STUDIES ON SOME ASPECTS OF ADULT BEHAVIOUR OF FOWL ON DEEP LITTER

A Thesis
Submitted to the
West Bengal University of Animal and Fishery Sciences
In partial fulfillment of the requirements for the degree of

MASTER OF VETERINARY SCIENCE
In
LIVESTOCK PRODUCTION MANAGEMENT

By

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2011

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Certificate

This is to certify that the work embodied in this thesis entitled ***"Studies on some aspects of adult behaviour of fowl on deep litter"*** *submitted by* ***Ayushman Modhukoilya*** *for the award of* ***Master of Veterinary Science*** *in Livestock Production Management of West Bengal University of Animal and Fishery Sciences, is the original work carried out by the candidate himself under my personal supervision and guidance. The results of the investigation reported in the thesis have not so far been submitted for any other Degree or Diploma. The assistance and help received during the course of investigation have been duly acknowledged.*

Dated: 07.12.2011
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APPROVAL OF EXAMINERS FOR THE AWARD OF THE DEGREE OF MASTER OF VETERINARY SCIENCE

Certified that thesis entitled "Studies on some aspects of adult behaviour of fowl on deep litter" submitted by Ayushman Modhukoilya in partial fulfillment for the Master of Veterinary Science in Livestock Production Management of West Bengal university of Animal and Fishery Sciences, Kolkata embodies the original work done by the candidate. The candidate has carried out his work sincerely and methodically.

We have carefully gone through the contents of the thesis and are fully satisfied with the work, which is being presented by him. It is therefore approved on 15.3.2012 for the award of the degree of Master of Veterinary Science of this Institute.

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ACKNOWLEDGEMENT

The author bows his head with great reverence to the Almighty who is omnipresent, omnipotent and omniscient.

At the outset, I take the privilege in expressing my deep sense of gratitude and indebtedness to my Major advisor Prof. Subhransu Pan, BVSc&AH(Hons.) MSc.(Dairying), Ph. D. FEFN(WWF), Graduate ITC(Jersey), FNAPM, Professor, Head, Deptt. of Livestock Production Management, F/O Veterinary and Animal Sciences, West Bengal University of Animal and Fishery Sciences, Kolkata – 37for his invaluable and critical suggestions, scholarly guidance, active persuasion and supervision, which served as a constant source of inspiration throughout the course of my study and research work.

The author is extremely obliged to the members of his advisory committee, Prof. A. K. Samanta, Prof. R. Samanta, both from Deptt. of Livestock Production Management, Prof. S. K. Misra, Deptt. of Animal Genetics and Breeding, Faculty of Veterinary and Animal Sciences, W. B. U. A. F. S., Kol. – 37 for their kind cooperation.

Sincere gratitude is extended to Mr. R. Dasgupta, Deptt. of Animal Genetics and Breeding, for his valuable suggestions during this present endeavour.

The author also conveys his deepest sense of gratitude to the Hon'ble Vice-Chancellor, Prof. C. S. Chakraborty and Dean, Prof. D. K. De, Faculty of Veterinary and Animal Sciences, West Bengal University of Animal and Fishery Sciences, Kol – 37.

I take this opportunity to acknowledge the encouragement and motivation imparted by my colleagues Dr. A. Gabur, my department senior Dr. M. Islam and seniors Dr. A. Maiti.

A very special mention needs to be made of the logistical help rendered, encouragement given and sacrifices made by Dr. Gautam Bordoloi, PhD scholar, Deptt. of Vety. Parasitology, WBUAFS, Kolkata- 37. It is with great thanks that I acknowledged the same.

A simple word of acknowledgement is not enough for Dr. Utpal T., Dr. Karuna D., Dr. T. B, Dr. Debabrat H., Dr. Bana T., Dr. Suraj G., Dr. Ruman B., Dr. Utpal S., Dr. Anupam B., Dr. Gaurav K., Dr. Aminur R. and Mr. Rakesh K. for their sincere help and friendly assistance during the research work.

The author is indebted forever and conveys full respect to his reverend parents for their most affectionate encouragement, selfless devotion, endurance, financial support and blessings throughout his career.

Appreciation also goes to all staff-members of the department of Livestock Production and Management, West Bengal University of Animal and Fishery Science, staff members of the respective farms, Mohanpur campus, Librarian and the staff members of the Central Library, West Bengal University of Animal and Fishery Sciences, Kol-37 for their all kinds of assistance.

It will be serious injustice in his part if the author will not acknowledge and express his deepest sense of gratitude to the innumerable number of farmers of his country, whose dreams for a better economic future led the author to take up this project and he will be proud if this work gives a little, whatever minute it may be uplift to destitute mass of this country.

Ayushman Modhukoilya

Dated: [illegible] 12 11 (Ayushman Modhukoilya)

Belgachia

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ABBREVIATIONS

°C	:	Degree Celsius
/	:	Oblique, or
@	:	At the rate
<	:	Less than
%	:	Percentage
a.m.	:	Ante Meridian, Before Noon
cm	:	Centimetre
et al.	:	*et alli;* and others
etc.	:	et cetera and so forth
Fig.	:	Figure
g./gm	:	gram
GDP	:	Gross Domestic Product
GNP	:	Gross National Product
i.e.,	:	That is
INR	:	Indian National Rupees
kg	:	Kilogram
m	:	Meter
ME	:	Metabolic Energy
MJ	:	Mega Joule
min	:	Minute
mm	:	Millimetre
No./Nos.	:	Number / Numbers
p.m.	:	Post Meridian, Afternoon
Rs.	:	Rupees
Sq.ft.	:	Square feet
USD	:	United State Dollar
Viz.	:	Videlicet, namely

Chapter- 01

Introduction

Livestock and poultry sector plays a significant role in India's economy. Out of the total country's economy of 480 billion USD, agriculture sector's contribution is 120 billion USD of which the contribution of livestock sector is 41 billion USD i.e. around 34 percent of the agrarian economy and 8.5 percent of the total economy. Poultry sector with its contribution of 7 percent to the overall livestock economy employs 3.5 million people. Poultry sector also produces 1.4 million ton broiler valued at 1.6 billion USD and 41 billion eggs valued at 1.2 billion USD (Bujarbaruah and Gupta, 2005).

Among different activities in the livestock sector, poultry farming is the fastest growing sector which was once started as a novelty in the 1970's - egg and broiler production - has now turned out to be a highly organized agribusiness. While the production of agricultural crops has been rising at a rate of 1.5 to 2 percent per annum that of eggs and broilers has been rising at a rate of 8 to 10 percent per annum. As a result, India is now the world's 3rd largest egg producer (506,630 billion / annum) and the 5th largest producer of chicken (Anon., 2009). This expansion has resulted due to combination of certain factors viz., growth in per capita income, a growing urban population and falling real poultry prices. The pattern of growth has resulted in a highly competitive market.

The poultry sector in India has undergone a paradigm shift in structure and operation. A significant feature of India's poultry industry has been its transformation from a mere backyard activity into a major commercial activity in just about four decades. This transformation has involved sizeable investments in breeding, hatching, rearing and processing. The growth of the poultry sector in India is also marked by an increase in the size and number of the poultry farm. In India, there are more than 500 commercial hatcheries and breeding farms, about 100 commercial feed mills, veterinary pharmaceuticals and equipment manufacturers. Those have made poultry farming a dynamic agri-business, duly supported by research and development (Anon., 2008).

Behaviour is the way in which an animal establishes and maintains itself in its ecological niche and also is a key link between an animal and its environment.

Behaviour has become a distinct subject in its own right in the last 60 years. The formal study of behaviour acquired a new life in the 1950s. Ethology aimed to describe and explain behaviour in terms of its function, mechanism, ontogeny and evolution (Tinbergen, 1963). Behavioural ecology has been a lively development of ethology. A cost–benefit approach to foraging was an early frontier. Bird Study contained an early note on cloaca pecking (Harrison & Binfield, 1967). John Hurrell Crook (1980) studied the behaviour of weaverbirds and demonstrated the links between ecological conditions, behaviour and social systems (Konishi *et al.,* 1989, Crook, 1964, Crook, 1980). Principles from economics were introduced to the study of biology by Jerram L. Brown (1964). This led to the study of behaviour using cost-benefit analyses (Brown, 1964). The rising interest in socio-biology also led to a spurt of bird studies in this area (Konishi *et al.,* 1989, John, 1981).

Among domestic animals, chickens are unique as to the conditions under which they are maintained, and this is reflected in the type of behaviour which has received the most attention. An understanding of behaviour is important in any consideration of poultry welfare. Successful housing and management to improve production efficiency and welfare of chickens requires knowledge of animal behaviour (Siegel, 1993).

Knowledge of the behaviour of the stock and the application of that knowledge in the care of the stock plays an important role in the maximization of production efficiency of a poultry production enterprise. In addition, the management of the domestic fowl has received considerable attention over recent years from the community, particularly animal liberation groups, because of the way that commercial poultry management systems have intensified. As a consequence, the study of poultry behaviour is important to the unit manager, not only to ensure that the welfare of the birds and production efficiency are maintained but also to minimize the influence of what is often uninformed debate. Behaviour is the way that fowls respond to the different stimuli they encounter in their environment. The stimuli may be from other birds, their environment, people or any other thing or occurrence (Poultryhub.org, 2000).

There are two reasons why an understanding of behaviour is important in any consideration of poultry welfare. The first is that an animal's behaviour may be the best indicator we have of its welfare. There is an emerging view that welfare is to do with how an animal feels (Dawkins, 1990, Duncan and Petherick, 1991, Duncan, 1993). The second reason why behaviour is important for welfare is that the performance of some behaviour may be important in its own right. The idea of "behavioural needs" crept into the scientific literature (and even into some codes and legislation) without any scientific evidence (Duncan, 1998).

Knowledge of feeding behaviour has its own importance in respect to poultry welfare and production efficiency. Feeding behaviour refers as any action of an animal or bird that is directed toward the procurement of nutrients. Because much of animal evolution involves adaptation for the procurement of food, the extent of the meaning of the term feeding behaviour is not clear (Encyclopaedia Britannica, 2011). The way of having food, water and execution of foraging activity refers as feeding behaviour in fowl. Fowls exhibits feeding behaviour from its very early age of life. After hatching, chickens inherently know how to peck and they can pick up objects i.e. eat. However, they do not know how to discriminate between what they should or should not eat. It is largely by trial and error that they find out the difference. Therefore, the first feeding experience should provide easy access to food and deny access to material other than food. Similarly, chickens initially approach the water because they are attracted to some physical aspect e.g. a bubble or dust on the surface. Once they have learned where to find their water the drinkers should be adjusted for depth and height to ensure that spillage is kept to a minimum (Poultryhub.org, 2000). Laying hens have complex interrelationships involving feeding behaviour, social rank and egg production (Mench and Keeling, 2001). Chickens show socially facilitated feeding, in particular, they peck more at feed when they have company than when alone (Keeling and Hurnick, 1996). Thus the knowledge of feeding behaviour i.e. how they eat, when and what they preferred to eat helps one to manage the arrangements of farm in such a way that there will be a minimum of spoilage of food but ensures that it does not affect the growth, more precisely the production.

