the effect of increasing relative humidity and ambient temperatures on gilts in pens inside respiration chambers and found that respiration rate in the range from 21.3 to 23.4ºC and the upper critical temperatures was least at 80% R.H. ($P < 0.05$).

Renaudeau (2005) studied the effect of short-term exposure to high ambient temperature and relative humidity on thermoregulatory responses of European (large white) and Caribbean (creole) restrictively-fed growing pigs and found that respiration rate increased between 28 and 34º C (+ 34.4 vs. 18.4 breaths per min, $P < 0.001$) and suggested that breed can affect response to heat stress.

Pazzani *et al*. (2014) reported that the respiratory rate remained within physiological limits from 25 to 40 mov/min in all treatments when the behaviour and welfare of piglets was evaluated from weaning to 60 days in different farming systems.

Pereira *et al.* (2019) made an experiment on contactless motion-based approach for monitoring cardiorespiratory signals (heart rate and respiratory rate) in anesthetized pigs using infrared thermography and found that the mean absolute error averaged 0.27 ± 0.48 breaths per minute for respiratory rate.

Chavez *et al.* (2020) after using computer vision technology and thermal infrared imagery to detect changes in animal physiology like respiration rate between infected and healthy pigs. They obtained the results that respiration rate showed less difference between infected and healthy pigs which highlights that computer vision techniques can provide important and useable data regarding physiological changes that can indicate early signs of respiratory infection in pigs.

2.2.3 Body Temperature

Andersson and Jonasson (1993) recorded the rectal temperature of pigs to be 38.7 ºC to 39.8 ºC. The normal body temperatures for piglets were recorded as 38.5 ºC to 39.5 ºC.

Huynh *et al.* (2005a) studied the effects of increasing temperatures on physiological changes in pigs at different relative humidity and reported that rectal temperature was a delayed indicator of heat stress tolerance with upper critical temperature ranging from 24.6 to 27.1ºC for both of these indicators the upper critical temperature was least at 80% RH ($P < 0.05$).

Caldara *et al.* (2012) made a study on the physiological parameters of pigs reared under three production systems which is concrete floor, deep bedding with wood shaving and deep bedding with coffee husks. Rectal temperature was higher in animals reared on coffee husk bedding (39.5 ºC) and deep bedding with wood shaving (39.3 ºC) in relation to the concrete floor (39.0 ºC).

Sipos *et al.* (2013) in their clinical trial for rectal temperature (RT) found that the RT of piglets increased during the first week of life to 39.5 ºC and than decreased slightly until the time of weaning at an age of 21 days. There was then an increase until week 15 to 39.6 ºC, followed by a decrease to the mean level of finishers of 39.21 ºC which reveals that some major differences to historic reference values.

Godyn and Herbut (2017) in their review stated that temperature measurement is one of the most important indices in estimating the state of health both in humans and animals. Continuous body temperature measurements provide a better control of the herd and a precise determination of the environmental impact on animal. The review of professional publications warrants the conclusion that the systems based on continuous temperature measurements acquire ever increasing importance in the studies in livestock. Remote measurement of the body temperature is needed by implementing technologies although these techniques are not free from certain imperfections and the best solution should be sought for a strong premise in favour of continuing the research in this domain in view of all the limitations.

Zhang *et al.* (2019) made a study on body temperature detection of pig based on infrared technology which is an emerging technology with its advantages on non-contact long distance and real time for temperature measurement which is also an effective means to assist in disease diagnosis and pig health monitoring. Nowadays, the infrared temperature measurement equipment based on point-by-point analysis represented by infrared thermometer and temperature measurement equipment based on full-field analysis represented by infrared thermal imager have been applied in pig industry which is more convenient as compared to conventional method of measuring body temperature where a mercury column is used to obtain the rectal temperature. The conventional method is found to be complicated requiring a large amount of labour which can only stress the animal while contacting the animal for temperature measurement.

2.3 Ethological Behaviour

2.3.1 Feeding Behaviour

Walker (1991) studied the effects on performance and behaviour of number of growing pigs per mono-place feeder per pen which was the only source of both food and water for pigs penned in groups of 10, 20 or 30. He reported that for individual pigs, time spent at the feeder and the number of visits ranged from 5 minute to 140 minute and from 5 per 24 hours, respectively.

Gonyou *et al*. (1998) studied the behaviour of pigs weaned at 12 and 21 days of age from weaning to market and found that pigs weaned at 21 days of age spent more time eating than those weaned at 12 days of age ($P < 0.05$). Although both age groups ate little (< 3% of time) during the initial 12 hours, those weaned at 21 days of age began increasing time spent eating during the subsequent 12 hours and reached a normal level of approximately 9% of time spent eating by 36 hours post weaning. No noticeable increase in eating occurred among those weaned at 12 days of age until 36 hours at which point the level quickly increased to 10% of time.

Bornett *et al*. (2000) reported causal changes in feeding behaviour of pigs were observed when they were kept in groups to investigate the effects of grouping on feeding pattern, time taken and the social behaviour of pigs kept at individuals from weaning until grouping.

Morgan *et al.* (2000) observed that feeding behaviour by random models to analyse the feeding behaviour of pigs. Daily feed intake increased with time and pigs made between 18.8 and 80.3 (mean 47.9) daily visits to the feeder. They suggested that pigs eat in meals separated by long intervals, meals consists of clusters of eating bouts separated by shorter intervals, sometimes associated with drinking and within each eating bout short intervals occur as pigs constantly move in and out of the feeder.

Renaudeau *et al.* (2005) studied the effects of breed and sex on individual growth performance and feeding behaviour in 45 to 90 kg body weight in two replicates of grouped housed pigs. They found that growth performance and feeding pattern were significantly affected by breed, sex and season.

Widowski *et al*. (2008) reported that piglets weaned prior to four weeks of age typically took longer time to ingest solid feed and piglets that spent more time on belly nosing also spent less time at the feeder and is evidenced linked to early weaned piglets.

Chinnamani *et al*. (2010) documented the feeding behaviour of crossbred Large White *Yorkshire* pigs under different feeding regime and recorded that there were highly significant ($P < 0.01$) differences in the feeding behaviour except the number of meals per day between the treatment groups.

Bakere *et al*. (2014) investigated the effect of feeding fibrous diets on growth performance and of aggressive behaviours in growing pigs. They found that pigs fed on fibrous feed spend more time eating compared to pigs on control diets.

Massari *et al*. (2017) made their study on identifying the best gender division pattern for swine at nursery stage, through the evaluation of behavioural and environmental parameters and reported that mixed sex housing had multivariate relations suggesting less aggressive behaviours over feed resources being an example of social interaction that improves swine welfare.

2.3.2 Drinking Behaviour

Yang *et al.* (1981) observed that water intake was unchanged or slightly decreased when food intake was allowed to increase. Both reduction of food supply to half its usual amount and fasting significantly increased drinking and water turnover rate. The pigs consumed more water when food was restricted, a behaviour attributed to hunger.

Bigelow and Houpt (1988) found that the drinking behaviour was often mirrors of feeding behaviour as 75 per cent of the water intake was associated with pig feed intake.

Turner *et al.* (2000c) studied the effect of pig live weight on drinking behaviour using four replicates of a 2 x 2 factorial design of two group sizes (20 vs. 60) and two drinker: pig ratio (1: 10 vs. 1: 20) on a 640 growing pigs. They found that the frequency of visits to the drinkers, drinking bout duration and daily drinking time were affected by group size and drinker allocation but not by weight or the interaction of treatments and weight. The diurnal spread of drinking was similar for each of the four treatment combinations and each weight category.

Torrey and Widowski (2006) reported that weaned piglets prefer a drinker (nipple drinker or the float bowl drinker) that is easy to find or provides easier access to water.

Deligeogis *et al*. (2006) reported that the duration of drinking time was longest at noon and shortest in the early morning hours when they studied the effect of drinker placed within the farrowing crate of newborn pigs.

Sarma *et al.* (2009) reported that the influence of different floor space allowance on the social behaviour of pigs managed under similar feeding and management showed that the time spent in feeding, drinking and movement has a decreasing trend during growing and finishing period.

Andersen *et al.* (2014) made a study on the growing pigs drinking behaviour for 52 cross-bred castrated male pigs (live weight 20.5 ± 1.7 kg) maintained as either 3 (N3) or 10 (N10) pigs per pen and water nipple (four groups/ treatment) were used. Their study revealed that social competition did not affect the drinking behaviour over 24 hour except for the proportion of interrupted visits where pigs, kept with recommended nipple availability (N10), showed as increased proportion of interrupted drinking bouts compared with pigs kept at very low level of competition (N3).

Zhu *et al.* (2017) made a study on using machine vision which is proposed to (a) recognise the presence of an individual pig within the drinking zone and (b) analyse the vision images to determine if the pig is drinking. The pigsty contains 7 pigs and is monitored in real time and 140 video clips containing images of the individual pigs while drinking were captured. The correct (drinking) recognition rate for individual pigs was 90.7%. This method differs from traditional methods in that it avoids any disturbance to the pigs. It is also used for recognition of individual pigs within a stress-free environment and the results can provide a reference point and direction for exploration of other behaviour of group housed pigs.

Chimainski *et al.* (2019) made an objective study about the daily behaviour of water intake of 60 male pigs in the growing and finishing phases. Feed and water intake were collected in real time during the entire experimental period. They found that water disappearance (WD) was 7.98 litres which increased during the study period. The time spent drinking (TSD) and number of drinker visit (NDV) also showed a peak in the afternoon: 13:00 and 17:00 hour for growing and finishing phases respectively. The TSD was 282.73 and 268.38 seconds and the NDV values were 16.13 and 13.84 hours for growing and finishing phase respectively.

2.3.3 Resting Behaviour

Robert *et al.* (1987) reported their study on role of environment and genetics in behaviour of wild and domestic pigs and observed that males activity was similar to that of females in the two groups. Wild pigs rest less than domestic pigs during day time leading to higher frequency of locomotion. Diurnal activity of wild pigs may be due to protected environment while it may be a tendency to conserve energy for domestic pigs. The domestic pig relative frequency of rest fluctuated between approximately 70 and 100% during the day time.

Huynh *et al*. (2005b) studied the effect of high ambient temperatures and humidity on growing pigs and found that at high temperature it greatly affect lying and excreting behaviour.

Debreceni *et al.* (2014) made a study on the effect of high temperature on the behaviour of growing-finishing pigs and made observations that pigs were most of the time lying (72%, $P < 0.001$). Pigs spent more time lying on the floor without bedding (86.65%, $P < 0.01$) compared to floor with bedding (13.35%, $P < 0.001$).

Li (2014) in his article described the resting behaviour of pigs in which he stated that pig spent the majority of their time resting or lying. On average, grow-finish pigs spent 75 to 85% of their time lying and 5 to 10% eating, with the remainder of their time involving in other activities such as walking, sitting, rooting/ nosing and drinking.

2.4 Blood Parameters

Plumb (2005) in his Veterinary Drug Handbook has given the reference value for cholesterol and glucose as 81-134 mg/dl and 66-116 mg/dl respectively for pigs.

Aladi *et al.* (2008) made a comparative study of different haematological characteristics of Large white and Nigerian indigenous and found no significant age or breed differences in haematological parameters ($P > 0.05$) and the values were within the normal ranges generally accepted as reference values for healthy pigs.

Mayengbam *et al.* (2014) reported their findings on haematological profile of Zovawk an indigenous pig of Mizoram and concluded that haematological profile changed with the age.

Adeoye *et al.* (2015) reported that genotype did not have significant effects ($P > 0.05$) on the blood parameters between F_1 and F_2 generations pigs farrowed by sows and boars of Large White sows, Large black sows, *Duroc* sows, Large White boar and Nigerian hybrid boar which were survivors of the African Swine Fever (ASF) outbreak in Nigeria in 2005.

Kumal *et al.* (2017) reported their work in which Whole blood samples were collected from apparently healthy indigenous pigs (60 no's) reared under scavenging and semi-intensive system from different parts of Tamil Nadu to study the haematological parameters. The mean PCV (%), HB (g/dl), RBC(10^6/µl), WBC(10^3/µl), Neutrophil (10^3/µl), Lymphocyte (10^3/µl), Eosinophil (10^3/µl), Monocyte (10^3/µl) were 42.08±0.85, 10.76±0.24, 7.02±0.14, 22.67±0.71, 10.87±0.35, 10.56±0.32, 0.51±0.04 and 0.73±0.04 respectively. There is no significant difference among sexes in all the haematological parameters analyzed.

2.5 Growth Performance

Nielsen *et al.* (1995) examined the effect of increased competition around a single-space feeder on individual performance and behaviour by manipulating the number of pigs per feeder. They reported that there was no difference found between group sizes in daily feed intake, live-weight gain and feed conversion ratio.

Turner *et al.* (2003a) recorded a significant negative approximately linear relationship in average daily gain (ADG) with increase in group size during the weaning (weaning up-to 30 kg) and grower (31-68 kg) stages. A large group size may compromise the growth performance of young pigs, but the long term consequences for the other economically important triats is likely to be slight.

Okeudo *et al*. (2007) reported that there was a significant difference ($P < 0.01$) in live weight, average daily gain (ADG), average daily feed intake (ADFI) and feed conversion ratio (FCR) among the Nigerian indigenous (NI), Large white (LW) and cross bred of LW x NI (F_1) pigs. The LW boars had significantly higher ADG and consumed more feed than the NI boars and had better FCR. At similar live weights, LW pigs were significantly ($P < 0.01$) younger and had higher in ADG, ADFI and FCR values than the other breeds.

Gopinathan and Usha (2011) made a comparative study on Large White *Yorkshire*, Crossbred and Desi from weaning to eight months of age and found that higher body weight and average daily gain were noticed in large white *Yorkshire* and followed by crossbred and desi pigs in all months. Better feed conversion efficiency was noticed at fifth month in large white *Yorkshire* and crossbred pigs and at fourth month in desi pigs respectively.

Banik *et al.* (2013) conducted a study to assess the pre weaning growth pattern and construct growth band in *Ghungroo* and *Niang Megha* pigs maintained under standard breeding, feeding and management condition and observed that the overall mean weight at weaning was 0.64±0.02 kg and 5.47±0.13 kg respectively.

Kaswan *et al.* (2015) in a study of crossbred (*landrace* x Desi) weaned male piglets of 6 weeks of age recorded body weight gain as 10.90±1.09. 12±0.97 and 12.47±1.19 kg for 0.9 m^2, 0.6 m^2 and 0.45 m^2 space allocation respectively.

CHAPTER III

MATERIALS AND METHODS

MATERIALS AND METHODS

3.1 Location of study

The experimental research work was carried out at pig project farm of Indian Council of Agricultural Research – All India Coordinated Research Project on Pig (ICAR-AICRP on pig), Department of livestock Production and Management, School of Agricultural Sciences and Rural Development (SASRD), Nagaland University, Medziphema Campus. The farm is located at 93.20 ºE to 95.15 ºE longitude and latitude between 25.6 ºN at an elevation of 310 meters above mean sea level (MSL).

The experimental work was initiated in the month of November 2018 and continued till May 2019.

3.2 Selection of Animals

The experimental animals were randomly selected irrespective of sex from three genotypes, seven numbers each from *Tenyivo*, 75% Upgraded *Tenyivo* (pig variety having 75 per cent *Hampshire* blood and 25 per cent *Tenyivo* blood) and *Hampshire* breed of both sexes at 60 days of age from the research pig farm of ICAR-AICRP on Pig, Department of Livestock production and Management, SASRD, Nagaland University, Medziphema Campus, Nagaland. The detailed grouping of the animal is given below:

1. Group I consists of seven Nagaland indigenous piglets (100% *Tenyivo*).
2. Group II consists of seven 75% upgraded *Tenyivo* piglets (75% *Hampshire* and 25% *Tenyivo*).
3. Group III consists of seven exotic *Hampshire* piglets (100% *Hampshire*).

3.3 Identification of Animal

The experimental animals are given yellow plastic ear tags for identification number, bearing the serial number 067 to 073, 074 to 080 and 081 to 087 for *Tenyivo*, 75% Upgraded *Tenyivo* and *Hampshire* piglets respectively. Ear tagging was carried out before weaning to reduce tagging stress. The ear to be tagged is shaved, applied chloroform spirit and antiseptic cream, Himax ointment over the site of the ear to fix the ear tag (photo plate 2A). With the assistance of a trained attendant the piglet is secured properly and the ear tag is fixed on the right ear using ear tagging forceps by following all antiseptic measures. All equipments are cleaned and disinfected before and after ear tagging.

3.4 Housing

The three experimental genotype groups of animals were housed in standard growers pen which is marked as pen number one, two and three (photo plate 1A). Before introducing the experimental animals the three pens were cleaned and disinfected using 0.05% potassium permanganate solution, kept for air drying for two days. Daily cleaning of floors, watering and feeding troughs were done once in the morning and in the evening. A disinfectant foot dip is provided at the entrance of the pig house which is filled with 0.05% potassium permanganate solutions that is daily replaced with new solutions.

3.5 De-worming the animals

De-worming of the experimental animals according to their body weight was carried out after weaning using piperazine citrate solution at the rate of 5 mg per kg body weight and administered orally before feeding the piglets. The de-worming medication was continued for three consecutive days.

PHOTO PLATES

1A: Pen of the three genotypes of pig

2A: Piglet ear tagging

3A: Weighing of piglet

3.6 Vaccination of experimental animals

All the selected animals were vaccinated against classical swine fever using Lapinised swine fever vaccine, manufactured by Institute of Animal Health and Veterinary Biological, pin code 700 037 Kolkata.

3.7 Feeding

Conventional standard feeding system of the animals rations were prepared as per the standard feeding prescribed by ICAR (2013). The required feed ingredients were acquired from M/S Amar Mill, Dimapur, Nagaland. The conventional feeds were freshly computed at the farm go-down on weekly basis. The feed was given *ad libitum* on daily basis once in the morning and once in the evening. The feed formulation is given in the tubular form:

Table No. 3.7 Balanced ration formulation in 100 kg feeds for different categories of pig

Sl. No.	Ingredients	Starter	Grower	Finisher
1.	Maize powder	62	60	65
2.	Rice polish/ bran	5	10	20
3.	Wheat bran	5	5	-
5.	Groundnut cake	18	18	10.5
5.	Fish Meal	8	5	3
6.	Mineral Mixture	1.5	1.5	1
7.	Salt	0.5	0.5	0.5
Total		100	100	100

3.8 Physical Behaviours

The physical behaviours of the experimental animals were recorded when the animal reached the age of six months. The three genotypes of pigs namely *Tenyivo*, 75% Upgraded *Tenyivo* and *Hampshire* breed were subjected to the recording of phenotypic morphometric characteristics. Measurement of all the different parts of the body were carried out causing minimum stress to the experimental animals assisted by two skilled attendants. The animals were firstly measured by using a cotton thread for accuracy. The cotton thread is then measured carefully on a measuring tape and a ruler with a scale marking in centimetres for data records. The measurement of the body parts under taken for recording includes the head, body, limbs and the tail. The measurements of the body parts were recorded in centimetres (photo plate 4A to 4F).

3.8.1 Head

Face Length: The face length was measured from between the head poll up to the tip of the snout.

Breadth of fore head: The distance from between the base of the right ear to the left ear was measured to record the breadth of the forehead.

Eye to eye space: The distance between the two eyes which is measured from the prominence of the upper eyelid of the inner cantus of the two eyes were measured to get the eye to eye space.