Social behaviour provides an organizational framework for relationships among members of a group. These relationships may take several forms including those between sexes, among and within age groups, and within sexes. Stable social relationships have important biological advantages including reducing energy expenditures and influencing gene flow across generations (Siegel, 2000). Knowledge of social behaviour of fowl plays an important role in poultry production enterprise. Fowls are a gregarious species with an elaborate social behaviour based on a definite group structure when kept in flocks. They maintain personal space by communication by postural changes. Important signals are associated with the position of the head and the relative angles of the head and the body to other birds. They maintain contact with flock mates by sight up to intermediate distances and by vocal communication at longer distances or if out of sight. There are a number of factors that influence social behaviour. These include: individual recognition, communication and pecking and the peck order (Poultryhub.org. 2000). The social order in broiler flocks is relatively unimportant as they are generally processed at an age when the establishment of social stratification is just beginning (Siegel, 1984). Whereas, laying hens have complex interrelationships involving social rank, aggression, feeding behaviour and egg production (Mench and Keeling, 2001). In large groups kept together for some months, subgroups form and become restricted to an area. This means that birds can recognise their own group members and those of an overlapping territory. It was suggested that this territorial behaviour is important in large flocks as it reduces the numbers of conflicts when strangers meet (McBride and Foenander, 1962). Laying hens choose to feed close to each other when given a choice of feeding locations, which demonstrates the importance of social attraction (Meunier-Salaun and Faure, 1984). The ability of flock mates to recognise and remember one another becomes very difficult under commercial poultry husbandry conditions where group sizes are very large (Mauldin, 1992). Mortality, production and behavioural problems are all worse in large groups of hens, which imply the formation of unstable social groups (Mench and Keeling, 2001), so this is particularly a problem in barn/aviary egg-production systems. Thus knowledge of social behaviour of flock is important for selection of species considering how an individual adjusts to its environment. One of the main considerations in poultry production is whether or not the husbandry practices are within the socially adaptive ability of the individual and the flock.

Studies on agonistic interactions also have an important consideration from management point of view. Agonistic pecking begins to occur within a few weeks after hatching, stable dominance and subordinate relationships usually do not become established until 6–8 weeks of age in cockerels and 8–10 weeks in pullets (Guhl, 1958). Most aggression is seen at the feed trough, where there is some competition among the chickens (Mench and Keeling, 2001). Aggression in cages is relatively low, as the small group size in the cages allows the hens to establish a stable dominance hierarchy (Mench and Keeling, 2001). Once a social group becomes organised, the incidence of agonistic interactions decreases (Mauldin, 1992). The knowledge on agonistic interaction of fowl is necessary from production point of view to identify the differences between the normal and aggressive behaviour, because earlier studies revealed that, if one bird starts aggression towards other birds in early life, then that bird continue to behave aggressively throughout the life of the flock (Mench and Keeling, 2001), causing problems of low fertility and high mortality.

Fowls communicate also with others by displays and changes in posture such as head up or head down, tail up or tail down, or feathers spread or not spread. Displays play an important part in mating behaviour (Poultryhub.org. 2000). A series of displays occurs before mating, based on a stimulus-response sequence (Fischer, 1975) initiated by the male. Male courtship displays are generally elaborate, involving vocalisations and noises, postures, spreading of the feathers to increase apparent size and emphasise plumage characteristics (Kovach, 1975). Pseudo-mating occurs most frequently between high ranking males and low-ranking males, who are pursued and trodden (Guhl, 1949) and indicates that dominance relationships are important. The same situation may occur in flocks of hens. Sexual behaviour and dominance relationships are important in the management of mating. Because the female must crouch to elicit courting behaviour in the male and this is also a submissive behaviour, high-status females are often difficult to mate. Although it is never done commercially, research suggests that to overcome this, chickens may be sub-flocked and this reduces the number of individuals each may dominate or be submissive (Guhl, 1950).

Behavioural ecology undoubtedly has a future role in illuminating population dynamics and ecology. These larger processes are built upon individuals making choices about foraging, dispersing, mating and life history. An evolutionary approach can consider how these individual choices maximize fitness. A group of behaviour patterns with a common general function comprises a behavioural system. The organization of behavioural systems differs from species to species, breeds to breeds, being well or poorly developed. The performance of certain behaviour seems to lead to an increase in health or physical condition that greatly increases the likelihood of improved welfare later in life. For successfully running a laying farm, one must understand the factors producing different behaviour that may be normal or whether it arises from aberrations in aggressive behaviour.

Keeping in view of the importance of different systems of behaviour in management of fowl the present groups of behavioural study were conducted on two genetic groups of poultry reared in deep litter housing management in two different farms located in Mohanpur campus, viz., Haringhata farm, Govt. of West Bengal and Poultry Seed Project (ICAR) farm, West Bengal University of Animal and Fishery Science. The first one keeps the Rhode Island Red, which is a dual purpose medium heavy fowl, used more for egg production than meat production because of its dark coloured pin feathers and its good rate of lay. The second one was the Vanaraja, which is multicoloured dual purpose bird with attractive plumage, can be reared either for meat or egg production. The behavioural elements were observed for both male and female birds separately.

The behavioural patterns of bird, that were studied, grouped into four major categories of behaviour. First one was the Ingestive behaviour. The second category was Social and Resting behaviour. During non feeding time, the birds used to show some behavioural patterns which are very normal to them. The third category of behaviour was agonistic behaviour, also was observed during non feeding period. Lastly, the sexual behavioural elements were studied separately for male and female birds under the category of sexual behaviour. Sexual behaviour in chickens is usually referred to as mating behaviour. A number of behaviour patterns are associated with sexual behaviour in chickens (Fisher and Hale, 1957, Williams and McGibbon, 1955 and 1957).

Specific objectives of the present study are as under:

1. To study the systems of ingestive, social, resting, agonistic and sexual behaviour of Rhode Island Red and Vanaraja fowl parent stock managed under deep litter system.

2. To compare the above systems of behaviour between the two genetic groups of fowl and

3. To suggest modification in management practices for two genetic groups of fowl under deep litter system of keeping in view of the present findings.

Chapter- 02

Review of Literature

Present study was conducted to study different systems of behaviour exhibited by fowl during feeding and non-feeding time and also sexual behaviours, reared under deep litter system. Experimental birds belong to two genetic groups, viz., Rhode Island Red and Vanaraja. Reviews or works relevant to present study are summarised under different subheadings.

2.1 Experimental birds

Many species and breeds of fowl were used by different workers for behavioural study. The species, breeds and strains of birds extensively used by different workers were Turkeys (Sherwin *et al.,* 1999), Japanese quail (Adkins and Adler, 1972, Castagna *et al.,* 1997), Duck (Steven, 1955), Pigeons (Carpenter, 1933, Collias, 1950), Red Jungle Fowl (Collias and Collias, 1967, Dawkins, 1989), Feral Fowl (McBridge *et al.,* 1969, Savory *et al.,* 1978), Broiler Chickens viz., Ross broiler (Andrews *et al.*, 1997, Millman *et al.,* 2000, Shields *et al.*, 2005), Anak-200 broiler strain chicken (Olukosi *et al.*, 2002) etc., Layer Chickens viz., White leghorn (Choudary and Craig, 1972, O'Keefe *et al.*, 1988), Rhode Island Red (Choudary and Craig, 1972), Lohmann Silver layers (Ramadan and Von Borell, 2008) etc., Commercial Laying strain viz., L=ISA brown (Millman *et al.*, 2000), local breeds of chickens in Taiwan and China viz., Taiwan Country chicken (Chiang, 1994, Lee & Chen, 2007), Beijing Fatty chicken, pure Silkies and upgraded commercial Silkies (Lee & Chen, 2007) and many more.

2.1.1 Rhode Island Red (RIR)

An American breed, the Rhode Island Red is one of the most recognized breeds. Their origin comes from crossing Shanghais, Malay and Red Javas with local birds at Narragansett Bay, Rhode Island State, as far back as the 1830s, the foreign birds coming in on trading ships. They did not get a standard until 1904, eggs having arrived in the UK the previous year. Selections were made for good laying and the Rhode Island is a prolific layer and used in the making of many commercial hybrids. Though a 'heavy' breed, Rhode Islands (Rhodies) are active, hardy and friendly. They have a broad, deep and long body with a flat back and medium sized tail. The wings are a good size but they are reluctant and not very good fliers. The head is average in shape, size and beak with a single comb, straight and upright. There are rose combed versions, but rarely seen. The comb, wattles, face and ear lobes are all bright red. Legs are yellow and in breeding cockerels there is a red on the shanks. Rhodies are primarily laying birds and may produce up to 260 tinted eggs a year. The hens do go broody but not excessively like more heavily feathered types. There are two varieties though the white is rarely seen i.e. red and bantam form. The red birds are a dark red-brown. The cockerels have black neck hackles and tail feathers; the hens have less black in the neck and tail. Legs are yellow. This is another of the breeds developed to satisfy the demands for eggs and meat for the rapidly increasing population of the USA in the late 19th century. Around the end of the 19th century, a group of R.I.R breeders formed a club and by 1901 a standard of perfection was devised and in 1904 the Rhode Island Red was accepted by the American Standards organization originally in the rose comb variety to be followed by the single comb later (www.poultrymad.co.uk). In 1909 it was exported to Britain, and included in the British Poultry Standards in 1920 (Skinner, 1978). The standard weight of these birds is: cock 3.8 kg, hen 2.9 kg, cockerel 3.4 kg and pullet 2.5 kg (Sastry and Thomas, 2005). Rhode Island Reds are a good choice for the small flock owner. Relatively hardy, they are probably the best egg layers of the dual purpose breeds. Reds handle marginal diets and poor housing conditions better than other breeds and still continue to produce eggs. The Rose Comb variety tends to be smaller but should be the same size as the Single Combed variety. The red colour fades after long exposure to the sun. (Skinner, 1978)

2.1.2 Vanaraja

Vanaraja is a multi-coloured dual-purpose chicken variety developed at Project Directorate on Poultry, Hyderabad, for free range and rural backyard rearing. The plumage colour and disease resistance of Vanaraja is similar to native chicken. Vanaraja grows fast and produces more eggs than native chicken. According to Rao *et al.* (2005) having realized the importance of backyard farming, a long-term program has been initiated at Project Directorate (PD) on Poultry to develop a suitable germplasm for backyard / free range farming. Project Directorate on Poultry (Indian Council of Agricultural Research), Hyderabad has developed a multicolored germplasm (Vanaraja), which can thrive well in village conditions. The genetic stocks used for this purpose were specially developed at PD on Poultry. It was developed by selective crossing of Cornish male and synthetic female. It is a multi colored, medium weight, and dual-purpose bird. The male parents have been developed for the traits like high juvenile body weight, better-feed efficiency, better fertility and hatchability, high immune competence and good shank length. The female parents have been developed for good production, appealing plumage color, high immune competence and better-feed efficiency. Natural color combination in this bird is more attractive than the Desi hen. It can thrive well and perform better even in adverse environmental conditions. It is sturdy and resistant to most of the common poultry diseases because of its high immune competence. It has better feed efficiency even with diets containing low energy and protein which are based on common feed ingredients available in rural tribal areas. It can perform better in backyard conditions by eating green grass and insects available through foraging. It starts producing eggs between 195 to 205 days of age and produces about 150 to 160 eggs in a year. Vanaraja eggs are heavier (55 to 63 g) and their color is more attractive than the eggs of Desi hen. An adult hen weighs about 3 to 4 kg, and cock weighs about 3.5 to 4.5 kg at 6 months of age. Due to its respectively lightweight and long shanks, the birds able to protect itself from predators, which is otherwise a major threat to the birds in backyards (www.poulvet.com).

2.2 Ingestive Behaviour of Fowl

One of the most important things in the life of a chicken is eating. Ingestive behaviour involves the consumption of food or nourishing substances, includes both solids and liquids (Scott, 1975). One or more birds' feeding will stimulate others to join. A dominant individual, after having fed, may return when its inferiors begin active feeding, thereby increasing its consumption and reducing that of those in lowest rank (Guhl and Fischer, 1975).

Duncan (1998) suggested that all the elements of feeding behaviour are essential and in general most husbandry systems allow the full range to be expressed.

Ingestive behaviour is consisted of the following components.

2.2.1 Feeding

Act of feeding in which the bird introduces the beak into the interior of the feeder. Before picking up a grain the chicken lifts its head so that it can see the grain with both eyes. Now it fixes the position of the grain and after aiming at it is able to hit it (Chicken-yard newsletter, 2001).

Masic *et al.* (1974) and Savory (1975) reported that layer type chickens spent more time feeding but consumed less feed than meat type birds. Vestergaard (1982), Appleby *et al.* (1992) and Channing *et al.* (2001) observed that birds showed increase feeding activity in the afternoon. Lee *et al.* (1985) found that Taiwan country chickens spent about the same time feeding but consumed only half the amount of feed as compared with commercial broilers. Gvaryahu *et al.* (1989) examined the effects of classical music on the behaviour and performance of meat chickens and reported reduced fearfulness assessed by tonic immobility and increased feeding time when provided intermittently with music. Andrews *et al.*, (1997) stated that there was no difference in the time males and females spent on feeding. Uner *et al.* (1997) found that birds kept at high densities spent more time concentrated in feeding activity.

Cornetto and Estevez (2001) observed in their studies on broiler chicken that the proportion of time spent feeding was not affected by group size. Olukosi *et al.* (2002) in their studies on Anak 200 broiler strain chickens reported that birds were more interested in feeding than engaging in other forms of behaviour during feeding time. Shields *et al.*(2005) in an experiment, using sand and wood shavings as litter material, reported no difference in the amount of feeding behaviour that occurred on each side during the day. Lee & Chen (2007) in their studies on four breeds viz. Taiwan country chicken, Beijing fatty chicken, pure Silkies and upgraded commercial Silkies, revealed that breed, sex and time of day all had highly significant effects on feeding behaviour. The commercial Silkies fed much more frequently than the other three breeds and also depicted that males had significantly higher feeding activity than females.

2.2.2 Drinking

Drinking which means act of taking water with the beak at assigned areas. For drinking birds dive their beak deep into the water, then they quickly lift their head so that the water can run down the throat (Chicken-yard newsletter, 2001).

Uner *et al.* (1997) found that birds kept at high densities spent more time concentrated around drinkers. Duncan (1998) reported that drinking behaviour appears to be closely linked to its normal functional consequences i.e. there is little tendency (under normal circumstances) to perform the behaviour when the bird is not thirsty. Cornetto and Estevez (2001) observed in their experiment on broiler chicken that the mean percentage of time drinking was not influenced by group size.

Shields *et al.*(2005) in an experiment, using sand and wood shavings as litter material, observed increased frequency of drinking on sand side but decreased frequency on the wood shavings side during day period and at night birds also drink more on the sand side. Lee & Chen (2007) in their studies on four breed's viz. Taiwan country chicken, Beijing fatty chicken, pure Silkies and upgraded commercial Silkies, revealed that males had significantly higher drinking activity than females.

2.2.3 Foraging

The act of scratching and pecking at the ground while moving is known as foraging. Foraging behaviour consists of pecking and ground scratching followed by ingestion (Folsch and Vestergaard, 1981). Dawkins (1989) and Savory *et al.* (1978) defined foraging as the appetitive phase of feeding. Bizeray *et al.* (2002) reported that pecking, scratching and feeding often occurred together, and so they were combined together into a new behavioural category, foraging. This behavioural category includes behaviours associated with high levels of locomotion and so can be considered a good general indicator of activity.

Duncan and Hughes (1972) stated that similar to other laboratory animals, the foraging drive is so strong in chickens that they will "work" for food in the presence of freely accessible identical food. Vestergaard (1982), Appleby *et al.* (1992) and Channing *et al.* (2001) observed that birds showed increase activities in the afternoon with more foraging. Cornetto and Estevez (2001) observed in their experiment on broiler chickens that foraging in the different pen locations was significantly affected by age. Conversely group size did not affect the amount of time the birds spent foraging.

Arnould *et al.* (2004) concluded that the way to increase activity levels might be to encourage broilers to display normal behaviours that require energetic movement that includes exercise of the legs, for example foraging behaviours. Lee & Chen (2007) in their studies on four breeds viz. Taiwan country chicken, Beijing fatty chicken, pure Silkies and upgraded commercial Silkies, revealed that breed, sex and time of day all had highly significant effects on foraging behaviour. The pure Silkies displayed a higher frequency of foraging activity than the other breeds. They also found that foraging decreased with age. It is possible that foraging is relaxed leisure behaviour and could be a useful indicator of good welfare in chickens and also depicted that males had significantly lower foraging activity than females.

2.2.4 Walking

Walking means relatively low speed displacement of the bird on the ground in which the propulsive force is derived from the action of the legs (Cornetto and Estevez, 2001).

Vestergaard (1982), Appleby *et al.* (1992) and Channing *et al.* (2001) observed that birds showed increase activities like walking behaviour in the afternoon. Newberry and Hall (1988) and Lewis and Hurnik (1990) in their separate studies, reported that twenty birds per square meter cause little discomfort in the early weeks of a birds' life, but may reduce welfare in later life by restricting locomotion i.e. walking. Andrews *et al.*(1997) observed on broiler chickens that when stocked at the low rate, the birds spent more time walking. According to them, male birds walked for longer than female birds. Keppler and Folsch (2000) found that hens will walk about 1 to 1.5 kilometres per day and fly to and from elevated places if they have the opportunity to do so.

In their experiment on broiler chickens, Cornetto and Estevez (2001) revealed that the percentage of time spent walking did not fluctuate with increasing group size, but differed across pen regions and age, with fewer observations were found for walking by the wall and centre regions of the pen. Mahboub *et al.* (2002, 2004) stated that walking and the frequency of short outdoor visits in free range laying hens was associated with a high probability of occurrence for being pecked. Arnould *et al.* (2004) concluded that the way to increase activity levels might be to encourage broilers to display normal behaviours that require energetic movement that includes exercise of the legs, for example walking. Lee & Chen (2007) also depicted that birds showed more walking and less resting behaviour in the early morning and late afternoon. They also observed that males had less walking than females.

There were three more behavioural elements viz., standing, preening and dust bathing were also studied during feeding time. Literatures obtained for these three types of behaviour have been presented under social and resting behaviour.

2.3 Social and Resting Behaviour of Fowl

Social behaviour of a flock depends on physiological, psychological and physical state of each member and is influenced by the appearance of the individual. Preening and dust bathing behaviours come under social behaviour which are also known as maintenance-comfort behaviour. Resting behaviour includes standing, lying, sleeping and dozing and sitting (Folsch *et al.,* 1988). Morphological features associated with the head and necks are important for both communication and social recognition (Mench and Keeling, 2001). Recognition of each other is based on features of the head, the comb being the most important cue (Guhl, 1953).

2.3.1 Preening

The grooming habits of birds are called preening. The act of pecking, nibbling, storking or combing plumage with the beak is known as preening (Cornetto and Estevez, 2001). Duncan and Wood- Gush (1972) suggested that preening behaviour is essential both in response to peripheral stimulation from feather disarray and as a displacement activity in mild frustrating or conflict situations. To keep their feathers in good condition, chickens must be able to preen themselves regularly. Chickens will certainly preen of their own, but they seem to prefer doing it as part of a group. It is not uncommon to see an entire flock of chickens preening at the same time (Folsch *et al.*, 1988).

Newberry and Hall (1988) and Lewis and Hurnik (1990) in their separate studies, reported that twenty birds per square meter cause little discomfort in the early weeks of a birds' life, but may reduce welfare in later life by restricting preening. Andrews *et al.* (1997) observed on broiler chickens that high stocking density decreases the act of preening. They also observed that male birds spent more time in preening than female birds. According to Fraser and Broom (1997), preening is one type of body-care behaviours in fowls. Newberry and Shackleton (1997) demonstrated, in two laying hen strain of domestic fowl, that chickens spend more time in areas enriched with artificial vertical panels. In addition, they observed increased resting and preening in the presence of cover in vertical panels. Cornetto and Estevez (2001) reported that preening occurred most often along the pen wall, but in the presence of vertical panels, the proportion of preening in the centre increased. They also depicted that preening was not affected by group size or age.

Shields *et al.* (2005) birds observed increased frequency of preening on sand side but decreased frequency on the wood shavings side during day period in broiler birds. Lee *et al.* (2007) revealed that among the four breeds viz. Taiwan country chicken, Beijing fatty chicken, pure Silkies and commercial Silkies; the fast growing commercial Silkies chicken showed less preening activity than the other breeds. They stated that females had significantly higher preening behaviour than males, which occurred more often in the early morning and less in the middle of the day.

2.3.2 Dust bathing

To keep their feathers in good condition, chickens must be able to take dust bathe regularly. When dust bathing, chickens toss the litter onto and between the fluffed feathers and subsequently enclose it by flattering the feathers. This comfort behaviour regulates the amount of feather lipids and maintains down and feather structure is in good condition (Folsch *et al.,* 1988).

Dust bathing is the act of building a dirt mound using feet, wings and beak and then lying on the ground and tossing dirt on its back and wings. Birds lie down in the dirt, scratch it onto their backs, roll in it, rub their necks in it and shuffle it under their feathers. The chickens usually have a favourite spot to dust bathe that they will come back to again and again (Cornetto and Estevez, 2001).

Vestergaard (1982) and Petherick *et al.* (1995) revealed that dust bathing is the most difficult behaviour pattern about which to draw a firm conclusion, because it is controlled by both internal and external factors. Vestergaard (1982), Appleby *et al.* (1992) and Channing *et al.* (2001) observed that birds showed increase activities in the afternoon with more dust bathing. Murphy and Preston (1988) reported no dust bathing in a commercial flock of broiler chickens, which they explained as a potential consequence of the selection for fast growth rate and efficient food utilization. Petherick and Duncan (1989), Van Liere (1991) and Sanotra *et al.* (1995) found that laying hens prefer to dust bathe in sand rather than in wood shavings or straw. Vestergaard *et al.* (1990) stated that dust bathing in chickens typically occurs in groups of birds that are in close proximity. Vestergaard (1994), Huber- Eicher and Wechsler (1998) reported that dust bathing behaviour was found to be associated with a high frequency of feather pecking. Fraser and Broom (1997) stated that dust bathing is a type of body-care behaviour in fowls.