3.8.2 Snout

Snout measurement: The circumference of the snout was measured while keeping the mouth of the animal closed.

3.8.3 Ear

Length: The ear length was measured from the base of the ear up to tip of the ear.

Circumference: The circumference of the ear was measured at the base of the ear.

3.8.4 Body

Length: The length of the pig body was measured from the point of the head poll to the base of the tail.

Hearth girth: The circumference of the hearth girth or the chest was measured just behind the foreleg.

Abdominal girth: The circumference of the abdomen was measured between the forelegs and hind legs at the naval region.

Pouch girth: The circumference of the pouch or waist or rear girth was measured just in front of the hind legs.

Height at withers: The height of the animal was measured at the tallest part of the body from the shoulder blade in standing posture.

3.8.5 Tail

Length: The length of the tail was measured from the base of the tail to the tip of the tail excluding the switch of the tail.

Circumference: The circumference of the tail was measured at the base of the tail.

PHOTO PLATES

4A: Measurement of face length

4B: Measurement of eye to eye distance

4C: Measurement of circumference of snout

4D: Measurement of body length

PHOTO PLATES

4E: Measurement of hearth girth

4F: Measurement of height at withers

3.8.6 Legs: Fore legs and hind legs

Fore-legs:

(i). **Length of knee to pastern**: It was measured from the length between the knee point and the pastern.

(ii). **Pastern to shoulder blade**: It was measured from the length between the pastern and the shoulder blade.

(iii). **Circumference of canon**: The circumference was measured at the canon.

Hind Legs:

(i). **Length of hock to pastern**: It was measured from the length between the hock point and the pastern.

(ii). **Pastern to back bone**: It was measured from the length between the pastern and the back bone.

(iii). **Circumference of canon**: The circumference is measured at the canon.

3.9 Physiological Behaviours

The physiological behaviours include pulse rate, respiratory rate and body temperature which were recorded once in a month from each genotype and the recording was carried out in the morning hours before feeding.

3.9.1 Pulse rate

The animals were restrained with the help of an attendant causing minimum stress and the pulse rate was recorded through palpitation of the femoral artery for a full one minute which was repeated for three times and average was taken to obtain the pulse rate.

3.9.2 Respiration rate

Respiration rate of the animals were taken during the morning hours when the animals were at rest. The respiration rate were recorded by counting the movements of the flanks which rise up and down for one full minute and the result was expressed as respiratory movements per minute. The observation was repeated for three consecutive times and the mean value was taken for each animal.

3.9.3 Body temperature

The body temperatures of the animals were recorded by using a digital thermometer. The pigs were restrained by a skilled attendant and the clinical digital thermometer was inserted into the rectum for a full one minute which was indicated by a peep sound indicating that the rectal body temperature recording process was completed. The rectal temperature (RT) recordings were repeated three times to get the average rectal temperature. The readings were recorded in degree Celsius (ºC) and after each use the thermometer was cleaned off with a soak cotton swap and sterilized with chloroform spirit for subsequent use.

3.10 Ethological Behaviours

The ethological behaviours were recorded for eight hours once in a month using a closed-circuit television (cctv) which was fitted on to each pen of three genotypes. The cctv has a coverage of 180 degree angle for recording the activities of the animals. The cctv recordings were transferred to a pen drive from which the recorded activities of the animals were noted using a computer. The initial time and the final time taken for every activity were recorded on a data record book by noting the time that was displayed on the computer screen when the recorded activities were running on the computer screen.

3.10.1 Feeding behaviour

The feeding behaviour of the animals was recorded in the cctv camera for eight hours a day starting from 7 am to 4 pm with one hour break from 11 am to 12 noon. The parameters under feeding behaviour were:

1. Time spent to consume supplied feed.
2. Frequency of eating the supplied feed.

The recording was taken once in a month. The time spent in feeding was taken from the time the pigs started to eat from the feeding trough and the frequency of feeding includes the number of time the animals indulged in eating after each interval that includes drinking, lying down, standing up and other activities. The times taken for eating the feeds were recorded in minutes.

3.10.2 Drinking behaviour

The drinking behaviour of the animal was observed in the cctv camera for eight hours a day starting from 7 am to 4 pm with one hour break from 11 am to 12 noon. The parameters under drinking behaviour were:

1. Time spent in drinking water
2. Number of drinks in eight hours

The recording was taken once in a month. The time spent in drinking was taken from the time the pigs started to drink from the watering trough and the frequency of drinking includes the number of time the animal indulged in drinking after each interval of eating, lying, standing and other activities. The times taken in drinking water were taken in seconds.

3.10.3 Resting behaviour

The resting behaviour of the animal was observed in the cctv camera for eight hours a day starting from 7 am to 4 pm with one hour break from 11 am to 12 noon. The parameters under feeding were:

1. Time spent in lying down
2. Frequency of lying down

The recording was taken once in a month. The time spent in lying was taken from the time the pigs started to lay down on the floors and the frequency of lying includes the number of time the animal indulged in lying down. The interval between the frequencies was indulged in drinking, eating, standing, walking, running and other activities. The times taken for lying were taken in minutes.

3.11 Blood Parameters

The blood samples was collected for Haematological and biochemical parameters like Red Blood Cells (RBC), White Blood Cells (WBC), Packed Cell Volume (PCV), Haemoglobin, glucose and cholesterol for the three different genotypes of pig under study. The blood was drawn through intravascular vein on the dorsal marginal ear vein of the pigs.

The procedures for blood collection and analysis of the samples were as per the procedures described by Sastry (1985).

The hairs of the ears were clipped where the venous blood was to be collected and tincture of iodine solution was applied for sterilizing the site and allowed to dry. The dorsal vein of the pig ear was distended by the skilled attendant by grapping the base of the ear. A 20 gauge one inch needle was used to draw blood into a 10 ml syringe. The collected blood was gently transferred from the syringe into the tube containing the anti coagulant (heparin) and gently placed between palms of the hands in a rotary movement to mix the blood well with the anticoagulant. Examination of the blood for haematological and biochemical constituents was completed using standard laboratory procedure.

3.11.1 Red blood cell

The collected blood with heparin as anticoagulant was mixed by rotating the specimen tube a few times and blood was drawn up to 0.5 marks in the RBC pipette with the red bead. The end of the pipette was wiped with a cotton or cloth, and the blood level was brought to the mark by allowing the end of the pipette to touch on the finger. The diluting fluid was drawn upto 101 mark. The tip of the pipette was closed with the fore finger and the pipette was shacked vigorously and discarding 2 or 3 drops by twisting the rubber tube.

The end of the pipette was applied at the junctions of the counting chamber and the cover-slip, the diluted blood flows under the cover slip by capillary attraction. To facilitate easy and uniform flow, the pipette was rotated slowly with finger intact. On filling the counting chamber completely avoiding trapped air bubbles and the over flow of fluid into the moats, the pipette is removed. Care is taken so that the counting chamber and the cover-glass are properly clean without any grease or particles of dust to avoid air bubbles getting trapped.

The cells were allowed to settle for a minute. Next the counting chamber was mounted on to the microscope. Most of the counting area is brought at the centre where it is divided into 16 small squares, the centre area was focused with the low power objective (2/3), then changed into the high power (1/6), the one square was divided into 16 squares and demarcated by triple lines was allowed to come into the field.

The cells were then counted in the 16 squares and those lying on two borders, leaving those lying on the other two borders. Similarly the cells were counted in 4 more squares with 16 small squares. All the counted cells in the five squares were multiplied by 10,000 to obtain the number of red cells in one cubic millimetre.

3.11.2 White blood cell

The heparinised blood was drawn up to 0.5 mark in the pipette which has a white bead in the bulb. The end of the pipette was wiped and reduced the column of the blood up to the mark 0.5. The diluting fluid was drawn up to point marked as 11, shaking it well and discarding two drops of the fluid in the stem. Next the chamber was filled by allowing the end of the pipette to touch the junction of the counting chamber and the cover-slip, the diluted blood flows under the cover slip by capillary attraction, keeping the finger closed at the end of the pipette to avoid over flow of the diluted blood. The counting chamber was mounted on to the microscope.

The 4 large squares was counted (each squares has an area of 1 sq. mm). The following formula was used for WBC count:

Total WBC count = Total numbers of the cells in 4 squares x 50/cm.

The inherent error was ± 10%

3.11.3 Haemoglobin

Haemoglobin concentration in the blood was estimated by Cyanmethemoglobin method and expressed in g/dl.

The Drabkin's soloution (5ml) was taken in a test tube. Drawing 0.02 ml of blood was drawn with a pipette, the outer surface of the pipette was wiped with an absorbent to remove excess blood and then it was slowly released into the solution. After mixing it properly, it was allowed to stand undisturbed for 5 minutes. The absorbance of this solution was measured at 540 nm in a spectrophotometer after adjusting the optical density at 0 and by using Drabkin's solution as blank. The reading was accordingly recorded. The values obtained were calculated as per the following formula and expressed in g/dl.

$$\text{Haemoglobin} = \frac{Value\ of\ test}{Value\ of\ standard} \text{ x Conc. of standard (60) x 0.251}$$

3.11.4 Packed cell volume

The packed cell volume was determined by using wintrobe tube. A Pasteur pipette with a long nozzle was filled with the blood and was mixed by a few rotation of the specimen tube. The nozzle was inserted into the tube touching the bottom. While squeezing the teat, slowly and gradually the pipette was raised and the Wintrobe tube was completely filled to the top avoiding air bubbles. The column of the blood was adjusted up to 10 mark. Putting the tube into clinical centrifuge and it was rotated at 3000 rpm for 30 minutes. The red cells was packed at the bottom with the plasma at top and leucocytes in between. PCV was expressed as percentage following the formula given below:

$$\text{PCV} = \frac{\text{Height of red cells in mm}}{\text{Total height of the column in mm}} \text{ x 100}$$

3.11.5 Total plasma cholesterol

The total plasma cholesterol concentration was estimated by following the procedure and expressed in mg/dl. The test tubes marked as per the sample numbers (TY1, TY2, ..TY7/HS1, HS2,...HS7/UG1, UG2...UG7) with one test tube marked as S (standard). 1 ml of reagent (R1) was taken in all the sample test tubes. In the test tube marked as S (standard) 10 µl of the cholesterol standard was added. Next, in the sample test tubes, 10 µl of all the sample serum was added, mixed and incubated at room temperature (25º - 30º C) for

10 minutes. The absorbent of this solution was measured at 510 nm in a spectrophotometer after adjusting the optical density at 0 by using distilled water and reagent (R1 or Ferric chloride reagent) as blank. The reading was accordingly recorded. The values obtained were calculated as per the following formula and expressed in mg/dl.

$$\text{Cholesterol} = \frac{Absorbance\ of\ test}{Absorbance\ of\ standard} \times 200$$

3.11.6 Determination of glucose

Blood glucose level of concentration was expressed in mg/dl.

The test tubes were marked as per the sample numbers with one tube marked as S (standard). 1 ml of reagent (A) was taken in all the sample test tubes. In the test tube marked for standard 10 µ1 of the glucose was added. In the sample test tubes, 10 µl of serum was added, mixed and incubated at room temperature (25 - 30º C) for 10 minutes. The absorbance of this solution was measured at 500 nm in a spectrophotometer after adjusting the optical density at 0 by mixing distilled water and reagent (A) as blank. The reading was recorded accordingly. The values obtained were calculated as per the following formula and was expressed in mg/dl.

$$\text{Glucose} = \frac{Absorbance\ of\ test}{Absorbance\ of\ standard} \times 100$$

3.12 Growth rate

The initial body weight at weaning was taken with the help of a digital weighing balance Sumo Digi Tech manufactured by Sumo Digital Incorporation, ISO 9001-2008 certified company, Government of India. The piglet was put in a weighing basket. The weighing basket was adjusted to zero prior to introducing the piglets in the weighing basket and the body weight of each animal were recorded in Kg (plate No.3A). The subsequent weights of the animals were taken on monthly basis till they attain six months of age.

3.13 Statistical Analysis

The experimental data was statistically analyzed using Analysis of Variance (ANOVA) in Randomized Block Design for comparison of different treatment groups as described by Snedecor and Cochran (1994).

CHAPTER IV

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

The results obtained from the experimental research on the topic "Behavioural Characteristics of Different Genotypes of Pig" were presented in the following data under various headings.

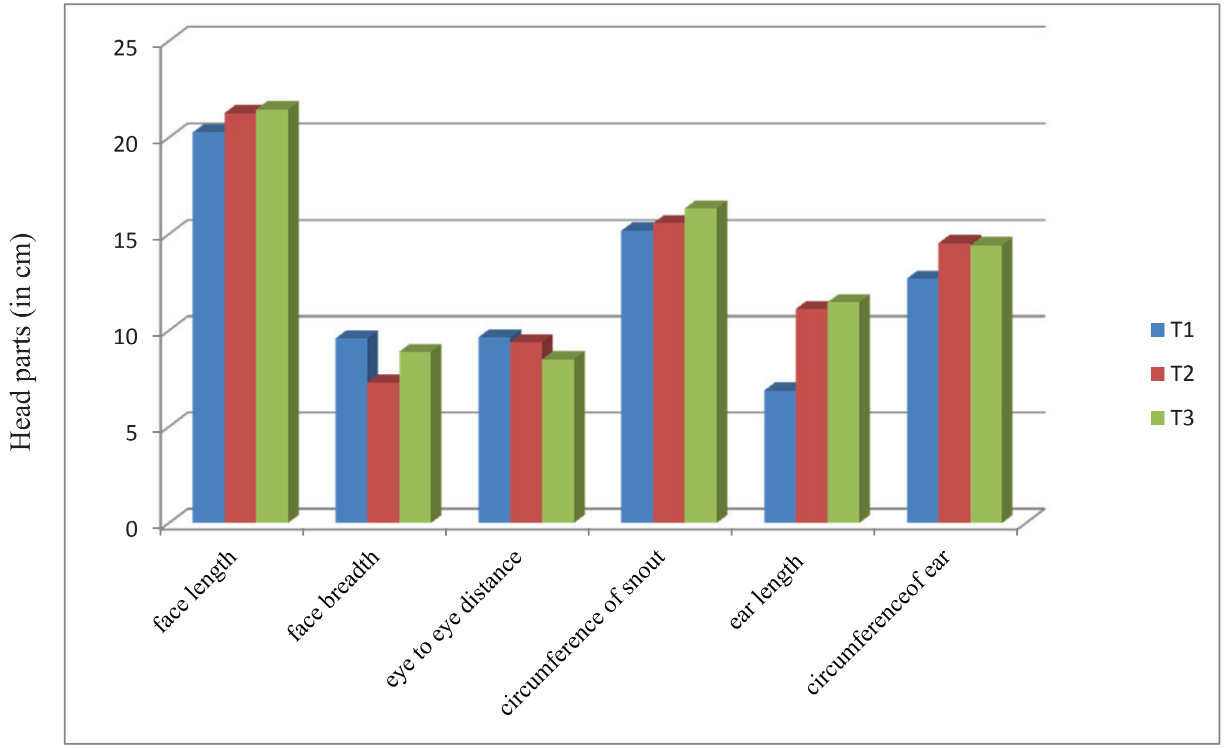
4.1 Physical Characteristics

The values for the physical characteristics of the three genotypes of pig were presented in Table 4.1 and depicted in Fig 4.1.1 to Fig 4.1.4 and Appendix-A. The results obtained for the physical characteristics are as follows:

4.1.1 Head

The head parts consists of face length, face breadth, eye to eye distance, circumference of snout, ear length and circumference of ear. From the table, it was observed that the values of face length were 20.27, 21.27 and 21.46 cm for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the face length was significantly ($P < 0.05$) higher in T_3 group followed by T_2 and lowest in T_1 group; however, there was no significant difference between T_2 and T_3 groups. The values of face breath were 9.60, 7.32 and 8.93 cm for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the face breath was significantly ($P < 0.05$) higher in T_1 group followed by T_3 and lowest in T_2 group. The values of eye to eye distance were 9.66, 9.39 and 8.51 cm for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the eye to eye distance was significantly ($P < 0.05$) higher in T_1 group followed by T_2 and lowest in T_3 group; however, there was no significant difference between T_1 and T_2 groups. The values of circumference of snout were 15.19, 15.57 and

Fig 4.1.1: Head parts (in cm) of the three genotypes of pig

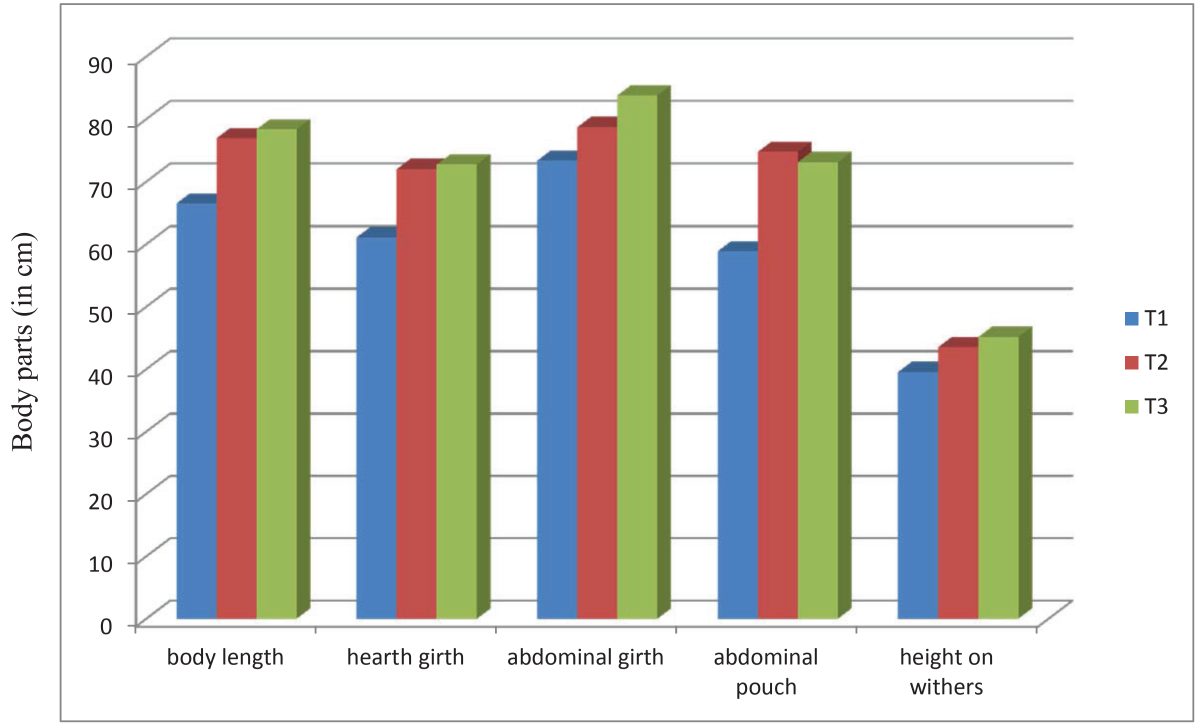


16.34 cm for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the circumference of snout was significantly ($P < 0.05$) higher in T_3 group followed by T_2 and lowest in T_1 group. The values of length of ear were 6.89, 11.13 and 11.47 cm for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the length of ear was significantly ($P < 0.05$) higher in T_3 group followed by T_2 and lowest in T_1 group; however, there was no significant difference between T_2 and T_3 groups. The values of circumference of ear were 12.70, 14.54 and 14.43 cm for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the circumference of ear was significantly ($P < 0.05$) higher in T_2 group followed by T_3 and lowest in T_1 group; however, there was no significant difference between T_2 and T_3 groups. From the results on head parameters, it was observed that majority of the parameters were significantly ($P < 0.05$) higher in T_3 and T_2 groups as compared to T_1 group. The results of the present study were well corroborated with the observations of Oke *et al.* (2006) who also stated that Hampshire sire progeny were superior to the progeny of the breeds for most of the traits measured post weaning. The results is also supported by Morenikeji *et al.* (2019) who investigated the effects of genotypes and found that performance characteristics were significantly ($P < 0.05$) influenced by genotype and sex.