Cornetto and Estevez (2001) reported that the proportion of dust bathing was significantly affected by group size. They also depicted that, in the mesh and frame treatments, dust bathing increased with increasing group size, whereas the opposite trend was observed when no vertical panels were provided. Arnould *et al.* (2004) in an experiment observed that the way to increase activity levels might be to encourage broilers to display normal behaviours that require energetic movement that includes exercise of the legs, e.g. dust bathing behaviour. Shields (2004) concluded that dust bathing behaviour of broiler chickens occurs primarily in the afternoon. Shields *et al.* (2005) observed in broiler birds increased frequency of dust bathing on sand side but decreased frequency on the wood shavings side during day period. Lee & Chen (2007) stated that male birds tended to have higher dust bathing activity than female birds. They also noted that most dust bathing activity occurred in the middle of the day.

2.3.3 Lying

Lying is the cessation of movement while the breast of the bird is in contact with the floor (Cornetto and Estevez, 2001). Dawson and Siegel (1967) and Wood-Gush *et al* (1978) noted that lying in chickens often occurred in groups. Murphy and Preston (1988) hypothesised that lying time is controlled by a combination of stocking density and total space availability. Murphy and Preston (1988) and Lewis and Hurnik (1990) observed separately in their respective experiments that lying bouts can be disrupted by a high stocking density particularly if it causes heat stress in birds.

Murphy and Preston (1988), Newberry and Hall (1990) and Weeks *et al.* (2000) reported that broiler chickens become increasingly inactive as they near market weight, spending as much as 80% of their time lying. Preston and Murphy (1989) and Estevez (1994) stated that chickens spend considerable time in lying. Yeh (1990) and Chiang (1994) indicated that installing a perch in the pen could effectively increase lying and improve feather condition in mature (13-16 weeks of age) Taiwan country chickens with males in the pen. Andrews *et al.* (1997) found no effect of stocking density on the total time spent lying in broiler chicken. Newberry and Shackleton (1997) observed that chickens preferred lying mostly near the walls of the pen.

2.3.4 Sleeping

Chickens only fall asleep in their familiar group. Only in absolute darkness they put their heads under the feathers and fall asleep with their eyes closed (Chicken-yard Newsletter, 2001).

Meddis (1975) noted that the increase in time spent sleeping by birds in the high stocking density may reflect the immobilization function of that bird. Blokhuis (1983, 1984) stated that sleeping and undisturbed resting are essential for birds.

Hughes and Appleby (1989) said that good health reasons for having a husbandry system that allows perching during sleep and rest. Andrews *et al.* (1997) in their studies on broiler chickens observed that when stocked at the low rate, the birds spent less time in sleeping. According to them, male birds slept less than females. Duncan (1998) noted that all husbandry systems for egg laying hens appear to allow sleeping and resting by providing a substantial dark period. He also reported that perching is the natural position in which sleeping and resting occurs; birds also seem to be able to adapt to other positions fairly easily.

2.3.5 Dozing

Dozing defines as to sleep lightly or for a short period of time (www.thefreedictionary.com).

Meddis (1975) noted that the increase in time spent dozing for birds in the high stocking density may reflect the immobilization function of fowl. Andrews *et al.* (1997) in their studies on broiler chicken observed that when stocked at the low rate, the birds spent less time in dozing. While dozing, eyes are half open or closed with flickering.

2.3.6 Sitting

Sitting defines as the act or position of one that sits (www.thefreedictionary.com).

Meddis (1975) noted that the increase in time spent at the expense of sitting for birds in the high stocking density may reflect the immobilization function of fowl. Vestergaard (1994) and Huber- Eicher and Wechsler (1998) reported that sitting behaviour was found to be associated with a high frequency of feather pecking. Andrews *et al.*(1997) in their studies on broiler chickens, observed that when stocked at the low rate, the birds spent more time sitting. While sitting, eyes are fully open. Shields *et al.*(2005) in an experiment on broiler birds observed increased frequency of sitting on sand side but decreased frequency on the wood shavings side during day period as did resting at night.

2.3.7 Standing

While standing, birds maintain an upright position on extended legs (Cornetto and Estevez, 2001).

Murphy and Preston (1988) and Lewis and Hurnik (1990) observed separately in their respective experiments that if high stocking density causes heat stress and results in birds' standing periodically to increase heat loss. Vestergaard (1994) and Huber- Eicher and Wechsler (1998) reported that standing behaviour was found to be associated with a high frequency of feather pecking. Andrews *et al.* (1997) in their studies on broiler chickens reported that male birds stood for longer than female birds. Cornetto and Estevez (2001) revealed that the proportion of time standing was affected by the presence of cover panels and pen region. They also stated that standing time was highest in the wall region but was reduced when vertical panels were absent. Lee & Chen (2007) also depicted that birds showed more stand and less resting behaviour in the early morning and late afternoon. They reported that birds decreased stand and increased resting from 5 to around 9-10 weeks of age, then increased stand and decreased resting to 16 weeks of age.

2.4 Agonistic Behaviour of Fowl

Scott and Frederickson (1951) defined agonistic behaviour as behaviour associated with fighting, escape, defensive and passive interactions between individuals.

Duncan and Wood-Gush (1971) reported that aggressive behaviour has been shown to increase in response to frustration association with feed deprivation, again raising the expectation that males fed *ad libitum* would be the least aggressive. Agonistic behaviour defined as any social behaviour related to fighting. It includes attack, escape, avoiding and submissive behaviour. These patterns of activity vary in intensity and can be recognized by differences in posture and movement. Attack includes fighting, pecking and threatening (Guhl and Fischer, 1975).

The effect of housing on incidence of agonistic behaviour in laying hens has been explored by several researchers (Al-Rawi and Craig, 1975, Hughes and Wood- Gush, 1977, Ylander and Craig, 1980). Newberry and Hall (1988) reported that broilers can make effective use of their floor space, but in the last weeks of growth movement may be reduced by the development of aggressive behaviour. Lee (1992) in his studies on Taiwan country chickens revealed that those birds are more active and aggressive than commercial broilers and farmers may face serious behavioural problems when rearing them under modern intensive systems. Oden *et al.* (1999) in their studies on laying hens, concluded that agonistic behaviour among females was more frequent in single sexed groups than among hens in mixed groups (i.e. male and female together).

Following patterns are commonly observed during agonistic interaction.

2.4.1 Pushes

One bird pushes another with head, body etc. when they are too close to one another (O'Keefe *et al.*, 1988).

2.4.2 Chasing

One or more birds pursue another bird across the enclosures. One hen chases another hen away from a limited food source (O'Keefe *et al.*, 1988).

Millman and Duncan (2000b) in their studies on game strain, broiler and layer breeder strains reported that chasing was performed more frequently to game strain females. Chasing appeared to be stimulated by the behaviour of game strain females, since males chased females when they ran or flew down from perches. Millman *et al.* (2000) revealed that chasing behaviour in females were extremely rare with laying strain males. In comparison with laying strain males, broiler breeder displayed five to ten times more chasing activity.

2.4.3 Threatening

Threat behaviour is any behaviour that signifies hostility or intends to attack another animal. Threat behaviour is meant to cause the opponent to back down and leave. Threat does not involved physical contact with another animal. Any threat behaviour most often elicits other agonistic behaviour in the recipient (Barrows, 2001).

Kruijt (1964) reported that postures and displays are used to signal threat and submission. Hughes and Wood-Gush (1977) observed that in cages that are too low for the chickens to raise their heads in a threat, aggression is provoked by an approaching bird rather than by a bird that is in continuous close proximity. According to a study it was found that feed restricted broiler threatens more frequently than those fed ad libitum during the rearing period (Mench, 1988, Shea *et al.*, 1990 and Mench *et al*, 1991).

Keppler *et al.* (1997) reported that a stable rank order is formed within a small group of chickens on the basis of personal affiliation, threat and avoidance behaviour, and factors such as age, colour, sex and size of the comb. Oden *et al.* (1999) in their studies on laying hens, revealed that aggressive threats among females was significantly less frequent in groups that also included males.

2.4.4 Fighting

Fighting is an important practical problem in animal management and bird welfare. Fighting is more pronounced in the males of all domestic mammals and birds, being particularly associated with competition for mates (Scott, 1975).

In fighting, two hens face up to each other and aim pecks with their beaks and kicks with their feet and spurs (O'Keefe *et al.*, 1988). Oden *et al.* (1999) in their studies on laying hens reported that females less frequently exhibit fighting behaviour when they were grouped along with the males. The initiation of threat will result in a display of physical attributes i.e. fight. Fighting appeared to be caused by one bird coming too close to another (Barrows, 2001).

2.4.5 Wing flapping

A display was performed, occurring in varying levels of intensity, in which wings were clapped together while the bird was in an upright posture. In a less intense form, wings were clapped together while the head and body of the bird remained level (Millman *et al.*, 2000).

Duncan (1970) reported that males perform more wing flapping, indicative of frustration, when males can interact with, but not mate with females. Whitehead *et al.* (1997/98) said that it is important to allow sufficient space for running and wing- flapping to maintain good bone strength. Millman and Duncan (2000b) in their studies on game strain, broiler and layer breeder strains observed that wing flapping by males occurred most frequently in game strain birds when they were housed with females. Millman *et al.*(2000) revealed that wing-flapping occurred twice as frequently in *ad libitum* fed than in restricted fed males.

2.4.6 Feather pecking

Feather pecking is interpreted as an abnormal behaviour where fowls peck the feathers of conspecifics, damage the plumage or even injure the skin. Aggressive pecking were always severe and fast, directed mainly at the head and given in a downward direction, occasionally when the attacked bird was moving away; an aggressive peck could also be directed to other parts of the body (Ramadan *et al.*, 2008).

Feekes (1971) found ground pecking, displayed by male jungle fowl during aggressive interaction, to be influenced by factors controlling feeding. Allen and Perry (1975), Gentle and Hunter (1990) noted that feather pecking reduces welfare in the recipient birds, because it has been suggested that having feathers pulled out is perceived as painful and lead to cannibalism. Blokhuis and Arkes (1984) stated that feather pecking is a redirected ground pecking. If birds do not spend a major portion of the day in foraging activities, chickens tend to peck, pull and tear at objects or conspecifics and often develop feather pecking behaviour.

Blokhuis (1986) has shown that feather (or body) pecking is motivationally connected with floor pecking. O'Keefe *et al.* (1988) demonstrated that agonistic interactions occur among most pairs of hens housed in pens but do not occur among most pairs of hens housed in cages. Therefore, peck orders could be constructed for hens housed in pens but not for hens housed in cages. Norgaard-Nielsen *et al.* (1993), Huber-Eicher and Wechsler (1997) and Nicol *et al.* (2001) concluded that rearing chicks with access to sand, peat or straw as litter substrates for dust bathing and foraging reduces tendencies to engage in feather pecking. Hansen and Braasted (1994) said that in high density situations, the birds and feathers make up a higher proportion of stimuli relative to the litter area. It is possible that the birds may perceive the feathers as dust and that may cause a redirection of ground pecking to feather pecking.

Savory (1995) and Blokhuis *et al.* (2000) stated that feather pecking is considered as one of the most widespread and serious problems of today's poultry production when hens are kept under commercial condition. Huber-Eicher and Wechsler (1997) told that feather pecking is a behavioural disorder, a sign that the housing and feeding conditions are not corresponding to the animal's behavioural needs. Johnsen *et al.* (1998) emphasised the importance of early rearing conditions (litter substrate) on the development of feather pecking behaviour, of which the presence of loose feathers on the floor in early life may affect subsequent pecking behaviour. Wechsler and Huber-Eicher (1998) observed that if straw is provided as litter substrate, special attention should be paid to its form, as long-cut straw is more efficient in reducing feather pecking than straw in shredded form.

Oden *et al.* (1999) revealed that no significant differences were observed in feather pecking behaviour between single sexed and mixed groups (male and female together) among the laying hens. Forkman (2003) reported that feather pecking can be viewed as foraging behaviour in which the birds first learn to peck at loose feathers on the floor and then develop into proper feather pecking when there are no more feathers available. Rodenburg and Koene (2003) stated that the intensity and severity of agonistic act (mainly feather pecking) seems to depend on age. Lee & Chen (2007) revealed that Taiwan country chicken show more aggressive and feather pecking behaviour.

2.4.7 Head pecking

In head pecking, a bird delivers a sharp blow with the beak to the head or body of another bird (O'Keefe *et al.*, 1988).

Appleby *et al.* (1992) stated that the vent pecking occurs principally in birds that have just laid and the red coloration of the vent, and later blood, provides a stimulus to the bird to peck, may be head or feather. Olukosi *et al.* (2002) in his studies on broilers, observed that agonistic acts were highest when the birds were feeding and that with a greater feeder space allowance the birds initiated fewer numbers of aggressive head pecks per hour than when the feeder space allowance was smaller.

2.4.8 Tidbiting

A courtship display was performed, in which the bird repeatedly pecked at the ground with his beak, with or without ground scratching with his feet (Millman *et al.*, 2000). They also reported that laying strain males performed tidbiting twice as frequently as did broiler breeder strains and display of tidbiting did not differ as a result of feeding regimen.

2.4.9 Crowing

A stereotyped vocalization was emitted as the bird maintained an upright posture (Millman *et al.*, 2000). They also revealed that crowing occurred twice as frequently in *ad libitum* fed than in restricted fed males.

2.5 Sexual Behaviour of Fowl

An understanding of the sexual behaviour in chickens can help the breeder manager and producer to observe the mating behaviour sequences in their flocks to assess whether their flock fertility should be good, average or poor. A number of behaviour patterns are associated with sexual behaviour in chickens. Some are definite components of the stimulus-response sequence which terminate in coitus; others occur there but also appear in agonistic behaviour and still others are post-copulatory reactions. Those patterns that function in the initiation, progression, and culmination of the stimulus-response sequence are most significant (Guhl and Fischer, 1975).

Wood-Gush (1956), Kruijt (1964) and Bastock (1967) revealed that courtship displacement may arise from conflicting sexual, attack and escape motivation. Kruijt (1964) described sexual aggression as a typical developmental stage of mating behaviour. Salzen (1965) suggested that unfamiliar objects evoked fear which masks sexual behaviour, but in the absence of fear, sexual behaviour will be elicited according to hormonal condition and depending on the object providing the appropriate stimulation. Siegel (1972) found that there was no relationship between aggressiveness and sex drive. North and Bell (1990) reported that feed-restricted broiler breeders would be the most sexually aggressive, because feed restriction delays sexual maturity.

Sexual behaviour has two components viz., male and female.

2.5.1 Male Sexual Behaviour

The cock typically takes the initiative in sexual behaviour moving among the hens as though testing each for sexual receptivity. If the male and females are well acquainted, the rear approach with head extended towards or over the female is the most common (Guhl, 1961). If the hens are unresponsive the cock may attract them by tid biting also called food-call. All of these behaviour patterns collectively have been called courting (Guhl and Fischer, 1975).

Leonard *et al.* (1993a), Leonard *et al.* (1993b) and Widowski *et al.* (1998) described that the effects of the social environment during rearing have been shown to affect sexual behaviour of male at maturity. Millman and Duncan (2000a) observed that feed restriction delays maturity and laying strain males develop secondary sexual characteristics and crowed at a later age than males fed *ad libitum.* Lee & Chen (2007) reported that sexual behaviour of males is increased after 8 – 12 weeks of age.

Male sexual behaviour is displayed through following patterns.

2.5.1.1 Mounting

Millman and Duncan (2000b) in their observation on game strain, broiler and layer breeder strains indicated that both game strain and broiler breeder males often attempted to mount females frontally or from the side, predisposing them to slipping from the female's back. Laying strain males, on the other hand, performed a rear approach, to which females responded by crouching. Millman *et al.* (2000) found that broiler breeder males performed more unsuccessful mating attempts, mounting females significantly more frequently than laying strain males. They also stated that feed restriction has no effects on mounting behaviour in males.

2.5.1.2 Forced mounting

When the female avoided the male, and no further elements of the copulatory sequence were observed, then the male approach the female forcefully to mount over her (Millman *et al.* 2000).

2.5.1.3 Copulation

The cock stands on the outstretched wings, grasps the comb or hackle, and moves his feet up and down in a treading motion. Subsequently he rears up, spreads his tail while the hen moves her tail to one side, and each everts the cloaca as the vents meet (Guhl and Fischer, 1975).

Collias (1950) and Guhl (1951) revealed that frequencies in copulation decreased substantially in males when he was placed singly and daily for short periods into a pen of hens. Wilson *et al.* (1979) and Duncan *et al.* (1990) stated that low fertility in broiler breeders was shown to result from lack of cloacal contact and from low levels of libido in males and also attributed problems of fertility in Cornish type males to defective mating behaviour. Millman and Duncan (2000b) in their studies on game strain, broiler and layer breeder strains observed that broiler breeder strain males copulated more frequently than other strains. This seemed to be most affected by difference in the behaviour of the females. Millman *et al.* (2000) detected that no difference resulting from feeding regimen in frequencies of copulation indicating that feed restriction did not affect the sexual motivation of males.

2.5.1.4 Forced copulation

The male mounts a female and appears to achieve cloacal contact following a struggle, during which the female attempts to avoid the male. The female often squawks during the struggle (Millman *et al.*, 2000).

McBridge *et al.* (1969) studied feral domestic fowl on an uninhabited island of the coast of Queensland. Australia and noted that forced copulations occurred when females ran or flew down from roosting areas in trees, apparently stimulating male to chase. Mench (1993) reported that males are extremely rough during mating, forcing copulation and often injuring or killing females. He also stated that in flocks in which aggression has become a problem, males typically chase and corral females into corners. Millman *et al.* (1996) concluded that broiler breeder males showed lower frequencies of courtship displays and forced more copulation when compared with commercial laying strain males. Millman and Duncan (2000b) observed in game strain, broiler and layer breeder strains, that the large size broiler breeder males allow them to forced copulation on unwilling females but also makes it difficult to achieve cloacal contact.

2.5.1.5 Male to male and male to female aggression

Mating behaviour in males in terms of dominance relationships must be evaluated on two terms- that of heterosexual dominance relationships and that of unisexual dominance relationships. In the former sense, cocks normally dominate hens and have their own peck order, separate from the females. This facilitates mating because the submissive crouch by the hen is a part of the mating sequence, unless the female is very dominant in her own peck order. In terms of unisexual dominance relationships, dominant males tend to interfere with subordinates when mating (Siegel, 1968). The male chases, pecks, or jumps at the other male in the pen, also the male pecks a female with a downward blow of the beak, usually directed at her head. The male may also jump at the female, kicking at her with his feet (Millman *et al.*, 2000).

Wood-Gush (1960) and Rushen (1983) stated that immature males may behave aggressively to females during mating. High levels of aggression directed toward female by male broiler breeder domestic fowl have been reported in the poultry industry during the past 10 to 15 years (Mench, 1993). Mench (1993) and Brake (1998) concluded that commercial broiler breeder males behaved aggressively toward females, injuring and sometimes killing them. Rushen (1993/94) stated that females' tendency to avoid males, stimulates males to behave aggressively towards females. Millman and Duncan (2000b) in their studies on game strain, broiler and layer breeder strains reported that broiler breeder males behave aggressively towards females as a result of sexual frustration associated with mating difficulties. Millman *et al.* (2000) found that broiler breeder males displayed significantly more male to male and male to female aggression than laying strain males.

2.5.1.6 Waltzing

The waltz (also called wing-flutter or circling) is common when the cock and hens are strangers. In this conspicuous behaviour the male drops and flutters the wing on the side towards the female, takes several quick steps in and or around the hen and kicks outward with the other leg. This is a displacement activity and has an element of aggression (Guhl and Fischer, 1975).

Collias (1950) and Guhl (1951) revealed that when a sexually active cock was placed singly and daily for short periods into a pen of hens, there was a decrease in the frequencies of waltzing in males. Wood-Gush (1956) reported that waltzing to be displayed when aggressive motivation is high relative to motivation for copulation or escape. Because waltzing was the only element of sexual behaviour to be affected by feeding regimen. It was concluded that waltzing reflected a stronger aggressive motivation than sexual motivation.

Millman and Duncan (2000b) observed that males of game type strain waltzed more than ten times as frequently as did males of other strains i.e. broiler breeder and layer strains. They also predicted that males performed waltzing as frequently to females of either strain suggesting that females of different strains did not differ as releasers of aggressive and sexual motivation. Millman *et al.* (2000) stated that waltzing was performed twice as frequently by males fed *ad libitum*. Frequency of waltzing, in both sexual and aggressive contexts, did not differ significantly between strains and occurred at low levels in laying strain males relative to tidbiting.

2.5.1.7 High step advance

A courtship display was performed, in which the male approached the female with a strutting walk. The legs were lifted and extended forward in an exaggerated manner (Millman *et al.* 2000). They also noted that laying strain males displayed high step advance much more frequently than did broiler breeder males.

2.5.1.8 Steps off

After mating is over the male usually steps off in a forward direction and execute a waltz (Guhl and Fischer, 1975).

2.5.2 Female Sexual Behaviour

Wood-Gush (1954, 1956 and 1958) suggested that sexual behaviour in the hen is largely triggered by external stimuli emanating found the rooster. A hen may respond negatively, positively or be indifferent to courting. As a negative reaction she may step aside, walk or run away, or struggle if captured. Such escape behaviour may be accompanied by vocalization varying in intensity from faint squawks to loud shrieks. A positive reaction, crouching, usually occurs with head low and wings spread (Guhl and Fischer, 1975). The level of the male's sexual arousal is increased if the head and tail of the hen are prone rather than erect (Carbaugh *et al.*, 1962). Leonard *et al.* (1993a), Leonard *et al.* (1993b) and Widowski *et al.* (1998) described that the effects of the social environment during rearing have been shown to affect sexual behaviour of females at maturity.

Female sexual behaviour is displayed through following patterns.

2.5.2.1 Crouching

A sexual behaviour of female in which she dips her head and body with wings spread to indicate receptiveness to the male (Guhl and Fischer, 1975).

Guhl (1950) revealed that when high ranking hens are isolated from hens lower in the peck order, they crouch more often than when in the layer flock and hens in the middle and lower thirds of the peck order crouched less often. Collias (1950) and Guhl (1951) stated that frequency of crouch in hens decreased gradually when a sexually active cock was placed singly and daily for short periods into a pen of hens. The sexual crouch is a strong stimulus for the cock to mount and tread, especially when he approaches from the rear (Guhl and Fischer, 1975).

Millman and Duncan (2000b) noticed that when laying strain males execute a rear approach, and then females accepted him by crouching. They also reported that broiler breeder females appeared to be highly motivated to male and often crouched prior to courtship by the male. Millman *et al.* (2000) reported that females housed with broiler breeder males rarely adopted a sexual crouch.