4.1.2 Body

The body parts consists of the length of the pig body which was measured from the point of the head poll to the base of the tail, heart girth which is the circumference of the hearth girth or the chest which was taken just behind the foreleg, abdominal girth which is the circumference of the abdomen which was taken between the forelegs and hind legs at the naval region, pouch girth which is the circumference of the pouch or waist or rear girth which is measured just in front of the hind legs, Height on withers which is the height of

Fig 4.1.2: Body parts (in cm) of the three genotypes of pig



the animal that was measured at the tallest part of the body from the shoulder blade in standing posture. The values of body length were 66.51, 76.94 and 78.37 cm for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the body length was significantly ($P < 0.05$) higher in T_3 group followed by T_2 and lowest in T_1 group; however, there was no significant difference between T_2 and T_3 groups. The values of heart girth were 61.13, 72.03 and 72.77 cm for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the heart girth was significantly ($P < 0.05$) higher in T_3 group followed by T_2 and lowest in T_1 group; however, there was no significant difference between T_2 and T_3 groups. The values of abdominal girth were 73.36, 78.72 and 83.80 cm for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the abdominal girth was significantly ($P < 0.05$) higher in T_3 group followed by T_2 and lowest in T_1 group; however, there was no significant difference between T_2 and T_3 groups and between T_1 and T_2 groups. The values of abdominal pouch were 58.87, 74.76 and 73.11 cm for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the abdominal pouch was significantly ($P < 0.05$) higher in T_2 group followed by T_3 and lowest in T_1 group; however, there was no significant difference between T_2 and T_3 groups. The values of height on withers were 39.56, 43.54 and 45.17 cm for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the height on withers was significantly ($P < 0.05$) higher in T_3 group followed by T_2 and lowest in T_1 group; however, there was no significant difference between T_2 and T_3 groups. From the results, it was observed that the values of different body measurement parameters, *viz.* body length, heart girth, abdominal girth, abdominal pouch and height on withers did not differ significantly ($P > 0.05$) between T_2 and T_3 groups; however, these values were significantly ($P < 0.05$) lower in T_1 group. The findings of the present study were in close conformation with the observations of Khargharia et al. (2014), Oluwole *et al.* (2014), Govindasamy *et al*. (2020) and Panda *et al*. (2020) who also studied on hybrid progenies from crossbreeding between the Nigerian Indigenous pig and Large White pigs and found that hybrid pigs male were heavier in weight and morphometric traits such as body length, heart girth and rump circumference, while the females were high in morphometric traits such as snout length, ear length and body height.

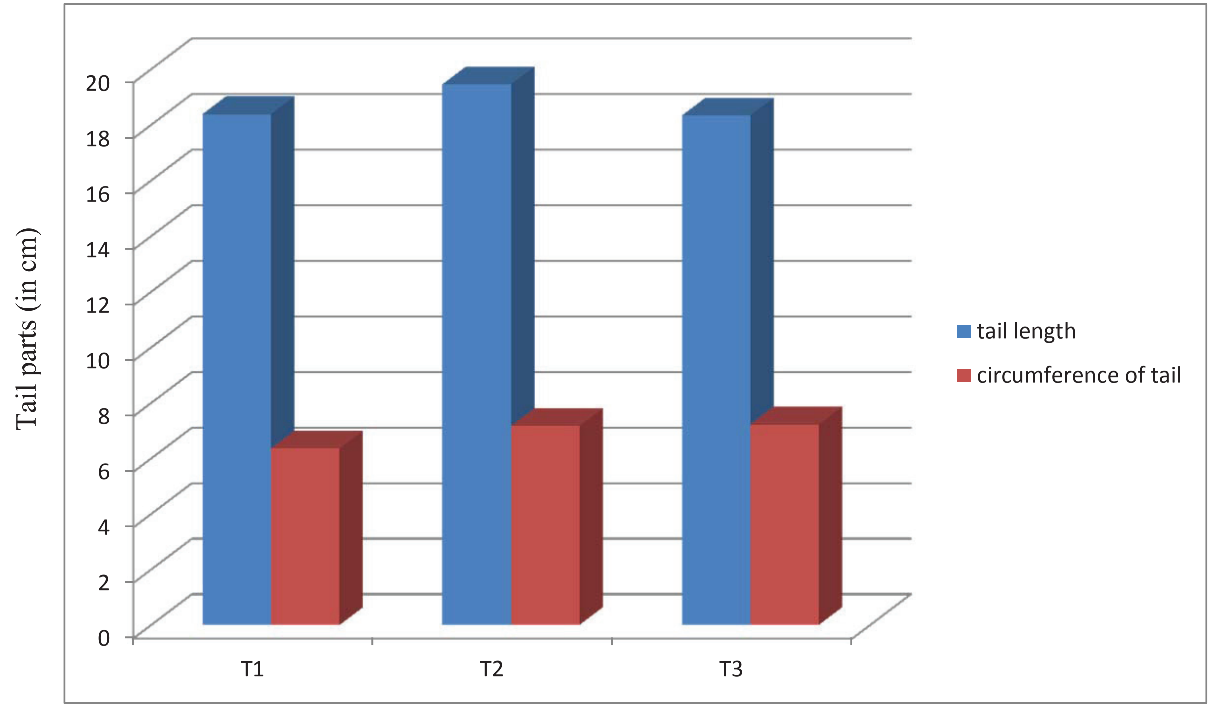
4.1.3 Tail

The values of tail length were 18.39, 19.46 and 18.34 cm for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the tail length did not differ significantly ($P > 0.05$) amongst all the three groups and the values were same in all the groups. The values for circumference of tail were 6.36, 7.17 and 7.23 cm for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the circumference of tail was significantly ($P < 0.05$) higher in T_3 group followed by T_2 and lowest in T_1 group; however, there was no significant difference between T_2 and T_3 groups. The findings of the present study were in close resemblance with the observations of Morenikeji *et al*. (2019) who investigated the effects of genotypes and their interaction on the performance characteristics of three pig genotypes and found that the tail length and shoulder to tail were significantly ($P < 0.05$) influenced by genotype.

4.1.4 Legs

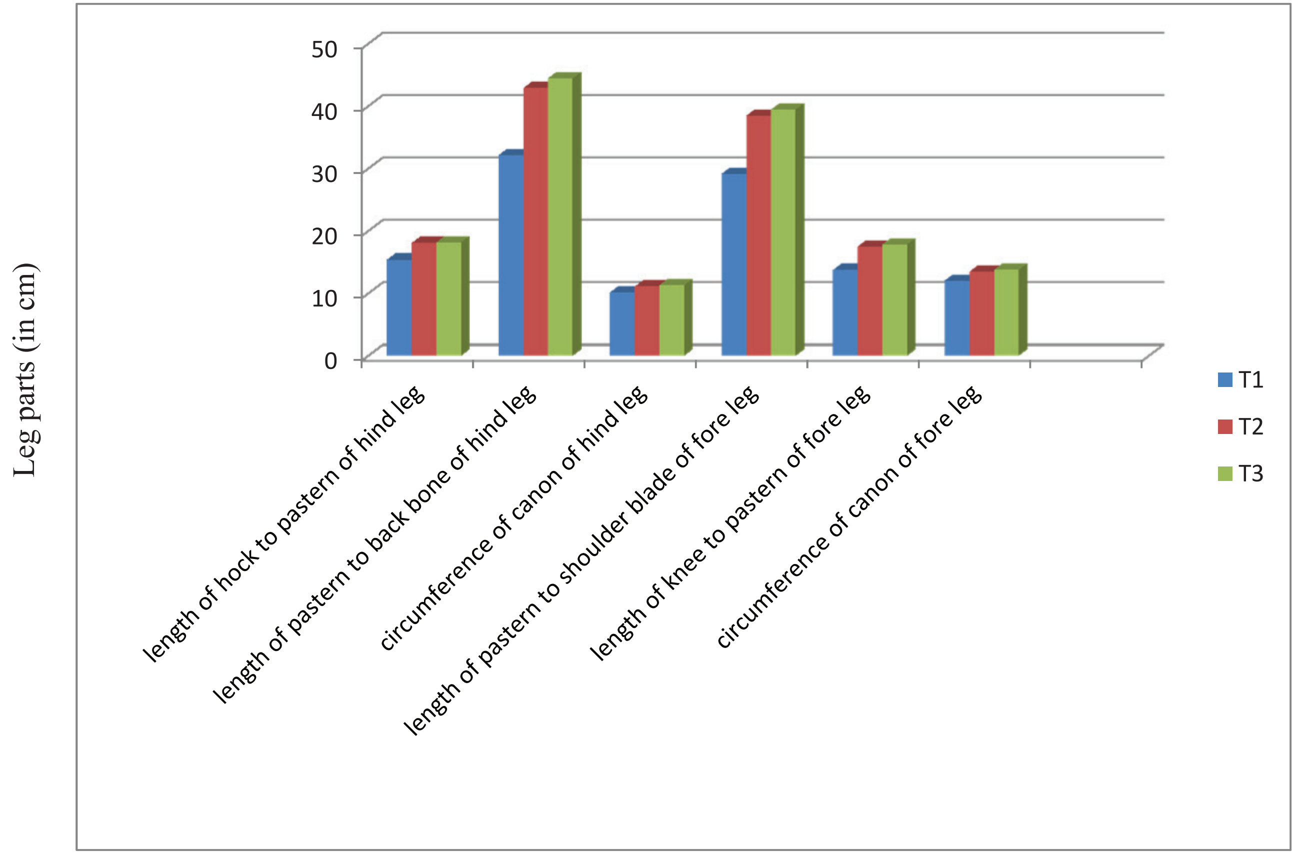
The leg parts consist of the fore leg and the hind leg. The hind leg consists of length of knee to pastern, length of pastern to backbone and circumference of canon. The fore leg consists of length of pastern to shoulder blade, length of knee to pastern and circumference of canon. The values for length of knee to pastern of hind legs were 15.41, 18.09 and 18.19 cm for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the length of knee to pastern of hind legs was significantly ($P < 0.05$)

Fig 4.1.3: Tail parts (in cm) of the three genotypes of pig



higher in T_3 group followed by T_2 and lowest in T_1 group; however, there was no significant difference between T_2 and T_3 groups. The values for length of pastern to backbone of hind legs were 32.14, 42.89 and 44.47 cm for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the length of pastern to backbone of hind legs was significantly ($P < 0.05$) higher in T_3 group followed by T_2 and lowest in T_1 group; however, there was no significant difference between T_2 and T_3 groups. The values for circumference of canon of hind legs were 10.17, 11.11 and 11.33 cm for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the circumference of canon of hind legs was significantly ($P < 0.05$) higher in T_3 group followed by T_2 and lowest in T_1 group; however, there was no significant difference between T_2 and T_3 groups. The values for length of pastern to shoulder blade of fore legs were 29.16, 38.47 and 39.46 cm for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the length of pastern to shoulder blade of fore legs was significantly ($P < 0.05$) higher in T_3 group followed by T_2 and lowest in T_1 group; however, there was no significant difference between T_2 and T_3 groups. The values for length of knee to pastern of fore legs were 13.76, 17.53 and 17.87 cm for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the length of knee to pastern of fore legs was significantly ($P < 0.05$) higher in T_3 group followed by T_2 and lowest in T_1 group; however, there was no significant difference between T_2 and T_3 groups. The values for circumference of canon of fore legs were 12.04, 13.47 and 13.77 cm for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the circumference of canon of fore legs was significantly ($P < 0.05$) higher in T_3 group followed by T_2 and lowest in T_1 group; however, there was no significant difference between T_2 and T_3 groups. From the results on leg measurement, it was observed that the values of all leg parameters *viz.* length of knee to pastern of hind leg, length of pastern to back bone of hind leg,

Fig 4.1.4: Leg parts (in cm) of the three genotypes of pig



circumference of canon of hind leg, length of pastern to shoulder blade of fore leg, length of knee to pastern of fore leg and circumference of canon of fore leg did not differ significantly ($P > 0.05$) between T_2 and T_3 groups; however, these values were significantly ($P < 0.05$) lower in T_1 group. These results were well corroborated with the findings of Panda *et al.* (2020) who made an investigation to derive fewer independent common factors through principal component analysis to characterize 75 per cent Landrace crossbreds *i.e.* 75 per cent Landrace x 25 per cent Bareilly local piglets and observed high correlation coefficients among most of the morphometric traits.

Table 4.1: Physical characteristics of the three genotypes of pig (in cm)

Parameters	Treatment groups			SEM	CD
	T_1	T_2	T_3	±	(5%)
Face length	20.27^{a}	21.27^{b}	21.46^{b}	0.15	0.54
Face breadth	9.60^{c}	7.32^{a}	8.93^{b}	0.16	0.58
Eye to eye distance	9.66^{b}	9.39^{b}	8.51^{a}	0.22	0.80
Circumference of snout	15.19^{a}	15.57^{b}	16.34^{c}	0.11	0.38
Ear length	6.89^{a}	11.13^{b}	11.47^{b}	0.34	1.24
Circumference of ear	12.70^{a}	14.54^{b}	14.43^{b}	0.17	0.62
Body length	66.51^{a}	76.94^{b}	78.37^{b}	1.11	4.04
Heart girth	61.13^{a}	72.03^{b}	72.77^{b}	1.10	3.98
Abdominal girth	73.36^{a}	78.72^{ab}	83.80^{b}	2.33	8.44
Abdominal pouch	58.87^{a}	74.76^{b}	73.11^{b}	1.23	4.47
Height on withers	39.56^{a}	43.54^{b}	45.17^{b}	0.49	1.78
Tail length	18.39	19.46	18.34	0.40	1.45
Circumference of tail	6.36^{a}	7.17^{b}	7.23^{b}	0.13	0.46
Length of knee to pastern of hind leg	15.41^{a}	18.09^{b}	18.19^{b}	0.22	0.80
Length of pastern to back bone of hind leg	32.14^{a}	42.89^{b}	44.47^{b}	0.67	2.44
Circumference of canon of hind leg	10.17^{a}	11.11^{b}	11.33^{b}	0.11	0.40
Length of pastern to shoulder blade of fore leg	29.16^{a}	38.47^{b}	39.46^{b}	0.57	2.06
Length of knee to pastern of fore leg	13.76^{a}	17.53^{b}	17.87^{b}	0.32	1.15
Circumference of canon of fore leg	12.04^{a}	13.47^{b}	13.77^{b}	0.16	0.56

$^{a, b, c}$ Means bearing different superscript in a row differ significantly ($P < 0.05$)

4.2 Physiological Behaviours

The values for pulse rate is presented in Table 4.2.1 and depicted in Fig 4.2.1, respiration rate is presented in Table 4.2.2 and depicted in Fig 4.2.2 and body temperature is presented in Table 4.2.3 and depicted in Fig 4.2.3 and Appendix-B. The results obtained for the physiological behaviour is as follows:

4.2.1 Pulse Rate

The values of PR at 60 days were 132.27, 125.14 and 78.27 beats for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the PR at 60 days was significantly ($P < 0.05$) higher for T_1 group followed by T_2 and lowest in T_3 group; however, there was no significant difference between T_1 and T_2 groups. The values of PR at 90 days were 106.43, 95.29 and 80.29 beats for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the PR at 90 days was significantly ($P < 0.05$) higher in T_1 group followed by T_2 and lowest in T_3 group. The values of PR at 120 days were 104.14, 87.86 and 85.86 beats for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the PR at 120 days was significantly ($P < 0.05$) higher in T_1 group followed by T_2 and lowest in T_3 group; however, there was no significant difference between T_2 and T_3 groups. The values of PR at 150 days were 104.71, 86.00 and 77.14 beats for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the PR at 150 days was significantly ($P < 0.05$) higher in T_1 group followed by T_2 and lowest in T_3 group. The values of the PR at 180 days were 94.00, 79.43 and 72.71 beats for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the PR at 180 days was significantly ($P < 0.05$) higher in T_1 group followed by T_2 and lowest in T_3 group; however, there was no significant difference between T_2 and T_3 groups. The results of the present study were well corroborated with the observation of Swindle *et al.* (2012) who also stated that hemodynamically there were differences between breeds of pigs and between pigs of different ages within the same breed, like heart rates were much higher in young swine than in adults. Zupan *et al.* (2016) studied the behaviour, heart rate and heart rate variability in pigs exposed to novelty and found that there was a complex and often contradictory nature of relationship between behaviour and cardiac responses to novelty in pigs of different breeds and sexes.