2.5.2.2 Interference

It is often surprising to observe females interfering with mating attempts involving other females. Interference most frequently consisted of a female running in full threat towards a copulating male, followed by a leaping attack. Females were not observed to direct aggression at the copulating female (Millman and Duncan, 2000a).

Millman and Duncan (2000b) reported that in game strain, broiler and layer breeder strains interference successfully disrupted copulation in some situations and females interfered with males of all strains. They also stated that females interfered with copulations by broiler breeder males frequently than by laying strain males fed *ad libitum*.

2.5.2.3 Allopecking

A female pecks gently at the comb, wattles or face of the male. Bouts of allopecking were terminated when the female engages in a different behaviour (Millman and Duncan, 2000b). They also observed in game strain, broiler and layer breeder strains of chickens that females performed allopecks to male of all strains, but when averaged over the four observation periods, allopecks were performed more frequently to laying strain males fed *ad libitum* than do broiler breeder and feed restricted laying strain males. They also found that broiler breeder females spent more time in close proximity to the male and performed significantly more allopecking to his comb and wattles than did game strain females.

2.5.2.4 Copulation

When a cock attempts a hen for mating, he rears up, spreads his tail while the hen moves her tail to one side, and each everts the cloaca as the vents meet (Guhl and Fischer, 1975).

Collias (1950) and Guhl (1951) observed that copulation frequencies decreased in subsequent situations in females when a highly sexually active male was introduced daily for short periods into a pen of hens. Millman and Duncan (2000b) reported that in game strain, broiler and layer breeder strains, forced copulation did not occur with females of either strain. Millman *et al.* (2000) found that in broiler breeder females, copulations usually occurred after a chase.

2.5.2.5 Avoidance by female

Avoidance often involves locomotion, and the individual tends to keep away from superior, that is, withdraws and avoids social as well as sexual contact. In well-integrated flocks at low intensities of social or sexual interaction avoidance may be indicated by merely moving the head away from flock mates (Guhl and Fischer, 1975). The male's behaviour results in a female running away from him (Millman *et al.*, 2000).

Guhl (1949), Wood-Gush (1958) and Rushen (1983/84) reported that females tend to avoid males that behave aggressively towards other males, implying that when aroused, males may direct aggression towards female. Mench (1993) stated that when forced copulation was executed by male, females used to avoid males by running away, by hiding in nest boxes and remaining on raised slatted areas. Millman and Duncan (2000b) in their study on game strain, broiler and layer breeder strains observed that game strain females avoided males more frequently than other strains.

2.5.2.6 Approach by female

The male's behaviour results in one or more females walking or running toward him (Millman *et al.*, 2000). They also found that broiler breeder males chased females, displaying little courtship behaviour whereas females were found to approach laying strain males much more frequently than broiler breeder males.

2.5.2.7 Female to male and female to female aggression

Mating behaviour in females in terms of dominance relationships must be evaluated on two terms- that of heterosexual dominance relationships and that of unisexual dominance relationships. In the former sense, hens normally dominate cocks and have their own peck order, separate from the males. This facilitates mating because the submissive crouch by the hen is a part of the mating sequence, unless the female is very dominant in her own peck order. In terms of unisexual dominance relationships, dominant females tend to interfere with subordinates when mating (Siegel, 1968). A female pecks the male or another female with a downward blow of her beak, usually directed at his/ her head. The female may also jump at the male or at the female, kicking with her feet (Millman and Duncan, 2000b).

Guhl (1949), Ylander and Craig (1980) and Bshary and Lamprecht (1994) stated that aggression between females tend to be low when they are in the presence of a dominant third party, particularly when the dominant is a male. Wood-Gush (1956) found female to male aggression to occur in situations where males were of similar size to females. According to them, female to female aggression also reported to have between similar age group of birds. Millman and Duncan (2000b) observed in game strain, broiler and layer breeder strains that there was no difference in frequencies of female to male aggressions between the strains.

2.5.2.8 Stands and shakes

After mating is over the hen ruffles her feathers as she gets to her feet and may run in a circle (Guhl and Fischer, 1975).

Chapter- 03

Materials and Methods

Present experiment was carried out to study different forms of behaviour during feeding and non feeding time along with sexual behaviour in two genetic groups of fowl (Rhode Island Red and Vanaraja), reared under deep litter systems. A brief account of experimental birds, their management, systems of behaviour studied, observation recording are given below.

3.1 Place of Investigation

The study has been conducted at the department of Livestock Production Management, West Bengal University of Animal and Fishery Sciences, Mohanpur campus, Nadia, West Bengal.

3.2 Period of Investigation

The experiment has been conducted for a period of 12 weeks (from 25.5.2011 to 27.8.2011).

3.3 Experimental Birds

The study has been conducted on two genetic groups of fowl, Rhode Island Red and Vanaraja. Rhode Island Red (RIR) is a good layer of large brown eggs and as a dual purpose medium heavy fowl also produces a fair sized roaster. The bird's feathers are rust coloured, but darker shades are known, including maroon bordering on back. Their eyes are red orange and they have yellow feet with reddish brown beaks. RIR chicken was originally developed in Massachusetts and Rhode Island in the 1880's and 1890's. The single combed variety was submitted to the APA's standard of Perfection in 1904 and the rose combed birds a year later (www.poultrymad.co.uk). The roosters usually weigh in at 8.5 pounds (3.8 kg), the hens slightly less at 6.5 pounds (2.9 kg) (Sastry and Thomas, 2005).

Vanaraja is a suitable bird for backyard farming in rural and tribal areas, developed by the Project Directorate on Poultry (ICAR), Hyderabad.

Vanaraja is a multicoloured dual purpose bird with attractive plumage which can be reared either for meat or egg production. The male bird is a coloured Cornish strain while the female parent bird is synthetic multicoloured. The mature female bird weighs 3.38 kg while male weighs 4.35 kg (www.poulvet.com).

These two genetic groups of fowl were taken as experimental birds for the current study. The age of the birds were selected for this experiment was between 36-48 weeks (9-12 months) in both the breeds. The average body weight in male is 3.4-4.0 kg and 2.7-3.2 kg in female of both the breeds. The experimental birds of RIR and Vanaraja were reared in two different farms viz., Haringhata Poultry Farm, Govt. of West Bengal and Poultry Seed Project Farm, West Bengal University of Animal and Fishery sciences respectively located at Mohanpur, Nadia, West Bengal.

3.4 Location of the Farm and Climate

Both the farms are located between 21°51' N and 87°26' E. Mean temperature is approximately 27°c to 30°c with relative humidity of 70%. Thus two genetic groups of experimental birds maintained at two different farms of Mohanpur campus were exposed to similar type of climatic condition.

3.5 Housing management

The farm building has been constructed with long axis in North-South direction and scientifically oriented to get proper ventilation and natural light. Floors are made up of cement concrete. The height of the side walls is one meter over which rat or predator proof wire netting was fitted on each side of the walls. There is provision of 0.75 meter wide passage surrounding the pens at floor level. The birds were reared on deep litter floor. In each pen sufficient numbers of 50 cm diameter hanging feeder and 40 cm diameter bell shaped automatic drinker were provided. All feeders and drinkers were regularly cleaned and disinfected. Sufficient numbers of nest boxes were provided in the pens. Nest boxes were made up of wood which were placed in all sides of the pens. All the birds were provided with uniform facilities according to rearing system throughout the experimental period.

3.5.1 Rearing of Birds

The birds were kept under deep litter systems of rearing with 2.5 sq. ft. per bird floor space permitting free and comfortable movement. Litter materials used were rice husks saw bust and straw. Depth of the deep litter was 2.5-3 inches. Standard practice for litter management was followed in both the farms.

3.5.2 Diet for experimental bird

Standard poultry feed (mash) was given according to age and body weight (Table-3.1). Feed were given in hanging feeder, were positioned in such a way that the upper edge is comfortably reached by the beak of the birds. Weighed amount of feed were offered in morning (8:30 am) and evening (4 pm).

Table-3.1 Chemical composition of poultry feed used (percentage)

Nutrients	Chick mash	Grower mash	Layer mash
Moisture (max.)	11.0	11.0	11.0
Crude Protein (min.)	20.0	16.0	18.0
Ether Extract (min.)	2.0	2.0	2.0
Crude Fibre (max.)	7.0	9.0	9.0
Acid Insoluble Ash (max.)	4.0	4.0	4.0
Salt (NaCl) (max.)	0.5	0.5	0.5
Calcium (min.)	1.0	1.0	3.0
Available Phosphorus	0.45	0.4	0.4
Lysine	1.0	0.7	0.7
Methionine + Cystine	0.7	0.6	0.6
Metabolizable Energy (Kcal/Kg) (min.)	2800	2500	2600

3.5.3 Water

Fresh and potable water was supplied *ad libitum* in bell shaped automatic drinker, which were hanged within 3 meters of feeder.

3.5.4 Light

The main source of illumination was natural light. Birds are sensitive to day length (photoperiod). Experimental birds were given 16 hours of total photoperiod (natural + artificial). Incandescent bulb was used as source of artificial light.

3.6 Design of Observation

There were 20 male and 200 female birds in each pen. In the present study, 10 males and 10 females of each genetic group were selected randomly but with age bodyweight within range as has been mentioned in 3.3. They were given identification marks with 10 different coloured ribbons tied on shanks. Coloured ribbons were used to get a clear visibility from a distance. Every pen was observed six days per week alternatively for each sex. The birds were scanned four times per day (Table-3.2) arranged from sunrise to sunset.

Table-3.2 Schedule for observation of different systems of behaviour

Time of observation	Systems of behaviour
08:30 A.M.	Ingestive behaviour
11:30 A.M.	Social and Resting behaviour
01:30 P.M.	Agonistic behaviour
05:00 P.M.	Sexual behaviour

Duration for each observation session was 60 minutes (1 hour). The above timing of observations was followed for each sex.

3.7 Systems of Behaviour

The behavioural systems studied in this experiment were categorised under four main systems of behaviour as follows:

3.7.1 Ingestive and Social behaviour during feeding time

Ingestive behaviour involves the consumption of food or nourishing substances includes both solids and liquids (Scott, 1975).

Feeding: During feeding bird introduces the beak into the interior of the feeder. Before picking up a grain the chicken lifts its head so that it can see the grain with both eyes. Then it fixes the position of the grain and after aiming at it is able to hit it (Chicken-yard newsletter, 2001).

Drinking: The act of taking in water with the beak at assigned areas (Cornetto and Estevez, 2001). For drinking they dive their beak deep into the water, then they quickly lift their head so that the water can run down the throat (Chicken-yard newsletter, 2001).

Foraging: The act of scratching and pecking at the ground while moving (Cornetto and Estevez, 2001).

Walking: Relatively low speed displacement of the bird on the ground in which the propulsive force is derived from the action of the legs (Cornetto and Estevez, 2001).

During feeding time birds were also observed for three types of social behaviour, viz. preening, dust-bathing and standing behaviour.

3.7.2 Social and Resting behaviour

Social and Resting behaviour of a flock depends on physiological, psychological and physical state of each member and is influenced by the appearance of the individual (Folsch *et al.,* 1988).

Preening: The grooming habits of birds are called preening. This includes acts of pecking, nibbling, storking, or combing plumage with the beak (Cornetto and Estevez, 2001).