Table 4.2.1: Pulse rate (beats/min) of the three genotypes of pig

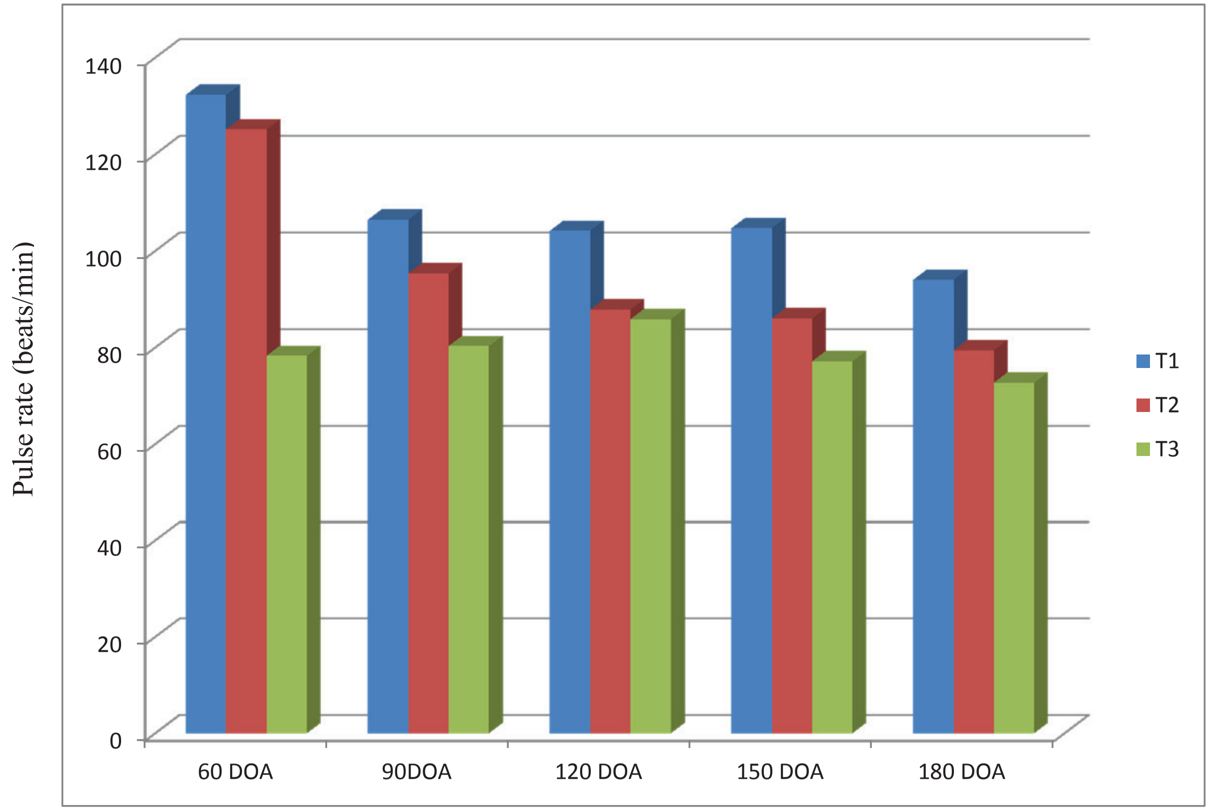
Treatments	Age of pigs (days)				
	60	90	120	150	180
T_1	132.27^b	106.43^c	104.14^b	104.71^c	94.00^b
T_2	125.14^b	95.29^b	87.86^a	86.00^b	79.43^a
T_3	78.27^a	80.29^a	85.86^a	77.14^a	72.71^a
Sem ±	3.98	2.45	3.35	1.74	2.81
CD at 5%	14.43	8.89	12.13	6.32	10.16

$^{a, b, c}$ Means bearing different superscript in a row differ significantly ($P < 0.05$)

4.2.2 Respiration rate

The values of RR at 60 days were 38.14, 28.85 and 33.89 mov/min for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the RR at 60 days was significantly ($P < 0.05$) higher for T_1 group followed by T_3 and lowest in T_2 group; however, there was no significant difference between T_1 and T_3 groups and between T_3 and T_2 groups. The values of RR at 90 days were 36.54, 26.73 and 25.81 mov/min for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the RR at 90 days was significantly ($P < 0.05$) higher for T_1 group followed by T_2 and lowest in T_3 group; however, there was no significant difference

Fig 4.2.1: Pulse rate (beats/min) of the three genotypes of pig



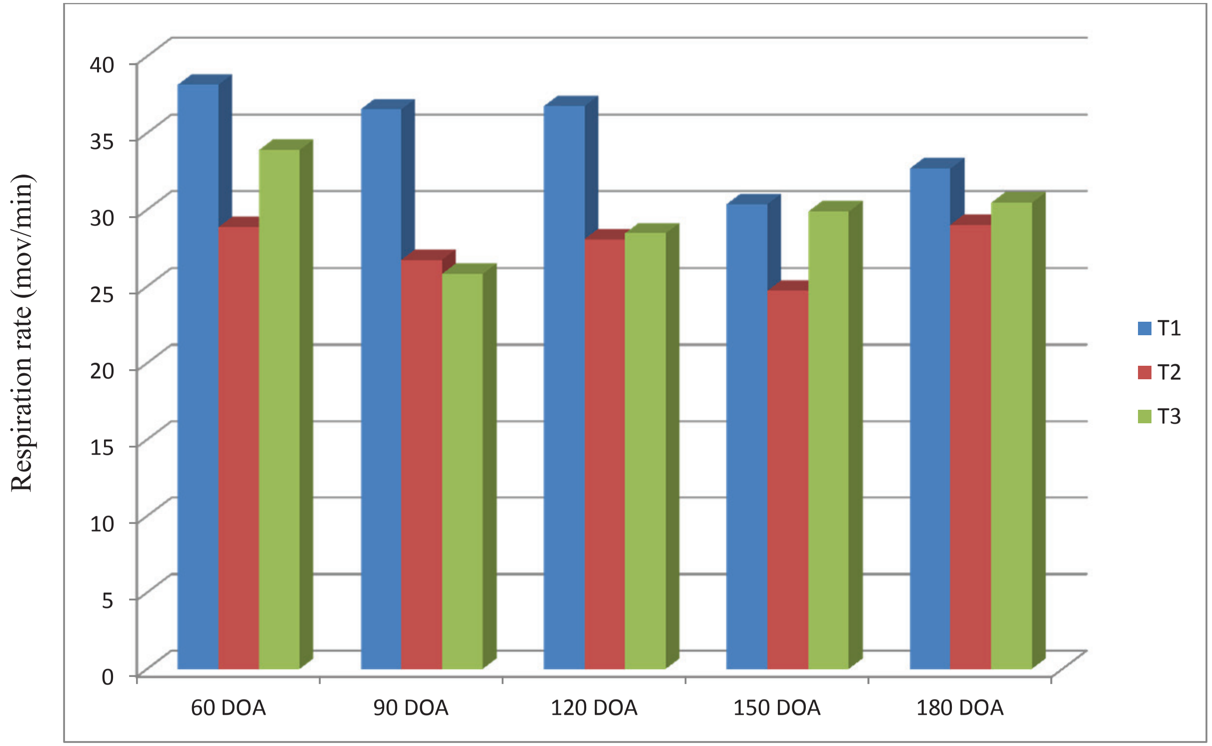
between T_2 and T_3 groups. The values of RR at 120 days were 36.74, 28.07 and 28.46 mov/min for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the mean value for the RR at 120 days was significantly ($P < 0.05$) higher for T_1 group followed by T_3 and lowest in T_2 group; however, there was no significant difference between T_2 and T_3 groups. The values of RR at 150 days were 30.36, 24.71 and 29.87 mov/min for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the RR at 150 days was significantly ($P < 0.05$) higher for T_1 group followed by T_3 and lowest in T_2 group; however, there was no significant difference between T_1 and T_3 groups. The values of RR at 180 days were 32.68, 29.02 and 30.45 mov/min for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the RR at 180 days did not differ significantly ($P > 0.05$) amongst all the three groups and the values were same in all the groups. The results of the present study were supported by Sipos *et al.* (2013) who also made a study on the physiological changes of respiratory rate of pigs at different ages and found that specific trends could be found for respiration rate where the study revealed some major differences to historic reference value.

Table 4.2.2: Respiration rate (mov/min) of the three genotypes of pig

Treatments	Age of pigs (days)				
	60	90	120	150	180
T_1	38.14^{b}	36.54^{b}	36.74^{b}	30.36^{b}	32.68
T_2	28.85^{ab}	26.73^{a}	28.07^{a}	24.71^{a}	29.02
T_3	33.89^{b}	25.81^{a}	28.46^{a}	29.87^{b}	30.45
Sem ±	1.57	1.43	2.13	1.40	1.15
CD at 5%	5.66	5.19	7.71	5.07	4.16

$^{a, b, c}$ Means bearing different superscript in a row differ significantly ($P < 0.05$)

Fig 4.2.2: Respiration rate (mov/min) of the three genotypes of pig



4.2.3 Body Temperature

The values of rectal body temperature (RT) at 60 days were 38.20, 38.50 and 38.20 ºC for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the RT at 60 days did not differ significantly ($P > 0.05$) amongst all the three groups. The values of RT at 90 days were 38.00, 39.40 and 39.10 ºC for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the RT at 90 days was higher in T_2 group followed by T_3 and lowest in T_1 group; however, there was no significant difference between T_2 and T_3 groups. The values of RT at 120 days were 38.70, 39.20 and 39.10 ºC for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the RT at 120 days was significantly ($P < 0.05$) higher in T_2 group followed by T_3 and lowest in T_1 group; however, there was no significant difference between T_2 and T_3 groups and between T_3 and T_1 groups. The values of RT at 150 days were 39.10, 39.10 and 38.90 ºC for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the RT at 150 days did not differ significantly ($P > 0.05$) amongst all the three groups. The values of RT at 180 days were 38.90, 38.90 and 38.90 ºC for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the RT at 180 days did not differ significantly ($P > 0.05$) amongst all the three groups. From the results it was observed that the RT of the animals in different age group has a normal body temperature range of 38.00 to 40.00 ºC. The result of the present study were in conformation with the findings of Andersson and Jonasson (1993) who recorded the rectal temperature of pigs to be 38.7 ºC to 39.8 ºC. They also reported that the normal body temperatures for piglets as 38.5 ºC to 39.5 ºC. Caldara *et al.* (2012) also made a study on the physiological parameters of pigs reared under three production systems which was concrete floor, deep bedding with wood shaving and deep bedding with coffee husks and found that RT of pigs reared on the concrete floor was 39.0 ºC which is similar to the present findings.

Table 4.2.3: Rectal temperature (ºC) of the three genotypes of pig

Treatments	Age of pigs (days)				
	60	90	120	150	180
T_1	38.20	38.00^a	38.70^a	39.10	38.90
T_2	38.50	39.40^b	39.20^b	39.10	38.90
T_3	38.20	39.10^b	39.10^{ab}	38.90	38.90
Sem ±	0.29	0.29	0.11	0.11	0.06
CD at 5%	1.05	1.05	0.42	0.42	0.25

^{a,b,c} Means bearing different superscript in a row differ significantly (P < 0.05)

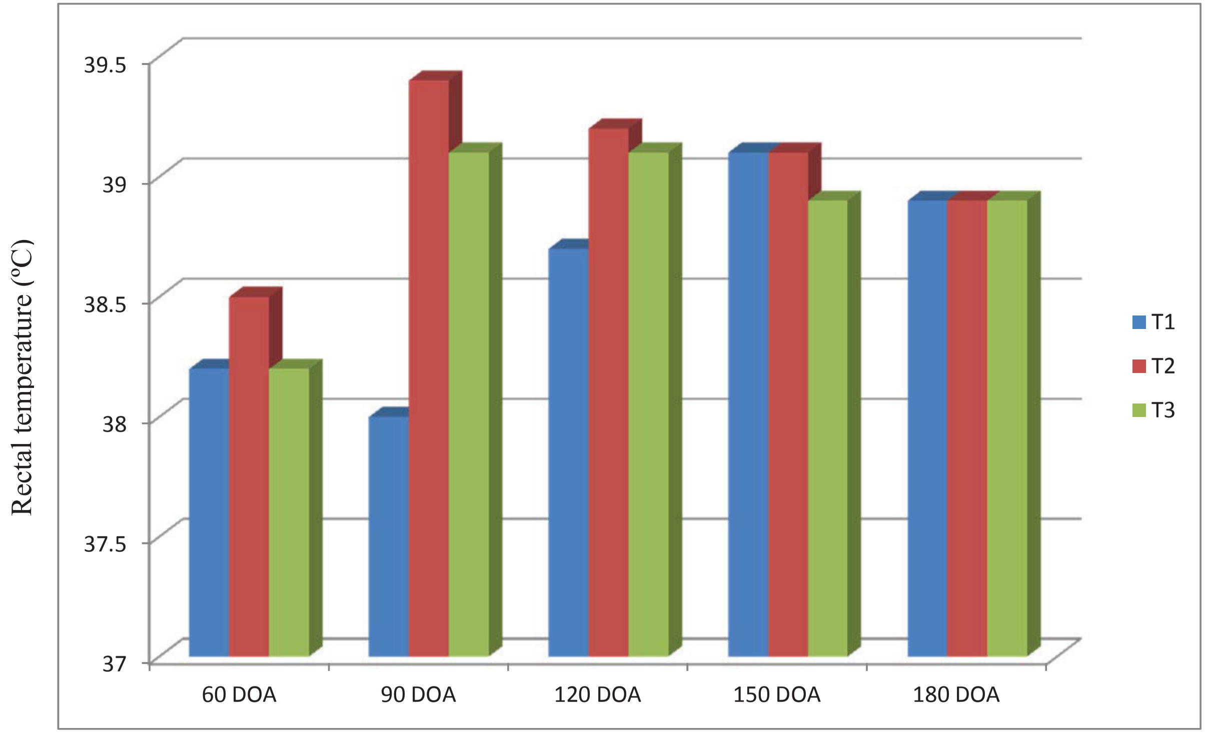
4.3 Ethological Behaviours

The value for the ethological behaviour on the time spent on feeding is presented in Table 4.3.1 and Fig 4.3. Frequency of eating is presented in Table 4.3.2 and Fig 4.3.2. Time spent on drinking is presented in Table 4.3.3 and Fig 4.3.3. Frequency of drinking is presented in Table 4.3.4 and Fig 4.3.4. Time spent on lying down is presented in Table 4.3.5 and Fig 4.3.5. Frequency of lying down is presented in Table 4.3.6 and Fig 4.3.6. The statistical analysis is presented in ANOVA-3 under Appendex-C.

4.3.1 Time spent on feeding

The time spent on feeding (TSF) was taken in minutes to eat the given feeds during the observation period. The values of TSF at 60 days were 87.60, 93.47 and 154.34 minutes for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the TSF at 60 days was significantly (P < 0.05) higher for T_3 group followed by T_2 and lowest in T_1 group. The values of TSF at 90 days were 103.86, 123.65 and 141.00 minutes for T_1, T_2

Fig 4.2.3: Rectal temperature (ºC) of the three genotypes of pig



and T_3 groups, respectively. On statistical analysis, it was perused that the value for the TSF at 90 days was significantly ($P < 0.05$) higher for T_3 group followed by T_2 and lowest in T_1 group. The values of TSF at 120 days were 81.28, 135.49 and 150.41 minutes for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the TSF at 120 days was significantly ($P < 0.05$) higher for T_3 group followed by T_2 and lowest in T_1 group. The values of TSF at 150 days were 82.12, 117.50 and 133.95 minutes for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the TSF at 150 days was significantly ($P < 0.05$) higher for T_3 group followed by T_2 and lowest in T_1 group. The values of TSF at 180 days were 82.34, 151.59 and 166.42 minutes for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the TSF at 180 days was significantly ($P < 0.05$) higher for T_3 group followed by T_2 and lowest in T_1 group. The results of the present findings were well corroborated with the observations of Renaudeau *et al.* (2005) who also studied the effects of breed and sex on individual growth performance and feeding behaviour of grouped housed pigs where they found that feeding pattern were significantly affected by breed, sex and season. The results were also in conformation with workers like Chinnamani *et al*. (2010) who documented that feeding behaviour of crossbred Large White Yokshire pigs showed highly significant ($P < 0.01$) differences in the feeding behaviour except the number of meals per day between the treatment groups. The results were also supported by Morgan *et al.* (2000) who also observed that feeding behaviour by random models to analyze the feeding behaviour of pigs and found that daily feed intake increased with time and suggested that pigs ate their meals separated by long intervals.

Table 4.3.1: Time spent on feeding (min) by the three genotypes of pig

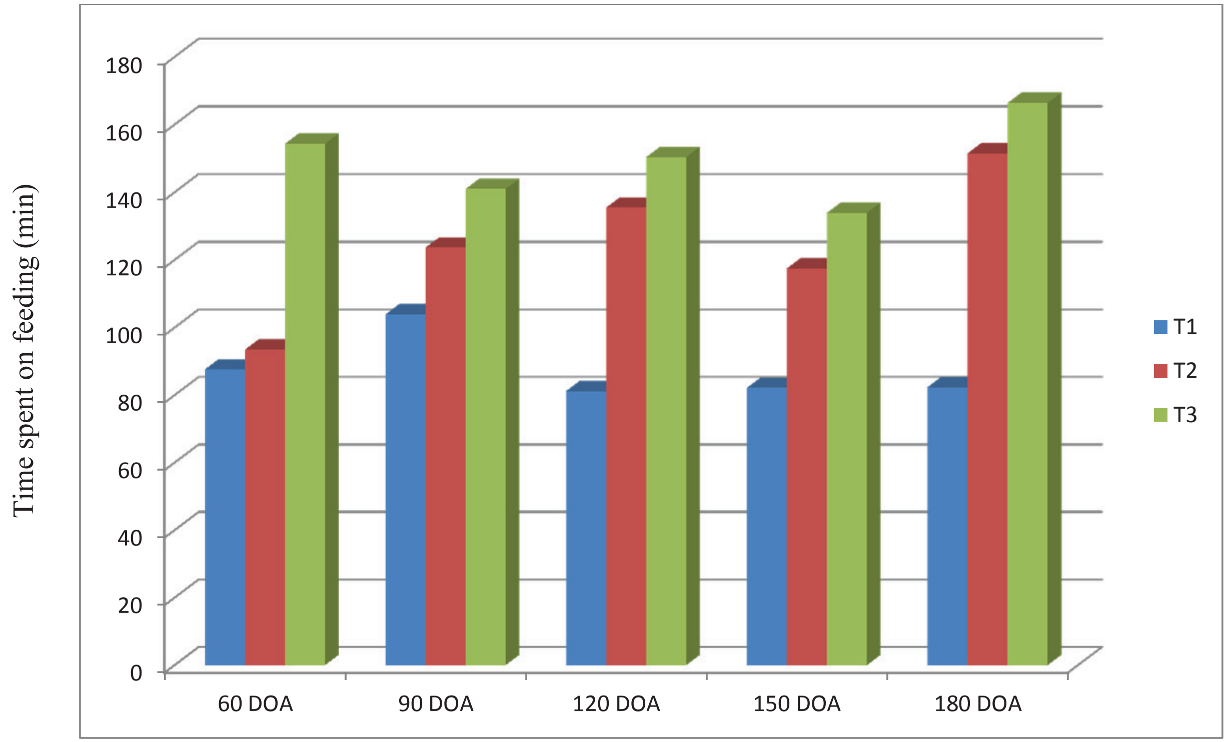
Treatments	Age of pigs (days)				
	60	**90**	**120**	**150**	**180**
T_1	87.60[a]	103.86[a]	81.28[a]	82.12[a]	82.34[a]
T_2	93.47[b]	123.65[b]	135.49[b]	117.50[b]	151.59[b]
T_3	168.63[c]	141.00[c]	150.41[c]	133.95[c]	166.42[c]
Sem ±	1.29	1.06	0.68	1.52	0.67
CD at 5%	4.69	3.87	2.46	5.52	2.43

[a, b, c] Means bearing different superscript in a row differ significantly ($P < 0.05$)

4.3.2 Frequency of feeding

The frequency of feeding (FOF) is the number of times the animals take their feed from the feeding trough during the observation period. The values of FOF at 60 days were 21.00, 39.57 and 33.60 times for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the FOF at 60 days was significantly ($P < 0.05$) higher for T_2 group followed by T_3 and lowest in T_1 group. The values of FOF at 90 days were 27.73, 40.14 and 45.60 times for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the FOF at 90 days was significantly ($P < 0.05$) higher for T_3 group followed by T_2 and lowest in T_1 group. The values of FOF at 120 days were 26.29, 66.57 and 50.20 times for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the FOF at 120 days was significantly ($P < 0.05$) higher for T_2 group followed by T_3 and lowest in T_1 group. The values of FOF at 150 days were 25.29, 77.57 and 60.27 times for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the FOF at 150 days was significantly ($P < 0.05$) higher for T_2 group followed by T_3 and lowest in T_1 group. The values of FOF

Fig 4.3.1: Time spent on feeding (min) by the three genotypes of pig



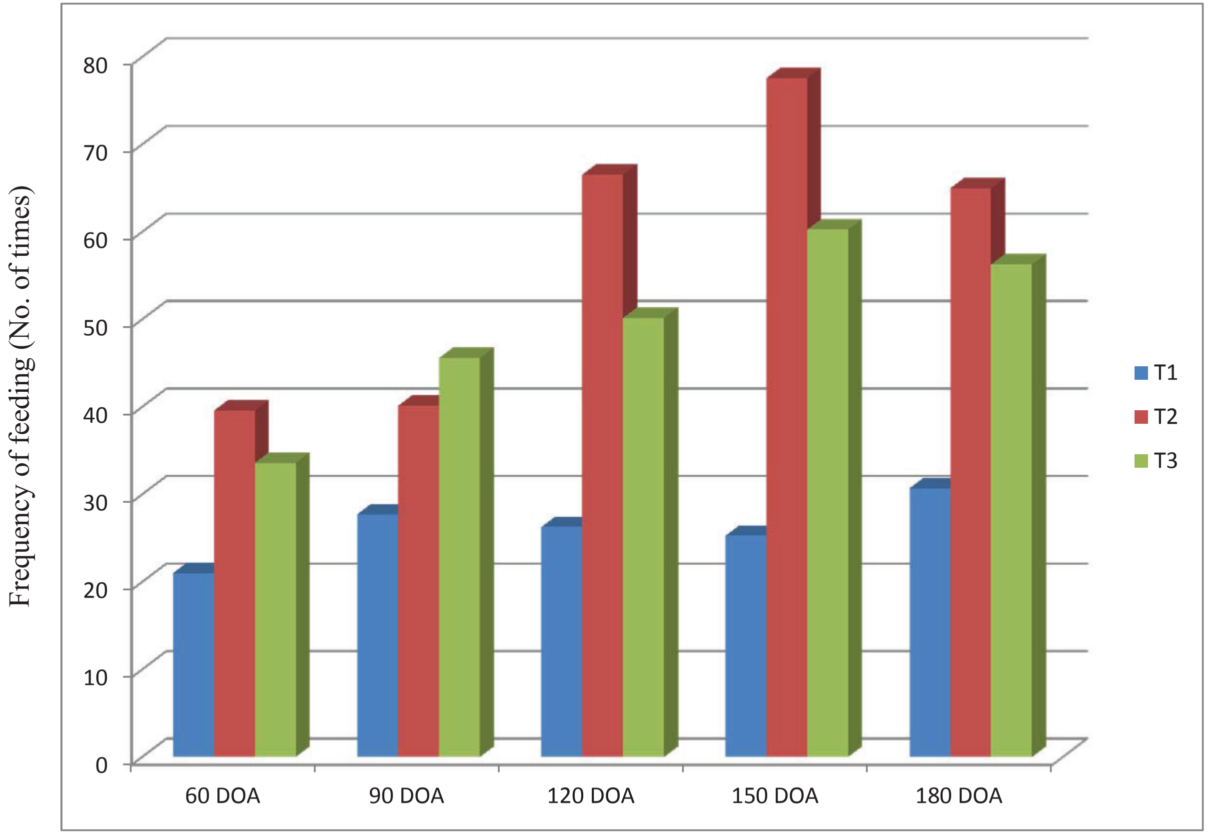
at 180 days were 30.71, 65.00 and 56.29 times for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the mean value for the FOF at 180 days was significantly ($P < 0.05$) higher for T_2 group followed by T_3 and lowest in T_1 group. From the above results, it was found that the FOF was significantly ($P < 0.05$) different between the three treatment groups at all the age wise groups. The findings of the present results were in conformity with the findings of Morgan *et al.* (2000) who also observed that feeding behaviour by random models on pigs where they found that daily feed intake increased with time and pigs made between 18.8 and 80.3 (mean 47.9) daily visits to the feeder suggesting that pigs ate in meals separated by long intervals where meals consists of clusters of eating bouts separated by shorter intervals, sometimes associated with drinking and within each eating bout short intervals occur as pigs constantly move in and out of the feeder. The result findings were also supported by workers like Renaudeau *et al.* (2005) who studied the effects of breed and sex on individual feeding behaviour and found that growth performance and feeding pattern were significantly affected by breed, sex and season.

Table 4.3.2: Frequency of feeding (no of times) by the three genotypes of pig

Treatments	Age of pigs (days)				
	60	90	120	150	180
T_1	21.00^a	27.73^a	26.29^a	25.29^a	30.71^a
T_2	39.57^c	40.14^b	66.57^c	77.57^c	65.00^c
T_3	33.60^b	45.60^c	50.20^b	60.27^b	56.29^b
Sem ±	0.92	0.43	1.74	0.96	1.44
CD at 5%	3.32	1.54	6.29	3.47	5.23

$^{a, b, c}$ Means bearing different superscript in a row differ significantly ($P < 0.05$)

Fig 4.3.2: Frequency of feeding (No. of times) by the three genotypes of pig



4.3.3 Time spent on drinking

The drinking behaviour of the animals was counted from the time the animals put their mouth on the water trough and was counted in seconds to drink the water. The values of time spent on drinking (TSD) at 60 days were 229.87, 268.80 and 247.13 seconds for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the TSD at 60 days was significantly ($P < 0.05$) higher for T_2 group followed by T_3 and lowest in T_1 group. The values of TSD at 90 days were 252.34, 287.19 and 270.50 seconds for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the TSD at 90 days was significantly ($P < 0.05$) higher for T_2 group followed by T_3 and lowest in T_1 group. The values of TSD at 120 days were 149.23, 271.80 and 295.63 seconds for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the TSD at 120 days was significantly ($P < 0.05$) higher for T_3 group followed by T_2 and lowest in T_1 group. The values of TSD at 150 days were 181.20, 244.80 and 276.60 seconds for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the TSD at 150 days was significantly ($P < 0.05$) higher for T_3 group followed by T_2 and lowest in T_1 group. The values of TSD at 180 days were 225.60, 253.20 and 273.90 seconds for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the TSD at 180 days group was significantly ($P < 0.05$) higher for T_3 group followed by T_2 and lowest in T_1 group. From the results, the time spent on drinking was significantly ($P < 0.05$) different between the three treatment groups at all the age wise groups. The findings of the present results were in close conformation with the observations of Yang *et al.* (1981) who also observed that water intake was unchanged or slightly decreased when food intake was allowed to increase. The results were also supported by Zhu *et al.* (2017) who also made a study on using machine vision images which determined the correct (drinking) recognition rate for individual pigs at 90.7 per cent that differs from traditional methods in that it avoided any disturbance to the pigs. Further the results findings were also supported by Chimainski *et al.* (2019) who made an objective study about the daily behaviour of water intake of male pigs in the growing and finishing phases where water intake was collected in real time during the entire experimental period in which the time spent drinking (TSD) showed a peak in the afternoon hour for growing and finishing phases respectively where TSD was 282.73 and 268.38 seconds.

Table 4.3.3: Time spent on drinking (sec) by the three genotypes of pig

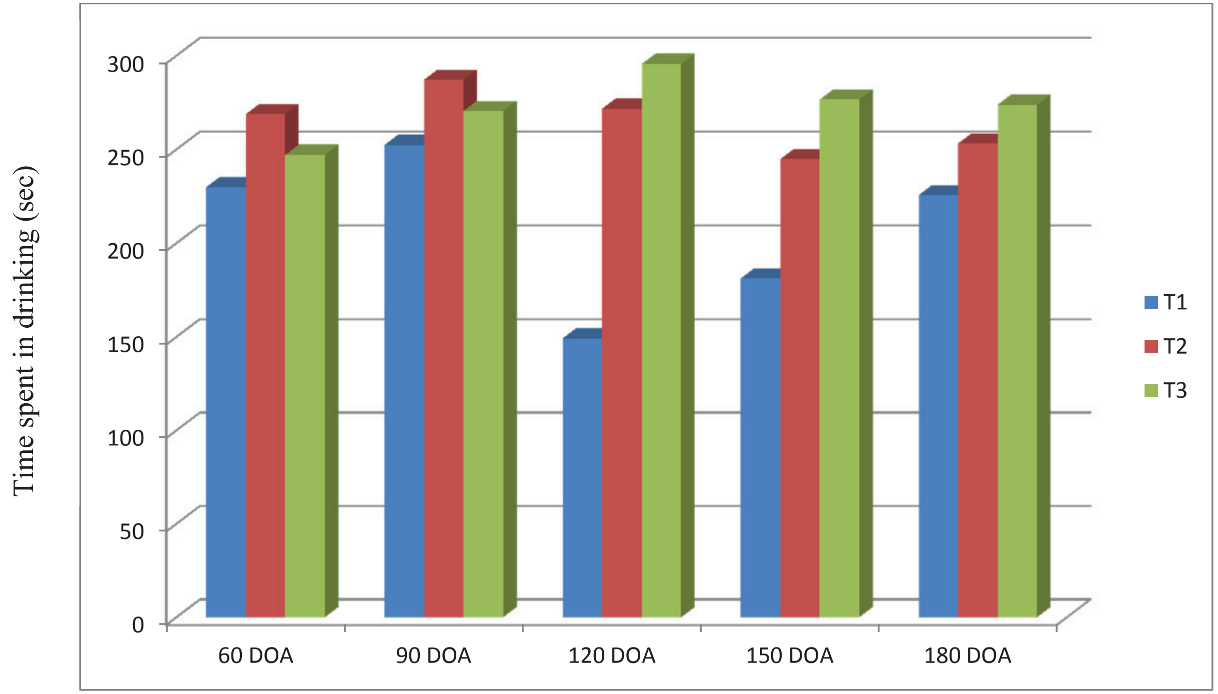
Treatments	Age of pigs (days)				
	60	90	120	150	180
T_1	229.87^a	252.34^a	149.23^a	181.20^a	225.60^a
T_2	268.80^c	287.19^c	271.80^b	244.80^b	253.20^b
T_3	247.13^b	270.50^b	295.63^c	276.60^c	273.90^c
Sem ±	4.41	4.32	6.01	3.12	2.87
CD at 5%	15.98	15.64	21.76	11.28	10.39

$^{a, b, c}$ Means bearing different superscript in a row differ significantly ($P < 0.05$)

4.3.4 Frequency of drinking

The frequency of drinking (FOD) was counted in number of drinks by the animals from the drinking trough. The values of FOD at 60 days were 17.29, 28.86 and 26.71 drinks for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the FOD in 60 days was significantly ($P < 0.05$) higher for T_2 group followed by T_3 and lowest in T_1 group. The values of FOD at 90 days were 21.86, 28.00 and 33.29 drinks for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the FOD at 90 days was significantly ($P < 0.05$) higher for T_3 group followed by T_2 and lowest in T_1 group. The values of FOD at 120 days

Fig 4.3.3: Time spent in drinking (sec) by the three genotypes of pig



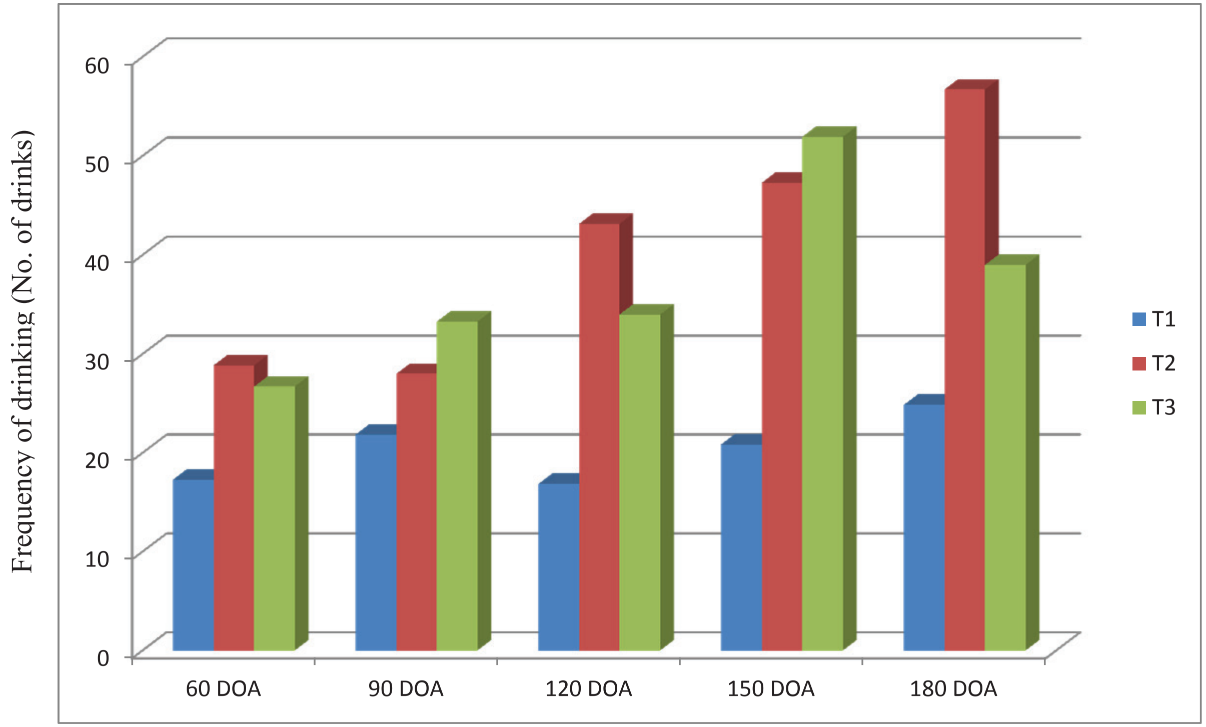
were 16.86, 43.14 and 34.00 drinks for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the FOD at 120 days was significantly ($P < 0.05$) higher for T_2 group followed by T_3 and lowest in T_1 group. The values of FOD at 150 days were 20.86, 47.29 and 51.94 drinks for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the FOD at 150 days was significantly ($P < 0.05$) higher for T_3 group followed by T_2 and lowest in T_1 group. The values of FOD at 180 days were 24.86, 56.71 and 39.00 drinks for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the FOD at 180 days was significantly ($P < 0.05$) higher for T_2 group followed by T_3 and lowest in T_1 group. The findings of the present results were in agreement with the observations of Turner *et al.* (2000) who also found that the frequency of visits to the drinkers, drinking bout duration and daily drinking time were affected by group size and drinker allocation but not by weight or the interaction of treatments and weight. Bigelow and Houpt (1988) also found that the drinking behaviour was often mirrors of feeding behaviour as 75 per cent of the water intake was associated with pig feed intake.

Table 4.3.4: Frequency of drinking (no of drinks) by the three genotypes of pig

Treatments	Age of pigs (days)				
	60	90	120	150	180
T_1	17.29^a	21.86^a	16.86^a	20.86^a	24.86^a
T_2	28.86^c	28.00^b	43.14^c	47.29^b	56.71^c
T_3	26.71^b	33.29^c	34.00^b	51.94^c	39.00^b
Sem ±	0.48	0.83	0.72	0.62	0.50
CD at 5%	1.76	3.02	2.63	2.24	1.81

$^{a, b, c}$ Means bearing different superscript in a row differ significantly ($P < 0.05$)

Fig 4.3.4: Frequency of drinking (No. of drinks) by the three genotypes of pig



4.3.5 Time spent on lying

The time spent on lying (TSL) was taken from the time the animal start to lie on the floor and was counted in minutes. The values of TSL at 60 days were 164.29, 215.45 and 173.98 minutes for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the TSL at 60 days was significantly ($P < 0.05$) higher for T_2 group followed by T_3 and the lowest in T_1 group. The values of TSL at 90 days were 160.90, 224.84 and 210.83 minutes for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the TSL at 90 days was significantly ($P < 0.05$) higher for T_2 group followed by T_3 and lowest in T_1 group. The values of TSL at 120 days were 110.68, 189.27 and 215.77 minutes for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the TSL at 120 days was significantly ($P < 0.05$) higher for T_3 group followed by T_2 and lowest in T_1 group. The values of TSL at 150 days were 100.98, 133.78 and 245.81 minutes for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the TSL at 150 days was significantly ($P < 0.05$) higher for T_3 group followed by T_2 and lowest in T_1 group. The values of TSL at 180 days were 86.73, 154.70 and 293.41 minutes for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the TSL at 180 days was significantly ($P < 0.05$) higher for T_3 group followed by T_2 and lowest in T_1 group. From the results it was concluded that T_1 and T_2 had a decreasing trend in their resting behaviour with increase in age which might be attributed to their other activities involved in eating, drinking, standing, loitering etc while in T_3, they tended to increase in their resting behaviour with increase in age which could be a reason for conserving energy. The results of the present study were in conformation with findings of Li (2014) who stated that pig spent the majority of their time resting or lying. Debreceni *et al.* (2014) also made a study on the effect of high temperature on the behaviour of growing-finishing pigs and made observations that pigs were most of the time lying (72 per cent, P < 0.001).

Table 4.3.5: Time spent on lying (min) by the three genotypes of pig

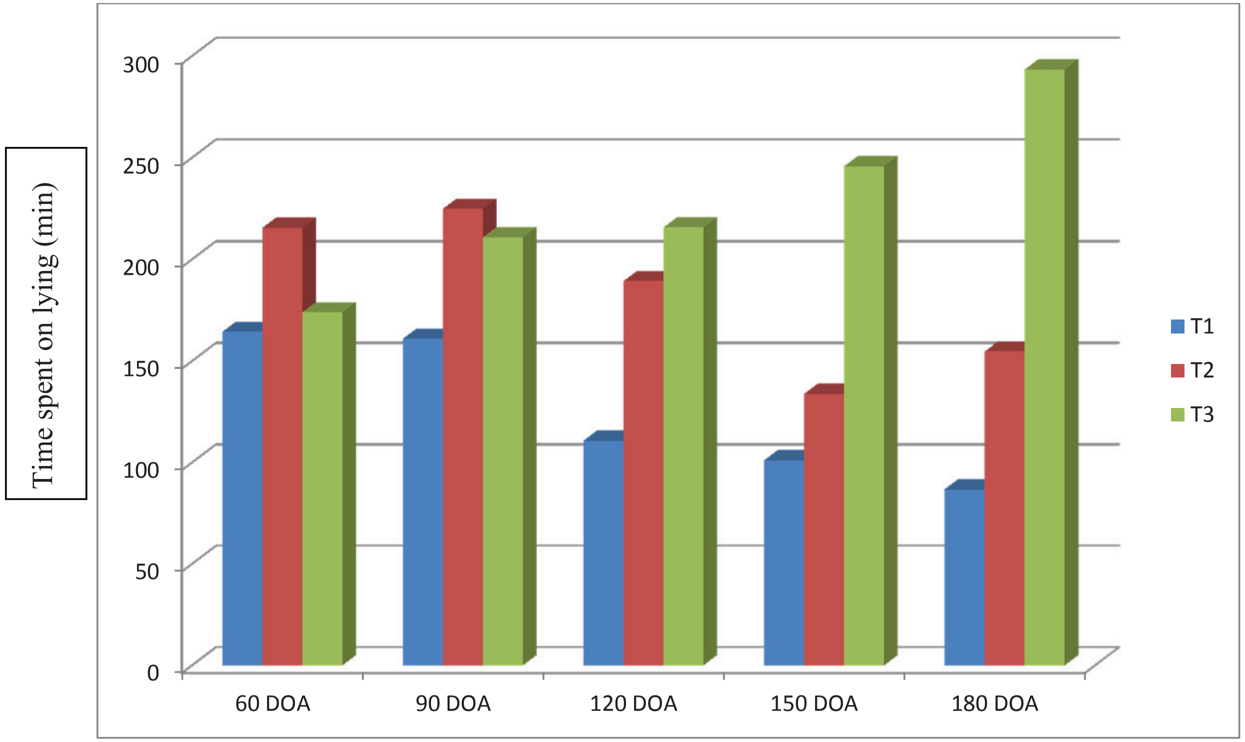
Treatments	Age of pigs (days)				
	60	90	120	150	180
T_1	164.29[a]	160.90[a]	110.68[a]	100.98[a]	86.73[a]
T_2	215.45[c]	224.84[c]	189.27[b]	133.78[b]	154.70[b]
T_3	173.98[b]	210.83[b]	215.77[c]	245.81[c]	293.41[c]
Sem ±	0.60	0.49	0.46	0.59	0.66
CD at 5%	2.19	1.80	1.68	2.16	2.41

[a, b, c] Means bearing different superscript in a row differ significantly (P < 0.05)

4.3.6: Frequency of lying down

The frequency of lying down (FLD) was the number of times the pigs lie down on the floor. The values of FLD at 60 days were 19.86, 29.14 and 44.71 times for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the mean value for the FLD at 60 days was significantly ($P < 0.05$) higher for T_3 group followed by T_2 and lowest in T_1 group. The values of FLD at 90 days were 18.43, 31.86 and 29.00 times for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the FLD at 90 days was significantly ($P < 0.05$) higher for T_2 group followed by T_3 group. The values of FLD at 120 days were 19.14, 33.71 and 30.58 times for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the FLD at 120 days was significantly ($P < 0.05$) higher for T_2 group followed by T_3 and lowest in T_1 group. The values of FLD at 150 days were 20.29, 26.76 and 32.00 times for T_1, T_2 and T_3 groups, respectively.