Dust Bathing: The act of building a dirt mound using feet, wings, and beak and then lying on the ground and tossing dirt on its back and wings. Birds lie down in the dirt, scratch it onto their backs, roll in it, rub their necks in it, and shuffle it under their feathers. The chickens usually have a favourite spot to dust bathe that they will come back to again and again (Cornetto and Estevez, 2001).

Lying: Cessation of movement while the breast of the bird is in contact with the floor (Cornetto and Estevez, 2001).

Sleeping: While sleeping, eyes closed for at least 30 sec. (Andrews et al. 1997). Chickens only fall asleep in their familiar group. Only in absolute darkness they put their heads under the feathers and fall asleep with their eyes are closed (Chicken-yard newsletter, 2001).

Dozing: While dozing, eyes are half open or closed with flickering (Andrews *et al.*, 1997).

Sitting: While sitting, eyes are fully open (Andrews *et al.*, 1997).

Standing: In standing posture bird maintains an upright position on extended legs (Cornetto and Estevez, 2001).

3.7.3 Agonistic interactions

Any behaviour associated with fighting, escape, defensive and passive interactions between individuals are termed as agonistic interaction (Scott and Frederickson, 1951).

Pushes: One bird pushes another with head, body etc. when they are too close to one another (O'Keefe *et al.*, 1988).

Chasing: One or more birds pursue another bird across the enclosures. One hen chases another hen away from a limited food source. (O'Keefe *et al.*, 1988).

Fig.3.1 Act of Preening

Fig.3.2 Act of Dust Bathing in group

Fig.3.3 Pattern of Sitting

Fig.3.4 Sleeping by fowl

Fig.3.5 Standing posture in fowl

Fig.3.6 Walking by fowl

Threatening: Threatening bird maintains an upright posture with head held high and chest extended, often with feathers ruffled. Threatening appears to be caused by one bird coming too close to another (O'Keefe *et al.*, 1988).

Fighting: In fighting, two hens face up to each other and aim pecks with their beaks and kicks with their feet and spurs (O'Keefe *et al.*, 1988).

Wing flapping: A display was performed, occurring in varying levels of intensity in which wings were clapped together while the bird is in a upright posture. In a less intense form, wings are clapped together while the head and body of the bird remain level (Millman *et al.*, 2000).

Feather pecking: It is interpreted as an abnormal behaviour where laying hens peck the feathers of conspecifics, damage the plumage or even injure the skin (Ramadan and Von Borell, 2008).

Head pecking: A bird delivers a sharp blow with the beak to the head or body of another bird (O'Keefe *et al.*, 1988).

Tidbiting: A courtship display is performed, in which the bird repeatedly pecked at the ground with his beak, with or without ground scratching with his feet (Millman *et al.*, 2000).

Crowing: A stereotyped vocalization is emitted as the bird maintained an upright posture (Millman *et al.*, 2000).

3.7.4 Sexual behaviours

A number of behaviour patterns are associated with sexual behaviour in chickens. Those patterns that function in the initiation, progression, and culmination of the stimulus-response sequence are most significant (Guhl and Fischer, 1975). Sexual behaviour has two components viz., male and female.

Fig.3.7 Act of Wing Flapping

Fig.3.8 Act of Fighting

Fig.3.9 Act of Tidbiting

Fig.3.10 Crowing posture in fowl

3.7.4.1 Male sexual behaviours

The cock typically takes the initiative in sexual behaviour moving among the hens as though testing each for sexual receptivity (Guhl, 1961). Male sexual behaviour is displayed through following patterns.

Mounting: The male approaches a female gently and places one or both feet on her back (Millman *et al.*, 2000).

Forced mounting: When the female avoided the male, and no further elements of the copulatory sequence were observed, then the male approach the female forcefully to mount over her (Millman *et al.*, 2000).

Copulation: The male mounts, grippes, and treads a female and appears to achieve cloacal contact. The female ruffles her feathers following the male's dismount (Millman *et al.*, 2000).

Forced copulation: The male mounts a female and appears to achieve cloacal contact following a struggle, during which the female attempts to avoid the male. The female often squawks during the struggle (Millman *et al.*, 2000).

Male to male aggression: The male chases, pecks, or jumps at the other male in the pen (Millman *et al.*, 2000).

Male to female aggression: The male pecks a female with a downward blow of the beak, usually directed at her head. The male may also jump at the female, kicking at her with his feet (Millman *et al.*, 2000).

Wing flutter/ Waltzing: A display is performed, occurring in courtship and aggressive situations, in which the male approaches the female in a sideways or circling path with his far wing lowered. His head is usually lowered and his feet make a rasping sound as they pass through the primary feathers of the wing (Millman *et al.*, 2000).

High step advance: A courtship display is performed, in which the male approaches the female with a strutting walk. The legs are lifted and extended forward in an exaggerated manner (Millman *et al.*, 2000).

Steps off: After mating the male usually steps off in a forward direction and the cock may execute a waltz (Guhl and Fischer, 1975).

3.7.4.2 Female sexual behaviour

A hen may respond negatively, positively or be indifferent to courting. Female sexual behaviour is displayed through following patterns.

Crouching: A sexual behaviour of female in which she dips her head and body with wings spread to indicate receptiveness to the male (Guhl and Fischer, 1975).

Interference: A female attacks or threatens the male while he is attempting to copulate with another female, disrupting the copulatory sequence (Millman and Duncan, 2000b).

Allopecking: A female pecks gently at the comb, wattles or face of the male. Bouts of allopecking were terminated when the female engages in a different behaviour (Millman and Duncan, 2000b).

Avoidance by female: The male's behaviour results in a female running away from him (Millman *et al.*, 2000).

Approach by female: The male's behaviour results in one or more females walking or running toward him (Millman *et al.*, 2000).

Female to male/female aggression: A female pecks the male or another female with a downward blow of her beak, usually directed at his/ her head. The female may also jump at the male or at the female, kicking with her feet (Millman and Duncan, 2000b).

Stands and shakes: After mating the hen stands and ruffles her feathers as she gets to her feet. Then she may run in a circle (Guhl and Fischer, 1975).

Fig.3.11 Mounting pattern in fowl

Fig.3.12 Act of Forced Mounting

Fig.3.13 Steps off by male

Fig.3.14 Act of Male to Male Aggression

Fig.3.15 Act of Female to Male Aggression

3.8 Recording of observation

At the beginning of an observation session, the observer took a position avoiding to be seen directly by birds and waited for 3-5 min until all the experimental birds are spotted. The observer then started a stopwatch and walked quietly along the passage outside the pen and recorded data on printed sheet for each systems of behaviour. Instantaneous scan samples (Martin and Bateson, 1986) of all the ten birds in a pen were recorded at the start of the observation and continued through the 60 minutes time at 5 min intervals. A tabulated data for each of the behaviour was obtained from each observation by summing the number of frequency, the birds engaged in that behaviour over the entire 60 mins time. Separated data sheets were prepared for each category of behaviour on the basis of frequency (per hour), duration (min. per hour) and relative duration (percentage).

3.8.1 Frequency (per hour)

Frequency is defined as the measure of the number of occurrences of a repeating event per unit time. To calculate the frequency, the numbers of occurrences of the event within a fixed time interval are counted, and then it is divided by the length of the time interval (www.asknumbers.com/FrequencyConversion.aspx). In the present study, the frequency of a repeating behaviour was calculated by counting the number of times that behavioural event occurred within a specific period of time (one hour in this case).

3.8.2 Duration (min. per hour)

Duration is the amount of time or particular time interval out of a specified time (Wikipedia). In this present study, duration was calculated as the time (min) out of one hour that a bird engaged in a particular behavioural element.

3.8.3 Relative duration (percentage)

Relative duration was calculated as the percentage of time for different forms of behaviour that a bird displayed within an hour of time.

3.9 Statistical Methodology

The count data was transformed to $\sqrt{X}$ to stabilize the variance. Similarly proportion data was subjected to arc-sine transformation to improve the equality of variance. (Snedecor and Cochran, 1992). The transformed data were analysed to study different effects as per following statistical model:

$$Y_{ijk} = \mu + a_i + b_j + c_{(ij)} + e_{(ijk)}$$

Where, Y_{ijk} is the k^{th} observation on the j^{th} sex under i^{th} breed,

μ is the overall mean,

a_i is the effect of i^{th} breed,

b_j is the effect of j^{th} sex,

$c_{(ij)}$ is the interaction effect between i^{th} breed and j^{th} sex and

$e_{(ijk)}$ is the random error.

Different means were compared for significant difference following Critical Difference (CD) test with the following formula:

$$\bar{X}_1 - \bar{X}_2 = t_{0.05} \text{ (at error df) } \sqrt{MSE\left(\frac{1}{m} + \frac{1}{n}\right)}$$

Where, $\bar{X}_1$ is the mean of one group,

$\bar{X}_2$ is the mean of other group,

df is the degree of freedom,

MSE is the mean square error,

m is the number of observation for first group and

n is the number of observation for second group.

The significance (P value) was recorded at 1% ($P \leq 0.01$) level and 5% ($P \leq 0.05$) level. The complete statistical analysis was done with the help of Statistical Package for Social Scientist (SPSS), windows version 10.0.

Chapter- 04

Results and Discussion

The present study has been carried out on two genetic groups of fowls viz. Rhode Island Red and Vanaraja to observe their ingestive, social, resting, agonistic and sexual behaviours under deep litter systems of management, to compare the above systems of behaviour between the two genetic groups and to suggest modification in management practices for both the groups keeping in view of the present findings. The results obtained in the present study regarding the various behavioural patterns exhibited by RIR and Vanaraja are presented and discussed under the following broad categories.

4.1 Ingestive Behaviour of Fowl

Ingestive behaviour of fowl refers to taking of food grain or water by searching the same or from certain assigned areas (Scott, 1975). In the present study the behaviours of fowl during feeding time of one hour have been categorised under different patterns of behaviour. The results obtained are tabulated in terms of frequency (per hour) of different pattern, their absolute and relative (percentage) duration (min. per hour). The results on frequency (per hour) are presented in Table-4.1.1 and graphically in Fig. 4.1.1 and on duration (min. per hour) are presented in Table-4.1.2 and graphically in Fig.4.1.2. Analysis of variance for frequency and duration is shown in Table-4.1.3. The results on relative (percentage) duration are presented in Table-4.1.4 and in Fig.4.1.3. Analysis of variance for relative duration is shown in Table-4.1.5. Findings are discussed in following sections.

4.1.1 Feeding

Feeding is the principal pattern of behaviour during ingestion. Feeding means picking up grains by introducing the beak into the interior of the feeder (Chicken-yard Newsletter, 2001).

a) Frequency of feeding

The frequencies of feeding per hour exhibited by RIR are 3.13 ± 0.01 in male, 3.08 ± 0.01 in female and the overall genetic group value is 3.10 ± 0.02. The respective values in Vanaraja are 3.16 ± 0.01, 3.17 ± 0.01 and 3.16 ± 0.05. The overall mean values for male and female irrespective of genetic group are 3.14 ± 0.01 and 3.13 ± 0.01 respectively. The effect of sex is found to be non significant statistically. Comparison of values between the two genetic groups reveals a significantly ($P \leq 0.01$) higher value in Vanaraja (3.16 ± 0.05) than that in RIR (3.10 ± 0.02).