Fig 4.3.5: Time spent on lying (min) by the three genotypes of pig



On statistical analysis, it was perused that the value for the FLD at 150 days was significantly ($P < 0.05$) higher for T_3 group followed by T_2 and lowest in T_1 group. The values of FLD at 180 days were 20.57, 23.14 and 20.00 times for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the FLD at 180 days was significantly ($P < 0.05$) higher for T_2 group followed by T_3 and lowest in T_1 group. The findings of the present study were in agreement with the observations of Robert *et al.* (1987) who studied on role of environment and genetics in behaviour of wild and domestic pigs and observed that males activity was similar to that of females in the two groups. They reported that domestic pigs spent more time during day leading to lower frequency of locomotion which might be a tendency to conserve energy and their relative frequency of rest fluctuated between approximately 70 and 100 per cent during the day time.

Table 4.3.6: Frequency of lying down (no of times) by the three genotypes of pig

Treatments	Age of pigs (days)				
	60	90	120	150	180
T_1	19.86^a	18.43^a	19.14^a	20.29^a	20.57^a
T_2	29.14^b	31.86^c	33.71^c	26.76^b	23.14^c
T_3	44.71^c	29.00^b	30.58^b	32.00^c	20.00^b
Sem ±	0.47	0.661	0.66	0.44	0.56
CD at 5%	1.70	2.393	2.41	1.59	2.02

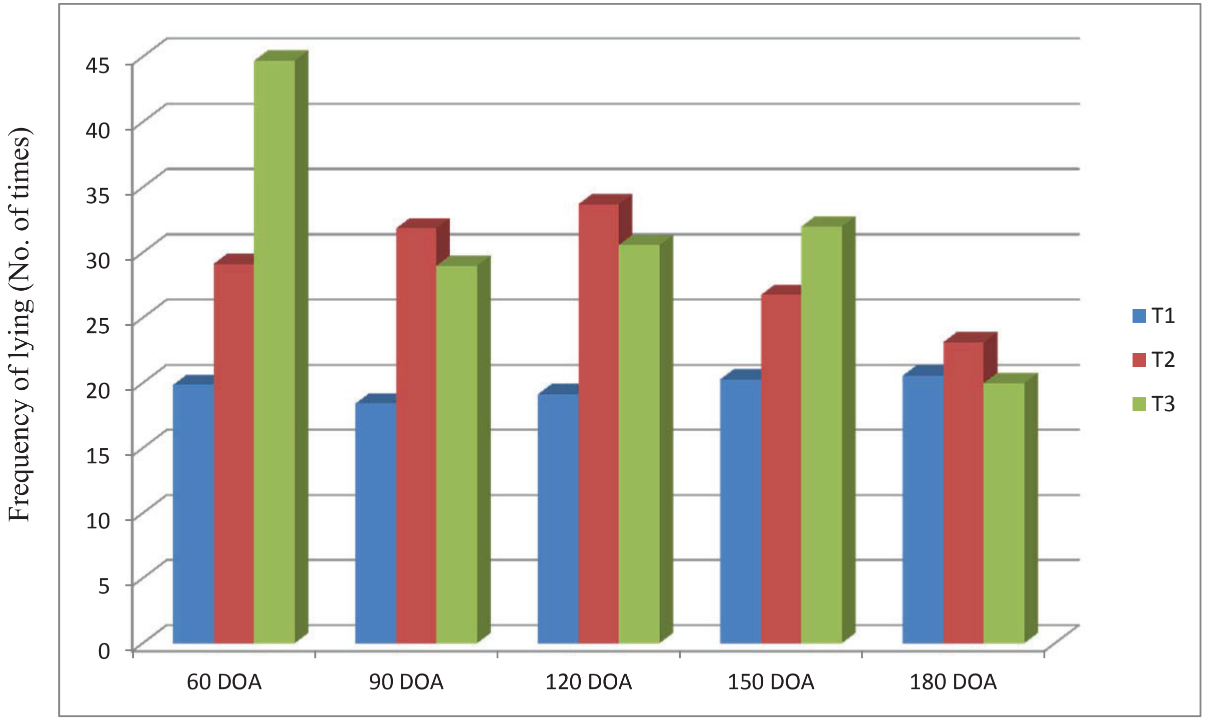
$^{a, b, c}$ Means bearing different superscript in a row differ significantly ($P < 0.05$)

4.4 Blood Parameters

The values for the blood constituents of the three genotypes of pig were presented in the Table 4.4.1 and the statistical values were presented in

ANOVA-4 under Appendix-D. The values of white blood cells were 19.86, 29.14 and 44.71 $10^3/\mu l$ for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the WBC was higher in T_2 group followed by T_3 and lowest in T_1 group; however, there was no significant ($P > 0.05$) difference between the three treatment groups. The values of haemoglobin were 11.31, 10.59 and 10.61 g/dl for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the haemoglobin was higher in T_3 group followed by T_2 and lowest in T_1 group; however, there was no significant ($P > 0.05$) difference between the three treatment groups. The values of RBC were 6.42, 6.52 and 6.67 $10^6/\mu l$ for T_1, T_2 and T_3 groups, respectively. On statistical analysis it was perused that the value for the RBC was higher in T_3 group followed by T_2 and lowest in T_1 group; however, there was no significant ($P > 0.05$) difference between the three treatment groups. The values of PCV were 31.89, 30.54 and 30.39 % for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value of PCV was higher in T_1 group followed by T_2 and lowest in T_3 group; however, there was no significant ($P > 0.05$) difference between the three treatment groups. The values of blood glucose were 72.2, 62.13 and 71.65 mg/dl for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the blood sugar was higher in T_1 group followed by T_3 and lowest in T_2 group; however, there was no significant ($P > 0.05$) difference between the three treatment groups. The values of cholesterol were 103.97, 101.52 and 105.63 mg/dl for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value of cholesterol was higher in T_3 group followed by T_1 and lowest in T_2 group; however, there was no significant ($P > 0.05$) difference between the three treatment groups. The results on blood analysis shows that there was no significant ($P > 0.05$) difference between the three treatment groups in all the blood parameters studied. The results of the present study was well corroborated with the

Fig 4.3.6: Frequency of lying (No. of times) by the three genotypes of pig



findings of Aladi *et al.* (2008) who has made a comparative study of different haematological characteristics of Large white and Nigerian indigenous and found no significant age or breed differences in haematological parameters ($P > 0.05$) and the values were within the normal ranges generally accepted as reference values for healthy pigs. The biochemical analysis on glucose and cholesterol were also found to be in normal range as per the reference values given by Plumb (2005) where the serum biochemical reference of cholesterol and glucose were given 81-134 and 66-116 in mg/dl respectively.

Table 4.4.1: Blood parameters of the three genotypes of pig

Parameters	Treatment groups			Sem	CD at 5%
	T_1	T_2	T_3	±	
White Blood cells (10^3/µl)	15.24	15.69	15.54	0.85	3.07
Haemoglobin (g/dl)	11.31	10.59	10.61	0.23	0.84
Red blood cells (10^6/µl)	6.42	6.52	6.67	0.11	0.40
Packed Cell Volume (%)	31.89	30.54	30.39	0.45	1.65
Blood glucose (mg/dl)	72.2	62.13	71.65	3.31	11.98
Total cholesterol (mg/dl)	103.97	101.52	105.63	2.21	8.01

*g/dl = gram per decilitre

*µl = micro litre *mg/dl = milligram per decilitre

4.5. Growth Performance

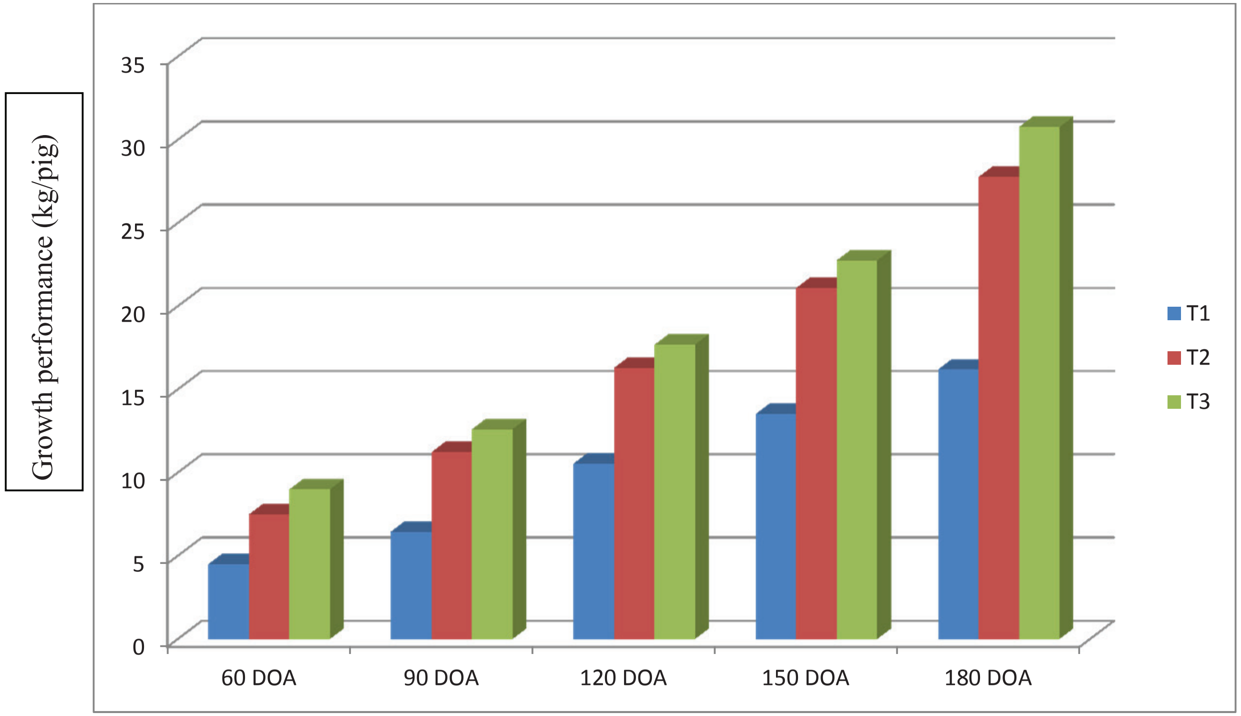
The growth performance is estimated by the growth rate in kg of the pigs which is presented in Table 4.5.1, Fig 4.5.1 and statistical values is presented in ANOVA-5 under Appendix-E. The values of mean body weight at 60 days were 4.494, 7.487 and 8.996 kg for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the body weight at 60 days was significantly ($P < 0.05$) higher for T_3 group followed by T_2 and lowest in T_1 group. The values of body weight at 90 days were 6.454, 11.229 and 12.609 kg for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value for the growth rate in 90 days was significantly ($P < 0.05$) higher for T_3 followed by T_2 and lowest in T_1 group. The values of body weight at 120 days were 10.545, 16.295 and 17.691 kg for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value of body weight at 120 days was significantly ($P < 0.05$) higher for T_3 group followed by T_2 and lowest in T_1 group. The values of body weight at 150 days were 13.530, 21.103 and 22.759 kg for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value of body weight at 150 days was significantly ($P < 0.05$) higher for T_3 group followed by T_2 and lowest in T_1 group. The values of body weight at 180 days were 16.199, 27.770 and 30.772 kg for T_1, T_2 and T_3 groups, respectively. On statistical analysis, it was perused that the value of body weight at 180 days was significantly ($P < 0.05$) higher for T_3 group followed by T_2 and lowest in T_1 group. From the results, it was observed that T_3 group had higher body weight gain as compared to T_2 and T_1 group. The findings of the present study were well corroborated with the observations of Okeudo *et al*. (2007) who reported that there was a significant ($P < 0.05$) difference in live weight, average daily gain among the Nigerian indigenous (NI), Large white (LW) and cross bred of LW x NI (F_1) pigs. Our findings were also in conformation with the findings of Gopinathan and Usha (2011) who made a comparative study on Large White Yorkshire, Crossbred and Desi from weaning to eight months of age and found that higher body weight gain were noticed in large white Yorkshire followed by crossbred and desi pigs in all age wise.

Table 4.5.1: Body weight (kg/pig) of the three genotypes of pig

Treatments	Age of pigs (days)				
	60	90	120	150	180
T_1	4.494^a	6.454^a	10.545^a	13.530^a	16.199^a
T_2	7.487^b	11.229^b	16.295^b	21.103^b	27.770^b
T_3	8.996^c	12.609^c	17.691^c	22.759^c	30.772^c
Sem ±	0.41	0.37	0.33	0.35	0.67
CD at 5%	1.49	1.32	1.18	1.27	2.43

$^{a, b, c}$ Means bearing different superscript in a row differ significantly ($P < 0.05$)

Fig 4.5.1: Growth performance (kg/pig) of the three genotypes of pig



CHAPTER V

SUMMARY AND CONCLUSIONS

SUMMARY AND CONCLUSIONS

The study "Behavioural Characteristics of Different Genotypes of Pig" was carried out at the pig project farm of Indian Council of Agricultural Research- All India Coordinated Research Project on Pig (ICAR-AICRP-pig), Department of Livestock Production and Management, School of Agricultural Sciences and Rural Development (SASRD), Nagaland University, Medziphema Campus with the following objectives:

1. To study the physical characteristic of the three genotypes of pig.
2. To study the physiological behaviours of three genotypes of pig.
3. To study the ethological behaviours of the three genotypes of pig.
4. To study the haematological and biochemical parameters of blood from three pig population.
5. To study the growth performance of the three pig population.

The study was carried out with 21 pigs irrespective of sexes divided into three groups having three different genotypes in each group, respectively consisting of 7 numbers of pigs in each group. The three genotypes of pigs were indigenous pure *Tenyivo* (100%) in group 1 (T_1), Upgraded pig of *Tenyivo* x *Hampshire* (in the ratio of 25: 75 %) in group 2 (T_2) and pure *Hampshire* (100 %) pigs in group 3 (T_3), respectively. All the animals were reared under similar feeding regime and standard housing system irrespective of the genotypes.

5.1 Physical Characteristics

The physical measurements of the animals taken at 180 days of age were considered for the head, body, tail and legs parts. T_1 has the lowest values in most of the physical measurements except its face breadth which has higher value as compared to T_2 and T_3. With regard to body conformation T_3 has higher values as compared to T_2 and T_1; however there was no significant difference in most body confirmation between T_3 and T_2. There was no significant difference in tail length among the treatment group but the circumference of the tail was significantly different for T_3 and T_1 but not between T_3 and T_2. The measurement for both fore leg and hind legs showed significant difference between T_3 and T_1 but not between T_3 and T_2.

5.2 Physiological Behaviour

The values for RR were significantly ($P < 0.05$) higher in T_1 group followed by T_3 and lowest in T_2 group irrespective of various periods of observation; however, there was no significant difference in the values of RR between T_2 and T_3 groups except at 150 days of observation. Similarly, the values of RR did not differ significantly between T_1 and T_3 except at 90 and 120 days of observation. The values of RT were significantly ($P < 0.05$) higher in T_2 group followed by T_3 group and the lowest in T_1 group at 90 and 120 days of observation; however, there was no significant difference between T_2 and T_3 group. The values of RT were same in all the three groups for remaining period of observation.

5.3 Ethological Behaviour

The parameters of ethological behaviour studied were on feeding behaviour, drinking behaviour and resting behaviour which was recorded through the use of close circuit television (cctv). From the results, it was found that the values of TSF, TSD and TSL were highest in *Hampshire* breed as compared to other genotypes; however, the values of FOF, FOD and FLD were highest in crosses of *Hampshire* x *Tenyivo* breed as compared to other genotypes.

5.4 Blood constituents

The blood parameters such as Red Blood Cells, White Blood Cells, Haemoglobin, Packed Cell Volume, Glucose and Cholesterol were found to have no significant ($P > 0.05$) difference between the three treatment groups in the blood parameters studied.

5.6 Growth Performance

The values for average body weight was significantly higher in T_3 group followed by T_2 group and the least in T_1 group irrespective of various period of observation.

CONCLUSIONS

Based on the results of the present study the following conclusions had been drawn:

1. From the physical characteristics study it has been concluded that T_3 had higher values in most observation as compared to T_2 and T_1. Further it was observed that there was no difference in physical measurement between T_3 and T_2 indicating that the upgraded pigs represented by T_2 can be further researched at different levels of management to assess its production potentials. The *Tenyivo* breed represented by T_1 were observed to have lower values in almost all the physical observations and so further improvement in management practices is needed to harness their best quality.

2. From the physiological behaviour it was concluded that the values of PR, RR and RT were found to be at normal range for the three treatment groups at different age wise respectively.

3. There was significant difference between the three genotypes in their ethological behaviour studied at different age wise group on their feeding, drinking and resting behaviour which clearly indicates that genotypes effects the ethological behaviour of the animals.

4. The findings on blood parameters can be used as base line study or reference values but one can also study more details on blood parameters related to nutritional effect, age wise effect, different managemental effects etc in details.

5. It can be concluded that the values on the body weight were undoubtedly the best in *Hampshire* breed of pigs; however, considering the climatic conditions and availability of the resources like feed and breed at different pockets of state of Nagaland, it can be concluded that crosses of *Hampshire* x *Tenyivo* (in the ratio of 75:25) can be advocated for rearing under prevailing environmental conditions of Nagaland.

CHAPTER VI

REFERENCES

REFERENCES

Adeoye, A.A., Udoh, J.E., Rotimi, E.A., Ikeobi, C.O.N. and Adebambo, O.A. 2015. Heamatology and serum biochemistry of F_1 and F_2 pigs produced by ASF-Recoverd pigs. *Ife Journal of Science.* **17** (2): 281-287.

Aladi, O.N., Okeudo, N.J., Okoli, C.I. and Akanno, E.C. 2008. Reproductive and Haematological Characteristics of the Nigerian Indigenous and Large White Pigs in a Humid Tropical Environment. *Asian Journal of Animal and Veterinary Advances*. **3** (1): 17-23.

Andersen, H.M.L., Dybkjaer, L. and Herskin, M.S. 2014. Growing pigs' drinking behaviour: number of visits, duration, water intake and diurnal variation. *Animal.* **8**: 1-8.

Andersson, B.E. and Jonasson, H. 1993. Temperature regulation and environmental physiology. In: Swenson MJ, Reece WO, eds. Dukes, physiology of Domesticated Animals. 11th Ed. Ithaca, NY: Cornwell University Press.

Bakere, G.A., Madzimure, J., Ndou, S.P. and Chimonyo, M. 2014. Growth performance and behaviour in grouped pigs fed fibrous diet. *Asian-Australasian Journal of Animal Sciences.* **27** (8): 1204-1210.

Banik, S., Naskar, S., Pankaj, P.K., Sahoo, N.R., Tamuli, M.K. and Das, A. 2012. Effect of different body measurement on body weight in Ghungroo pigs. *Indian Journal of Animal Sciences.* **82** (9): 1094-1097.

Banik, S., Nasker, S., Pankaj, P.K., Pourochottamane, R., Barman, K., Sahoo, N.R. and Tamuli, M.K. 2013. Construction of growth band for early selection of indigenous pigs in India. *Applied Biological Research.* **15** (1): 73-77.

Bigelow, J.B. and Houpt, T.R. 1998. Feeding and drinking patterns in young pigs. *Physiology and Behaviour.* **43**: 99-109.

Borkotoky, D., Perumal, P. and Singh, R.K. 2014. Morphometric attributes of Naga local pigs. *Veterinary Research International*. **2** (1): 8-11.

Bornett, H.L.I., Morgan, C.A., Lawrance, A.B. and Mann, J. 2000. The effect of group housing on feeding patterns and social behaviour of previously individually housed growing pigs. *Applied Animal Behaviour Science.* **70** (2): 127-141.

Boro, P., Patel, B.H.M., Sahoo, N.R., Naha, B.C., Malkar, A., Gaur, G.K., Singh, M., Dutt, T., Verma, M.R., Upadhyay, D. and Singh, A.K. 2016.

Phenotypic attributes of Bareilly Desi Pig. *International Journal of Advanced Biological Research.* **6** (3): 390-393.

Brown, J.E., Brown, C.J. and Butts, W.T., 1973. Evaluating Relationship among immature measures of size, shape and performance on beef bulls. 1. Principal component as measures of size and shape in young Hereford and Angus Bulls. *Journal of Animal Science.* **36**: 1010-1020.

Caldara, F.R., Rosa, P.S.G., Ferreira, R.A., Reis, N.M.O., Naas, I.A., Paz, C.I.L.A., Carcia, R.G. and Ferreina, M.O.S. 2012. Behaviour performance and physiological parameters of pigs reared in deep bedding. *Engenharia Agricola Taboticaba.* ***32*****:** 38-46.

Chakraborty, A., Soren, S., Tamuly, U.R., Deka, S.S., Chabukdhara, P., Saikia, K. and Boruah, K. 2018. Physiological responses in growing pigs reared under scavenging and semi-intensive system. *International Journal of Current Microbiology and Applied Sciences*. **7** (2): 534-537.

Chavez, M.J., Fuentes, S., Dunshea, F.R., Warner, R.D., Poblete, T., Morrison, R.S. and Jongman, E.C. 2020. Remotely sensed imagery for early detection of respiratory disease in pigs: A pilot study. *Animals*. **10** (3): 451-462.

Chimainski, M., Ceron, M.S., Kuhn, M.F., Muniz, H.C.M., Rocha, L.T., Pacheco, P.S., Kessler, A.M. and Oliveira, V. 2019. Water disappearance dynamics in growing-finishing pig production. *Brazilian Journal of Animal Science.* **48:** 1-11

Chinnamani, K., Sivakumar, T., Gnanaraj, P.T. and Murugan, M. 2010. Feeding behaviour of crossbred Large White Yorkshire pigs under different feed regime. *Journal of Veterinary and Animal Science.* **41**: 51-53.

De Haer, L.C.M. and De Vries, A.G. 1992. Feed intake patterns of and feed digestibility in growing pigs housed individually or in groups. *Livestock Production Sciences*. **33**: 277-292.

Debreceni, O., Lehotayova, A., Bucko, O. and Petrak, J. 2014. The behaviour of the pigs housed in hot climatic conditions. *Journal of Central European Agriculture.* **15** (1): 64-75.

Deligeorgis, S.G, Karalis, K. and Kanzouros, G. 2006. The influence of drinker location and colour on drinking behaviour and water intake of newborn pigs under hot environment. *Applied Animal Behaviour Science.* **96** (3-4): 233-244.

Godyn, D. and Herbut, P. 2017. Application of continuous body temperature measurements in pigs- a review. *Animal Science.* **56** (2): 209-220.

Gonyou, H.W., Beltranena, E., Whittington, L.D. and Patience, F.J. 1998. The behaviour of pigs weaned at 12 and 21 days of age from weaning to market. *Canadian Journal of Animal Science.* **78** (4): 517-523.

Gopinathan, A. and Usha, A.P. 2011. Comparative evaluation of growth and carcass triats in Large White Yorkshire, Desi and their crossbred pigs. *Indian Journal of Animal Research.* **45** (3): 203-206.

Govindasamy, K., Rahman, M., Singh, L.A., Singh, N.M. and Kumar, R. 2020. Phenotypic characterization and performance evaluation of Burmese black pig: A unique indigenous germplasm of north east region of India. *Journal of Animal Research.* **54** (7): 813-819.

Huynh, T.T.T., Aamink, A.J.A., Gerrits, W.J.J., Heetkamp, M.J.W., Canh, T.T., Spoolder, M.A.M., Kemp, B. and Verstegen, M.W.A. 2005b. Thermal behaviour of growing pigs in response to high temperature and humidity. *Applied Animal Behaviour Science.* **91** (1-2): 1-16.

Huynh, T.T.T., Aamink, A.J.A., Verstegen, M.W.A., Gerrits, W.J.J., Heetkamp, M.J.W., Kemp, B. and Canh, T.T. 2005a. Effects of increasing temperatures on physiological changes in pigs at different relative humidity. *Journal of Animal Science.* **83** (6): 1385-1396.

ICAR. 2013. Nutrient Requirement of Livestock. Indian Council of Agriculture Research, New Delhi, India.

Ige, A.O., Akinlade, J.A., Ojedapo, L.O., Oladunjoye, I.O., Amao, S.R. and Animashaun, A.O. 2006. Effect of sex interrelationship between body weight and linear measurements of commercial broiler in a Derived Savannah Environment of Nigeria. **In**: Proceedings of the 11th Annual Conference of the Animal Science Association of Nigeria. 18-21 September, Ibadan, Oyo State, Nigeria.

Kalita, G., Sarma, K., Rahman, S., Talukdar, D. and Ahmed, F.A. 2017. Morphometric and reproductive attributes of local pigs of Mizoram. *International Journal of Livestock Research.* **8** (2): 173-177.

Kaswan, S., Patel, B.H.M., Mondal, S.K., Dutt, T., Verma, M.R., Verma, A.K. and Upadhyay, D. 2015. Effect of reduced floor space allowance on performance of weaner barrows. *Indian Journal of Animal Research.* **49** (2): 241-247.

Kennedy, B.W. 1984. Between and within litter variation, sex effects and trends in sire and dam transmitting abilities on performance tested pigs in Ontario. *Journal of Animal Science.* **59**: 338-345.

Khargharia, G., Zaman, G., Laskar, S., Das, B., Aziz, A., Roychoudhury, R. and Roy, T.C. 2014. Phenotypic characterisation and performance studies of Niang Megha and Doom pigs of North-eastern India. *Asian Academic Research Journal of Multidisciplinary.* **1** (7): 667-676.

Kumal, S.V., Balasubramanyam, D., Senthil, R.N., Manju, G., Vairamuthu, S. and Gopi, H. 2017. Haematological profile of Indigenous Pigs in Tamil

Nadu. *International Journal of Pure and Applied Bioscience.* **5** (4): 395-398.

Li, Y. 2014. Normal and abnormal behaviour of swine under productions conditions. Pork Information Gateway. Factsheets Number PIG 05-03-02. pp 1-5

Livestock Census, 2019. Directorate of Economics and Statistics, and Animal Husbandry Statistics Division, Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, New Delhi, India. pp 33-34.

Massari, J.M., Vercellino, R.D.A., Curi, T.D.C., Moura, D.J., Medeiros, B.B.L. and Salgado, D.D. 2017. Different gender division patterns for swine housing in wean to finish system. *Journal of the Brazilian Association of Agricultural Engineering.* **37**: 13-23.

Mayengbam, P., Tolenkhomba, T.C. and Ali, M.A. 2014. Haematological profile of Zovawk- an indigenous pig of Mizoram. *Veterinary World*. **7**: 505-508.

Milligann, B.N., Fraser, D. and Kramer, D.L. 2001. Birth weight variation in the domestic pig: Effects on offspring survival, weight gain and sucking behaviour. *Applied Animal Behaviour Science*. **73**: 179-191.

Morenikeji, O.B., Chineke, C.A. and Aro, S.O. 2013. Genetic Correlation and heritability of performance traits among three pig genotypes. *International Journal of Scientific & Engineering Research.* **4** (3): 2229-5518.

Morenikeji, O.B., Ogunshola, O.J., Adu, O.A., Aro, S.O. and Chineke, C.A. 2019. Genotype and sex effects on the performance characteristic of pigs. *International Journal of Livestock Production.* **10** (4): 127-134.

Morgan, A.C., Emmans, G., Tolkamp, B. and Kyriazakis, I. 2000. Analysis of the feeding behaviour of pigs using different models. *Physiology & Behaviour.* **68** (3): 395-403.

Nielsen, B.L., Lawrence, A.B. and Whittemore, C.T. 1995. Effect of group size on feeding behaviour, social behaviour and performance of growing pigs using single-space feeders. *Livestock Production Science.* **44** (1): 73-85.

Nielsen, B.L. 1999. On the interpretation of feeding behaviour measures and the use of feeding rate as an indicator of social constraint. *Applied Animal Behaviour Sciences*. **63**: 79-91.

Oke, U.K., Ibe, S.N., Ologbose, F.I. and Amaefula, K.U. 2006. Effect of breed of sire on growth performance of exotic crossbred pigs in a humid tropical environment. *Journal of Animal and Veterinary Advances.* **5** (9): 744-748.

Okeudo, J.N., Aladi, O.N., Okoli, C.I. and Akanno, C.E. 2007. Comparative study of the growth and carcass characteristics of Nigerian Indigenous and Large White pigs. **1** (2): 57-66.

Oluwole, O.O., Tiamiyu, A.K., Olurungbounmi, T.O., Oladele-Bukola, M.O. and Akintoye, N.A. 2014. Pre-weaning growth traits in Nigerian indigenous pig crossbreds. *Agricultural Sciences*. **5**: 891-896.

Onyimonyi, A.E., Ugwu, S.O.C. and Machebe, N.S. 2010. Performance and linear measurements of growing pigs fed on basis of their body weight. *Pakistan Journal of Nutrition*. **9** (1): 57-59.

Panda, S., Gaur, G.K., Sahoo, N.R., Bharti, P.K. and Kar, J. 2020. Principal component analysis of morphometric and growth traits in crossbred piglets. *Indian Journal of Animal Sciences.* **90** (8): 1168-1171.

Pazzini, J.M., De Nardi, A.B., Oliveira, G.L. and Mello, S.P. 2014. Behaviour and welfare of pigs from weaning to 60 days of age. *Journal of Animal Science Advances.* **4** (9): 1033-1037.

Pereira, C.B., Dohmeier, H., Kunczik, J., Hochhausen, N., Tolba, R. and Czaplik, M. 2019. Contactless monitoring of heart and respiratory rate in anesthetized pigs using infrared thermography. PLoS ONE . **14** (11): 1-12.

Plumb, D.C. 2005. Plumb's Veterinary Drug Handbook. 5th Edition. pp 1241-1249.

Quiniou, N., Renaudeau, D., Dubois, S. and Noblet, J. 2000. Influence of high ambient temperatures on food intake and feeding behaviour of multiparous lactating sows. *Animal Science*. **70**: 471-479.

Renaudeau, D. 2005. Effect of short-term exposure to high ambient temperature and relative humidity on thermoregulatory responses of European (Large white) and Caribbean (creole) restrictively-fed growing pigs. *Animal Research. EDP Sciences.* **54** (2): 81-93.

Renaudeau, D., Giorgi, M., Silou, F. and Weisbecker, J.L. 2005. Effect of breed (lean or fat pigs) and sex on performance and feeding behaviour of group housed growing pigs in a tropical climate. *Asian-Australian Journal of Animal Science.* **19** (4): 593-600.

Robert, S., Dancosse, J. and Dallaire, A. 1987. Some observations on the role of environment and genetics in behaviour of wild and domestic forms of *Sus scrofa* (European wild boars and domestic pigs). *Applied Animal Behaviour.* **17** (3-4): 253-262.

Sarma, P.K., Saikia, S., Baruah, K.K. and Bora, M.C. 2009. Effect of stocking density and floor space allowance upon the behaviour of growing- finishing pigs. *Livestock International.* **13** (1): 20-22.

Sastry, A.G. 1985. Veterinary Clinical Pathology. Published by CBS Publishers & Distributers, Jain Bhawan, Bhola Nath Nagar Shahdara, Delhi-110032, India, Reprint 1985.

Saxena, C.B. and Saxena, R.K. 2003. Pig Production, Planning, Management and Monitoring. 1st Edition. Published by, International Book Distribution Co., Charbagh, Lucknow, U.P. (India). pp 7-13.

Sipos, W., Wiener, S., Entenfellner, F. and Sipos, S. 2013. Physiological changes of rectal temperature, pulse rate and respiratory rate of pigs at different ages including the critical peripartal period. *Veterinary Medicine Austria.* **100** (3): 93-98.

Snedecor, G.W. and Cochran, W.G. 1994. Statistical Method. 8th Ed. Oxford and IBH Publishing Co. New Delhi, India.

Sulabo, R.C., Quackenbush, J., Goodband, R.D., Tokach, M.D., Dritz, S.S., DeRouchey, J.M. and Nelssen, J.L. 2006. Validation of flank-to-flank measurements for predicting boar weight. *Swine Day*: 19-23.

Swindle, M.M., Makin, A., Herron, A.J., Clubb, F.J. and Frazier, K.S. 2012. Swine as models in biomedical research and toxicology testing. *Veterinary Pathology.* **49** (2): 344-356.

Tegbe, J.S. and Olurunju, S.A.S. 1998. The prediction of liveweight of crossbred pigs from three body measurements. *Nigerian Journal of Animal Production.* **15**: 9-13.

Torrey, S. and Widowski, T.M. 2006. A note on piglets preferences for drinker types at two weaning ages. *Applied Animal Behavioural Science.* **100** (3- 4): 333-341.

Turner, S.P., Allcroft, D.J. and Edwards, S.A. 2003a. Housing pigs in large social groups: A review of implications for performance and other economic traits. *Livestock Production Science.* **83**: 39-51.

Turner, S.P., Horgan, G.W. and Edwards, S.A. 2003b. Assessment of sub- grouping behaviour in pigs housed at different group sizes. *Applied Animal Behaviour Science.* **84 (**4**):** 291-302.

Turner, S.P., Sinclair, A.G. and Edwards, S.A. 2000c. The interaction of liveweight and the degree of competition on drinking behaviour in pigs at different group sizes. *Applied Animal Behaviour Science.* **67 (**4**):** 321-334.

Von Borell, E.V., Langbein, J., Despres, G., Hansen, S., Leterrier, C., Forde, J.M., Forde, R.M., Mohr, E., Prunies, A., Valance, Dorothee and Veissier, I. 2007. Heart rate variability as a measure of autonomic regulation of cardiac activity for assessing stress and welfare in farm animals. *Physiology and Behaviour.* **92** (3): 293-316.

Walker, N. 1991. The effect on performance and behaviour of number of growing pigs per mono-place feeder. *Animal Feed Science and Technology.* **35** (1-2): 3-13.

Widowski, T.M., Torry, S., Bench, C.J. and Gonyou, H.W. 2008. Development of ingestive behaviour and the relationship to belly nosing in early weaned piglets. *Applied Animal Behaviour Science.* **110** (1-2): 109- 127.

Yang, T.S., Howard, E.B. and Macfarlane, V.W. 1981. Effects of food on drinking behaviour of growing pigs. *Applied Animal Ethology.* **7** (3): 259-270.

Zhang, Z., Zhang, H. and Liu, T. 2019. Study on body temperature detection of pig based on infrared technology: A review. *Artificial Intelligence in Agriculture.* **1**: 14-26.

Zhu, W.X., Guo, Y.Z., Jiao, P.P. and Ma, C.H. 2017. Recognition and drinking behaviour analysis of individual pigs based on machine vision. *Livestock Science.* **205**: 129-136.

Zupan, M., Framstad, T. and Zanella, A.J. 2016. Behaviour, heart rate and heart rate variability in pigs exposed to novelty. *Revista Brasileira de Zootecnia.* **45** (3): 121-129.

APPENDICES

APPENDIX - A

ANOVA 1: Physical characteristics of the three genotypes of pig

Physical parameters	SOV	df	SS	MSS	F value	Table F	Logic	CV%	SEM±	CD 5%
Face length	Rep	6	0.506667	0.084444	0.545082	2.99612	NS	1.874284	0.148767	0.5386
	Group	2	5.694286	2.847143	18.37807	3.885294	Significant			
	Error	12	1.859048	0.154921						
	Total	20	8.06							
Face breadth	Rep	6	1.032381	0.172063	0.969155	2.99612	NS	4.523745	0.159257	0.5765 8
	Group	2	1.682857	0.841429	4.739383	3.885294	Significant			
	Error	12	2.130476	0.17754						
	Total	20	4.845714							
Eye to eye distance	Rep	6	3.072381	0.512063	1.490758	2.99612	NS	6.380363	0.221518	0.8019 92
	Group	2	4.991429	2.495714	7.265712	3.885294	Significant			
	Error	12	4.121905	0.343492						
	Total	20	12.18571							
Circumference of snout	Rep	6	0.906667	0.151111	1.825503	2.99612	NS	1.832556	0.108745	0.3937 03
	Group	2	4.86	2.43	29.3557	3.885294	Significant			
	Error	12	0.993333	0.082778						
	Total	20	6.76							
Ear length	Rep	6	2.362857	0.39381	0.482497	2.99612	NS	9.191902	0.341465	1.2362 53
	Group	2	91.34571	45.67286	55.95858	3.885294	Significant			
	Error	12	9.794286	0.81619						
	Total	20	103.5029							

Circumference of ear	Rep	6	1.724762	0.28746	1.387208	2.99612	NS	3.277186	0.172056	0.622916
	Group	2	14.92667	7.463333	36.01609	3.885294	Significant			
	Error	12	2.486667	0.207222						
	Total	20	19.1381							

Body length	Rep	6	44.5781	7.429683	0.854462	2.99612	NS	3.987884	1.114525	4.035063
	Group	2	586.5714	293.2857	33.72977	3.885294	Significant			
	Error	12	104.3419	8.695159						
	Total	20	735.4914							
Heart girth	Rep	6	55.43143	9.238571	1.094926	2.99612	NS	4.231697	1.097895	3.974857
	Group	2	594.8086	297.4043	35.24742	3.885294	Significant			
	Error	12	101.2514	8.437619						
	Total	20	751.4914							
Abdominal girth	Rep	6	111.9714	18.6619	0.490894	2.99612	NS	7.842061	2.330426	8.437151
	Group	2	381.7724	190.8862	5.021181	3.885294	Significant			
	Error	12	456.1943	38.01619						
	Total	20	949.9381							
Abdominal pouch	Rep	6	96.86659	16.14443	1.516227	2.99612	NS	4.734934	1.233333	4.465198
	Group	2	1068.634	534.3169	50.18113	3.885294	Significant			
	Error	12	127.7732	10.64777						

	Total	20	1293.274							
Height at wither	Rep	6	18.85143	3.141905	1.863052	2.99612	NS	3.037213	0.490834	1.777033
	Group	2	116.8029	58.40143	34.63024	3.885294	Significant			
	Error	12	20.23714	1.686429						
	Total	20	155.8914							
Tail length	Rep	6	11.02286	1.837143	1.635439	2.99612	NS	5.65913	0.400595	1.450327
	Group	2	5.58	2.79	2.48368	3.885294	NS			
	Error	12	13.48	1.123333						
	Total	20	30.08286							
Circumference of tail	Rep	6	1.605714	0.267619	2.327122	2.99612	NS	4.901202	0.128174	0.464045
	Group	2	3.326667	1.663333	14.46377	3.885294	Significant			
	Error	12	1.38	0.115						
	Total	20	6.312381							

Length of hock to pastern of hind leg	Rep	6	4.43619	0.739365	2.15898	2.99612	NS	3.39669	0.221185	0.800786
	Group	2	34.59714	17.29857	50.51263	3.885294	Significant			
	Error	12	4.109524	0.34246						
	Total	20	43.14286							
Length of pastern to backbone of hind leg	Rep	6	29.10952	4.851587	1.531888	2.99612	NS	4.467143	0.672635	2.43523
	Group	2	630.7352	315.3676	99.5773	3.885294	Significant			
	Error	12	38.00476	3.167063						
	Total	20	697.8495							
Circumference of canon of hind leg	Rep	6	0.829524	0.138254	1.583636	2.99612	NS	2.717844	0.111677	0.404318
	Group	2	5.305714	2.652857	30.38727	3.885294	Significant			
	Error	12	1.047619	0.087302						
	Total	20	7.182857							
Length of pastern to shoulder blade of fore leg	Rep	6	13.9	2.316667	1.024211	2.99612	NS	4.212782	0.568445	2.058016
	Group	2	452.7971	226.3986	100.092	3.885294	Significant			
	Error	12	27.14286	2.261905						
	Total	20	493.84							
Length of knee to pastern of fore leg	Rep	6	7.132381	1.18873	1.695495	2.99612	NS	5.110084	0.316479	1.14579
	Group	2	72.96	36.48	52.0317	3.885294	Significant			
	Error	12	8.413333	0.701111						
	Total	20	88.50571							
Circumference of canon of fore leg	Rep	6	0.269524	0.044921	0.267359	2.99612	NS	3.130126	0.154927	0.560902

	Group	2	11.94381	5.971905	35.54369	3.885294	Significant			
	Error	12	2.01619	0.168016						
	Total	20	14.22952							

APPENDIX - B

ANOVA 2: Physiological Behaviours of the three genotypes of pig

Physiological parameters	SOV	df	SS	MSS	F value	Table F	Logic	CV%	SEM±	CD 5%
Pulse rate at 60 days	Rep	6	713.8095	118.9683	1.070256	2.99612	NS	9.421569	3.984949	14.427 24
	Group	2	12046.1	6023.048	54.18421	3.885294	Significant			
	Error	12	1333.905	111.1587						
	Total	20	14093.81							
Pulse rate at 90 days	Rep	6	172	28.66667	0.679075	2.99612	NS	6.91197	2.45573	8.8908 09
	Group	2	2409.429	1204.714	28.53807	3.885294	Significant			
	Error	12	506.5714	42.21429						
	Total	20	3088							
Pulse rate at 120 days	Rep	6	583.619	97.26984	1.237855	2.99612	NS	9.570926	3.350466	12.130 14
	Group	2	1408.381	704.1905	8.961519	3.885294	Significant			
	Error	12	942.9524	78.57937						
	Total	20	2934.952							
Pulse rate at 150 days	Rep	6	380.2857	63.38095	2.970982	2.99612	NS	5.173058	1.745743	6.3203 47
	Group	2	2774	1387	65.01563	3.885294	Significant			
	Error	12	256	21.33333						

	Total	20	3410.286							
Pulse rate at 180 days	Rep	6	314	52.33333	0.94864	2.99612	NS	8.912912	2.807303	10.16365
	Group	2	2372.667	1186.333	21.50453	3.885294	Significant			
	Error	12	662	55.16667						
	Total	20	3348.667							
Respiration rate at 60 days	Rep	6	324.8312	54.13853	3.240333	2.99612	Significant	12.24066	1.544932	5.593323
	Group	2	260.1108	130.0554	7.784159	3.885294	Significant			
	Error	12	200.4924	16.7077						
	Total	20	785.4344							
Respiration rate at 90 days	Rep	6	114.1748	19.02913	0.730746	2.99612	NS	114.1748	727.5616	312.4885
	Group	2	727.5616	363.7808	13.9697	3.885294	Significant			
	Error	12	312.4885	26.04071						
	Total	20	1154.225							

Respiration rate at 120 days	Rep	6	210.2403	35.04005	0.835743	2.99612	NS	22.31838	2.447355	8.860486
	Group	2	650.7802	325.3901	7.760904	3.885294	Significant			
	Error	12	503.1219	41.92683						
	Total	20	1364.142							
Respiration rate at 150 days	Rep	6	104.9065	17.48441	1.274078	2.99612	NS	13.08322	1.400162	5.069195
	Group	2	136.9369	68.46843	4.989253	3.885294	Significant			

	Error	12	164.6782	13.72318						
	Total	20	406.5215							
Respiration rate at 180 days	Rep	6	83.4725	13.91208	1.508966	2.99612	NS	9.903553	1.147645	4.1549 71
	Group	2	51.51521	25.7576	2.793783	3.885294	NS			
	Error	12	110.6354	9.219616						
	Total	20	245.6231							
Rectal temperature at 60 days	Rep	6	4.399048	0.733175	1.238006	2.99612	NS	2.00158	0.290866	1.0530 62
	Group	2	0.326667	0.163333	0.275797	3.885294	NS			
	Error	12	7.106667	0.592222						
	Total	20	11.83238							
Rectal temperature at 90 days	Rep	6	2.39619	0.399365	0.671381	2.99612	NS	1.984616	0.291509	1.0553 88
	Group	2	7.955238	3.977619	6.686858	3.885294	Significant			
	Error	12	7.138095	0.594841						
	Total	20	17.48952							
Rectal temperature	Rep	6	1.845714	0.307619	3.238095	2.99612	Significant	0.789249	0.116496	0.4217 68

at 120 days	Group	2	0.926667	0.463333	4.877193	3.885294	Significant			
	Error	12	1.14	0.095						
	Total	20	3.912381							
Rectal temperature at 150 DOA	Rep	6	0.504762	0.084127	0.882598	2.99612	NS	0.789797	0.116691	0.4224 72
	Group	2	0.149524	0.074762	0.784346	3.885294	NS			
	Error	12	1.14381	0.095317						
	Total	20	1.798095							
Rectal temperature at 180 days	Rep	6	0.515733	0.085956	2.527869	2.99612	NS	0.473791	0.069696	0.2523 31
	Group	2	0.052229	0.026114	0.767996	3.885294	NS			
	Error	12	0.408038	0.034003						
	Total	20	0.976							

APPENDIX - C

ANOVA 3: Ethological Behaviours of the three genotypes of pig

Ethological Behaviours	SOV	df	SS	MSS	F value	Table F	Logic	CV%	SEM±	CD 5%
Tine spent in feeding at 60 days	Rep	6	78.66472	13.11079	1.111562	2.99612	NS	3.07176	1.298071	4.69958
	Group	2	19117.86	9558.932	810.4278	3.885294	Significant			
	Error	12	141.539	11.79492						
	Total	20	19338.07							
Tine spent in feeding at 90 days	Rep	6	24.15976	4.026627	0.502435	2.99612	NS	2.30463	1.069995	3.873847
	Group	2	4835.583	2417.791	301.6873	3.885294	Significant			
	Error	12	96.17075	8.014229						
	Total	20	4955.913							
Tine spent in feeding at 120 days	Rep	6	12.60031	2.100052	0.649842	2.99612	NS	1.468757	0.679457	2.45993
	Group	2	18530.74	9265.368	2867.083	3.885294	Significant			
	Error	12	38.77963	3.231636						
	Total	20	18582.12							
Tine spent in feeding at 150 days	Rep	6	62.10026	10.35004	0.636909	2.99612	NS	3.625443	1.523643	5.516249
	Group	2	9819.632	4909.816	302.1347	3.885294	Significant			
	Error	12	195.0051	16.25042						
	Total	20	10076.74							
Tine spent in feeding at 180 days	Rep	6	10.77643	1.796071	0.567468	2.99612	NS	1.333135	0.672422	2.43446
	Group	2	28194.76	14097.38	4454.061	3.885294	Significant			
	Error	12	37.98074	3.165062						

	Total	20	28243.52							
Time spent in drinking water at 60 days	Rep	6	596.2686	99.37811	0.72802	2.99612	NS	4.699682	4.415956	15.98767
	Group	2	5326.95	2663.475	19.51197	3.885294	Significant			
	Error	12	1638.056	136.5047						
	Total	20	7561.275							
Time spent in drinking water at 90 days	Rep	6	826.6906	137.7818	1.054434	2.99612	NS	4.233529	4.320532	15.6422
	Group	2	4253.674	2126.837	16.27653	3.885294	Significant			
	Error	12	1568.028	130.669						
	Total	20	6648.392							
Time spent in drinking water at 120 days	Rep	6	330.5634	55.09391	0.217946	2.99612	NS	6.655597	6.009359	21.75648
	Group	2	86390.54	43195.27	170.8763	3.885294	Significant			
	Error	12	3033.442	252.7868						
	Total	20	89754.54							
Time spent in drinking water at 150 days	Rep	6	736.4093	122.7349	1.805834	2.99612	NS	3.520126	3.11599	11.28123
	Group	2	33033.84	16516.92	243.0183	3.885294	Significant			
	Error	12	815.5891	67.96576						
	Total	20	34585.84							
Time spent in drinking water at 180 days	Rep	6	109.9815	18.33024	0.317859	2.99612	NS	3.02668	2.870239	10.39151
	Group	2	8220.66	4110.33	71.27586	3.885294	Significant			
	Error	12	692.0149	57.66791						
	Total	20	9022.656							
Time spent in lying down at 60 days	Rep	6	8.795381	1.465897	0.571382	2.99612	NS	0.867804	0.605396	2.191795
	Group	2	10340.65	5170.323	2015.306	3.885294	Significant			
	Error	12	30.78633	2.565528						

	Total	20	10380.23							
Time spent in lying down at 90 days	Rep	6	23.88145	3.980241	2.296885	2.99612	NS	0.661972	0.497549	1.801344
	Group	2	15809.78	7904.892	4561.691	3.885294	Significant			
	Error	12	20.79464	1.732887						
	Total	20	15854.46							
Time spent in lying down at 120 days	Rep	6	14.03546	2.339243	1.550074	2.99612	NS	0.714615	0.464315	1.68102
	Group	2	41822.44	20911.22	13856.59	3.885294	Significant			
	Error	12	18.1094	1.509117						
	Total	20	41854.58							
Time spent in lying down at 150 days	Rep	6	3.735162	0.622527	0.248989	2.99612	NS	0.987086	0.597641	2.163719
	Group	2	80740.52	40370.26	16146.67	3.885294	Significant			
	Error	12	30.00267	2.500222						
	Total	20	80774.25							
Time spent in lying down at 180 days	Rep	6	3.531114	0.588519	0.189746	2.99612	NS	0.987855	0.665648	2.409935
	Group	2	155354.1	77677.07	25044.1	3.885294	Significant			
	Error	12	37.21934	3.101612						
	Total	20	155394.9							
Frequency of feeding at 60 days	Rep	6	42.27756	7.04626	1.194938	2.99612	NS	7.735864	0.91782	3.322908
	Group	2	1258.404	629.2019	106.703	3.885294	Significant			
	Error	12	70.76112	5.89676						
	Total	20	1371.442							
Frequency of feeding at 90 days	Rep	6	31.6805	5.280083	4.152713	2.99612	Significant	2.981186	0.426192	1.543
	Group	2	1174.327	587.1633	461.796	3.885294	Significant			
	Error	12	15.25773	1.271478						

	Total	20	1221.265							
Frequency of feeding at 120 days	Rep	6	66.20298	11.03383	0.520656	2.99612	NS	9.653822	1.739957	6.2993 99
	Group	2	5746.663	2873.331	135.5847	3.885294	Significant			
	Error	12	254.3059	21.19216						
	Total	20	6067.172							
Frequency of feeding at 150 days	Rep	6	25.89318	4.31553	0.668129	2.99612	NS	4.673926	0.960589	3.4777 5
	Group	2	9933.083	4966.542	768.9189	3.885294	Significant			
	Error	12	77.50948	6.459123						
	Total	20	10036.49							

Frequency of feeding at 180 days	Rep	6	55.21359	9.202265	0.630528	2.99612	NS	7.539812	1.44393	5.2276 51
	Group	2	4446.147	2223.073	152.3224	3.885294	Significant			
	Error	12	175.1344	14.59453						
	Total	20	4676.495							
Frequency of drinking at 60 days	Rep	6	16.28811	2.714686	1.647911	2.99612	NS	5.285275	0.485114	1.7563 23
	Group	2	530.4258	265.2129	160.9937	3.885294	Significant			
	Error	12	19.7682	1.64735						
	Total	20	566.4821							
Frequency of drinking at 90 days	Rep	6	4.490581	0.74843	0.153474	2.99612	NS	7.967675	0.834658	3.0218 24
	Group	2	458.3344	229.1672	46.99342	3.885294	Significant			
	Error	12	58.51896	4.87658						
	Total	20	521.3439							

Frequency of drinking at 120 days	Rep	6	23.60673	3.934456	1.067991	2.99612	NS	6.125647	0.725453	2.626456
	Group	2	2492.952	1246.476	338.3505	3.885294	Significant			
	Error	12	44.20775	3.683979						
	Total	20	2560.767							
Frequency of drinking at 150 days	Rep	6	13.3045	2.217416	0.829879	2.99612	NS	4.083773	0.617827	2.236803
	Group	2	3934.405	1967.203	736.2353	3.885294	Significant			
	Error	12	32.0637	2.671975						
	Total	20	3979.773							
Frequency of drinking at 180 days	Rep	6	17.6767	2.946116	1.676452	2.99612	NS	3.298422	0.501049	1.814015
	Group	2	3566.952	1783.476	1014.866	3.885294	Significant			
	Error	12	21.08822	1.757352						
	Total	20	3605.717							
Frequency of lying down at 60 days	Rep	6	11.384	1.897333	1.224067	2.99612	NS	3.985699	0.470566	1.703651
	Group	2	2207.858	1103.929	712.2014	3.885294	Significant			
	Error	12	18.60029	1.550024						
	Total	20	2237.842							

Frequency of lying down at 90 days	Rep	6	10.45572	1.742621	0.569836	2.99612	NS	6.616873	0.660963	2.392974
	Group	2	700.5714	350.2857	114.5433	3.885294	Significant			
	Error	12	36.6973	3.058109						
	Total	20	747.7245							

Frequency of lying down at 120 days	Rep	6	5.245048	0.874175	1.012007	2.99612	NS	3.341885	0.351284	1.2718
	Group	2	823.4039	411.7019	476.6155	3.885294	Significant			
	Error	12	10.36564	0.863803						
	Total	20	839.0146							
Frequency of lying down at 150 days	Rep	6	6.714867	1.119144	0.819962	2.99612	NS	4.433692	0.441568	1.5986 66
	Group	2	482.0879	241.0439	176.6054	3.885294	Significant			
	Error	12	16.37848	1.364873						
	Total	20	505.1812							
Frequency of lying down at 180 days	Rep	6	24.61132	4.101887	1.882139	2.99612	NS	6.951051	0.557978	2.0201 22
	Group	2	39.2381	19.61905	9.002142	3.885294	Significant			
	Error	12	26.1525	2.179375						
	Total	20	90.00192							

APPENDIX - D

ANOVA 4: Blood Constituents of the three genotypes of pig

Blood Parameters	**SOV**	**df**	**SS**	**MSS**	**F value**	**Table F**	**Logic**	**CV%**	**SEM±**	**CD 5%**
WBC (10^3/dl)	Rep	6	73.61143	12.26857	2.441854	2.99612	NS	14.47013	0.847204	3.0672 47
	Group	2	0.715238	0.357619	0.071178	3.885294	NS			
	Error	12	60.29143	5.024286						
	Total	20	134.6181							
Hemoglobin	Rep	6	0.43619	0.072698	0.190913	2.99612	NS	5.693665	0.233236	0.8444

(g/dl)										16
	Group	2	2.38381	1.191905	3.130054	3.885294	NS			
	Error	12	4.569524	0.380794						
	Total	20	7.389524							
RBC ($10^6/\mu l$)	Rep	6	1.148857	0.191476	2.188299	2.99612	NS	4.523985	0.111803	0.4047 77
	Group	2	0.2294	0.1147	1.310857	3.885294	NS			
	Error	12	1.05	0.0875						
	Total	20	2.428257							
PCV (%)	Rep	6	8.260257	1.37671	0.948523	2.99612	NS	3.894008	0.455353	1.6485 75
	Group	2	9.495114	4.747557	3.270965	3.885294	NS			
	Error	12	17.41709	1.451424						
	Total	20	35.17246							
Glucose (mg/dl)	Rep	6	87.93456	14.65576	0.191168	2.99612	NS	12.75171	3.309384	11.981 4
	Group	2	449.1203	224.5601	2.929141	3.885294	NS			
	Error	12	919.9699	76.66416						
	Total	20	1457.025							
Total cholesterol (mg/dl)	Rep	6	55.96858	9.328097	0.272044	2.99612	NS	5.646434	2.213237	8.0128 77
	Group	2	59.9222	29.9611	0.873784	3.885294	NS			
	Error	12	411.4671	34.28893						
	Total	20	527.3579							
	Total	20								

APPENDIX - E

ANOVA 5: Growth performance (kg/pig) of the three genotypes of pig

Growth performance	SOV	df	SS	MSS	F value	Table F	Logic	CV%	SEM±	CD 5%
Body weight at 60 days	Rep	6	11.05228	1.842047	1.558025	2.99612	NS	15.55144	0.410974	1.487903
	Group	2	73.51226	36.75613	31.08876	3.885294	Significant			
	Error	12	14.18756	1.182296						
	Total	20	98.7521							
Body weight at 90 days	Rep	6	2.300437	0.383406	0.605938	2.99612	NS	7.878164	0.300654	1.088496
	Group	2	146.0585	73.02923	115.416	3.885294	Significant			
	Error	12	7.592973	0.632748						
	Total	20	155.9519							
Body weight at 120 days	Rep	6	2.182861	0.36381	1.114034	2.99612	NS	3.849941	0.215993	0.781987
	Group	2	200.854	100.427	307.5204	3.885294	Significant			
	Error	12	3.918842	0.32657						
	Total	20	206.9557							
Body weight at 150 days	Rep	6	3.47254	0.578757	1.236783	2.99612	NS	3.575863	0.258555	0.936079
	Group	2	338.9111	169.4556	362.1208	3.885294	Significant			

	Error	12	5.615438	0.467953						
	Total	20	347.9991							
Body weight at 180 days	Rep	6	13.5412	2.256867	0.715679	2.99612	NS	7.127909	0.671189	2.4299 96
	Group	2	828.9743	414.4871	131.4387	3.885294	Significant			
	Error	12	37.84157	3.153464						
	Total	20	880.3571							