The genetic group x sex interaction effect on frequency of feeding per hour of feeding time is found to be significant ($P \leq 0.05$). Except the difference between sexes within Vanaraja, all other differences are significant.

b) **Duration of feeding**

Durations of feeding by RIR are 10.44 ± 0.06 min in male, 10.27 ± 0.06 min in female and the overall genetic group value is 10.35 ± 0.08 min. The respective values in Vanaraja are 10.54 ± 0.08, 10.59 ± 0.06 and 10.56 ± 0.02 min. The overall mean value for male and female irrespective of genetic group are 10.36 ± 0.03 and 10.32 ± 0.03 min respectively. The effect of sex is found to be non significant statistically. Comparison of values between the two genetic groups reveals a significantly ($P \leq 0.01$) higher value in Vanaraja (10.56 ± 0.02 min) than that in RIR (10.35 ± 0.08 min).

The genetic group x sex interaction effect on duration of feeding per hour of feeding time is found to be significant ($P \leq 0.05$). Except the difference between sexes within Vanaraja, all other differences are significant.

c) Relative duration (percentage) of feeding

Relative duration (per hour) of feeding for male, female and overall of RIR are 41.80 ± 0.46, 40.95 ± 0.51 and 41.37 ± 0.42 percent respectively. Likewise, in Vanaraja these values are 43.22 ± 0.06, 43.53 ± 0.49 and 43.37 ± 0.15 percent in that order. The overall mean value for male and female are 44.50 ± 0.00 and 43.70 ± 0.04 percent respectively. Comparison of overall genetic group values indicates a significantly ($P \leq 0.01$) higher value in

Vanaraja (43.37 ± 0.15%) than that in RIR (41.37 ± 0.42%). Analysis of variance indicates a non significant effect of sex, though the value of male (44.50 ± 0.00%) is slightly higher than that of female (43.70 ± 0.00%).

The genetic group x sex interaction effect on relative duration of feeding per hour of feeding time is found to be significant ($P \leq 0.05$). Except the difference between sexes within Vanaraja, all other differences are significant.

From this study, it is apparent that Vanaraja bird of both sexes spent significantly more time in feeding than RIR bird of both sexes. Also it is seen that frequency of feeding and relative duration of feeding is more in Vanaraja. It might be due to the fact that Vanaraja is a fast growing bird (Rao *et al.,* 2005). Reports suggested that fast growing breeds need to eat faster and spent more time in feeding than the slow growing ones (Masic *et al.*, 1974 and Savory, 1975). It is also observed that males spent more time in feeding than females in RIR but in case of Vanaraja females spent more time than male birds. No explanation is yet available in literature on sex difference in time spent in feeding.

Findings of the present study coincide well with the earlier findings by Masic *et al.* (1974) and Savory (1975), who also observed that layer type chicken spent more time in feeding. Olukosi *et al.* (2002) also reported in Anak 200 broiler strain that the birds were more interested in feeding than engaging in other forms of behaviour during feeding time.

In the present study it is found that male of RIR spent more time in feeding than the female whereas female of Vanaraja spent more time than the males which contradict with the findings of Andrews *et al.* (1997) who claimed that there was no difference in the time spent on feeding between males and females.

Males of RIR was found to spend more time in feeding activity than the female in the present study which is in agreement with the findings of Lee and Chen (2007) where they observed that the males of Taiwan country chicken, Beijing fatty chicken, pure Silkies and commercial Silkies had significantly higher feeding activity than females. However in Vanaraja breed

Table-4.1.1 Frequency (per hour) of different patterns of behaviour during feeding time in both sexes of two genetic-groups of fowl (Mean±SE)

Genetic group	Sex	Patterns of Behaviour						
		Feeding	Drinking	Foraging	Standing	Walking	Preening	Dust Bathing
Rhode Island Red	Male	$3.13^{a} \pm 0.01$	$2.49^{a} \pm 0.01$	2.16 ± 0.02	$1.82^{ab} \pm 0.02$	1.77 ± 0.02	1.71 ± 0.02	$1.68^{ac} \pm 0.02$
	Female	$3.08^{b} \pm 0.01$	$2.47^{a} \pm 0.01$	2.22 ± 0.02	$1.84^{a} \pm 0.02$	1.83 ± 0.02	1.63 ± 0.01	$1.55^{b} \pm 0.01$
	Overall	$3.10^{B} \pm 0.02$	2.48 ± 0.01	$2.19^{A} \pm 0.03$	$1.83^{A} \pm 0.01$	$1.80^{A} \pm 0.30$	$1.67^{B} \pm 0.04$	$1.61^{B} \pm 0.06$
Vanaraja	Male	$3.16^{c} \pm 0.01$	$2.37^{b} \pm 0.02$	2.14 ± 0.02	$1.77^{b} \pm 0.02$	1.69 ± 0.01	1.90 ± 0.02	$1.69^{d} \pm 0.02$
	Female	$3.17^{c} \pm 0.01$	$2.54^{c} \pm 0.01$	2.13 ± 0.02	$1.70^{ab} \pm 0.02$	1.69 ± 0.01	1.76 ± 0.02	$1.72^{c} \pm 0.02$
	Overall	$3.16^{A} \pm 0.05$	2.45 ± 0.08	$2.13^{B} \pm 0.05$	$1.73^{B} \pm 0.03$	$1.69^{B} \pm 0.01$	$1.83^{A} \pm 0.07$	$1.70^{A} \pm 0.01$
Overall	Male	3.14 ± 0.01	$2.43^{Y} \pm 0.01$	2.15 ± 0.01	1.79 ± 0.01	1.73 ± 0.01	$1.81^{X} \pm 0.01$	$1.69^{X} \pm 0.01$
	Female	3.13 ± 0.01	$2.51^{X} \pm 0.01$	2.18 ± 0.01	1.77 ± 0.01	1.75 ± 0.01	$1.69^{Y} \pm 0.01$	$1.63^{Y} \pm 0.01$

Means with common or without superscript in same column are not significantly different.

Table-4.1.2 Duration (min. per hour) of different patterns of behaviour during feeding time in both sexes of two genetic-groups of fowl (Mean ± SE)

Genetic group	Sex	Patterns of Behaviour						
		Feeding	Drinking	Foraging	Standing	Walking	Preening	Dust Bathing
Rhode Island Red	Male	$10.44^{a} \pm 0.06$	$8.32^{a} \pm 0.08$	7.20 ± 0.11	$6.07^{ab} \pm 0.11$	5.91 ± 0.10	5.72 ± 0.10	$5.63^{ac} \pm 0.11$
	Female	$10.27^{b} \pm 0.06$	$8.26^{a} \pm 0.08$	7.43 ± 0.10	$6.14^{a} \pm 0.12$	6.10 ± 0.11	5.44 ± 0.08	$5.17^{b} \pm 0.05$
	Overall	$10.35^{B} \pm 0.08$	8.29 ± 0.30	$7.31^{A} \pm 0.11$	$6.10^{A} \pm 0.03$	$6.00^{A} \pm 0.09$	$5.58^{B} \pm 0.14$	$5.40^{B} \pm 0.23$
Vanaraja	Male	$10.54^{c} \pm 0.08$	$7.92^{b} \pm 0.10$	7.16 ± 0.13	$5.91^{b} \pm 0.11$	5.65 ± 0.09	6.35 ± 0.14	$5.66^{d} \pm 0.12$
	Female	$10.59^{c} \pm 0.06$	$8.49^{c} \pm 0.07$	7.12 ± 0.12	$5.69^{ab} \pm 0.10$	5.64 ± 0.09	5.88 ± 0.11	$5.73^{c} \pm 0.12$
	Overall	$10.56^{A} \pm 0.02$	8.20 ± 0.28	$7.14^{B} \pm 0.02$	$5.80^{B} \pm 0.10$	$5.64^{B} \pm 0.00$	$6.11^{A} \pm 0.23$	$5.69^{A} \pm 0.03$
Overall	Male	10.36 ± 0.03	$8.01^{Y} \pm 0.03$	7.09 ± 0.05	5.90 ± 0.05	5.70 ± 0.04	$5.97^{X} \pm 0.05$	$5.77^{X} \pm 0.04$
	Female	10.32 ± 0.03	$8.28^{X} \pm 0.03$	7.19 ± 0.05	5.84 ± 0.05	5.77 ± 0.04	$5.57^{Y} \pm 0.05$	$5.37^{Y} \pm 0.04$

Means with common or without superscript in same column are not significantly different.

Table-4.1.3 Analysis of variance for frequency and duration of different patterns of behaviour during feeding time in two genetic-groups of fowl

Source of Variation	df	Ms						
		Feeding	Drinking	Foraging	Standing	Walking	Preening	Dust bathing
Genetic group	1	0.417 **	0.064 NS	0.326 *	0.917 **	1.376 **	2.844 **	0.864 **
Sex	1	0.034 NS	0.063 **	0.086 NS	0.060 NS	0.631 NS	1.405 **	0.352 **
Genetic group × sex interaction	1	0.123 *	0.976 **	0.176 NS	0.216 *	0.138 NS	0.094 NS	0.716 **
Error	996	0.021	0.036	0.062	0.567	0.489	0.059	0.538

NS = Non-significant

* = (P≤0.05) significant at 5% level

** = (P≤0.01) significant at 1% level

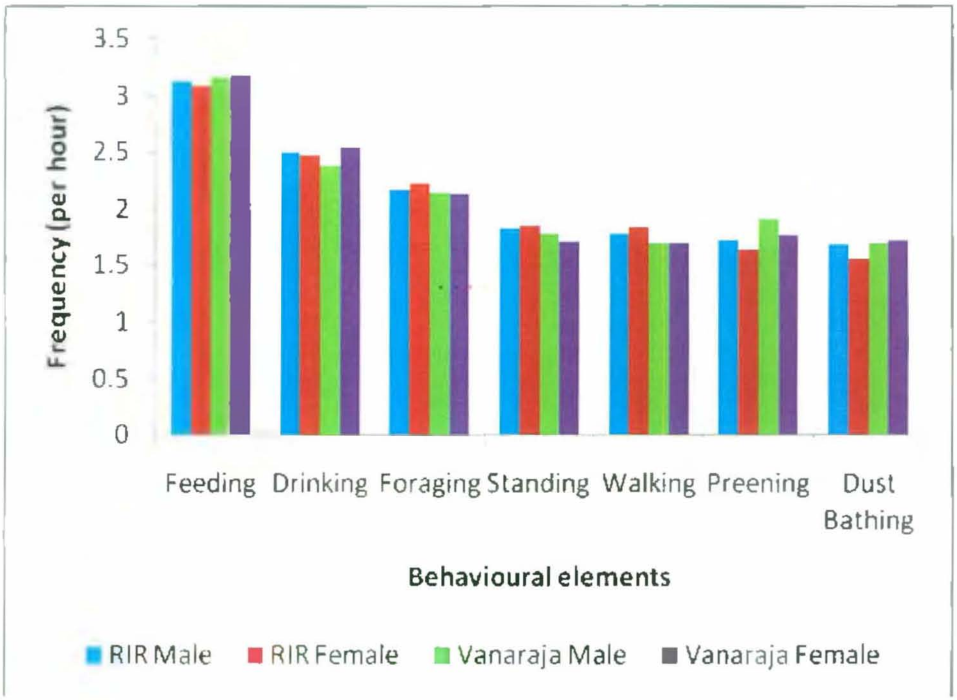

Fig-4.1.1 Frequency (per hour) of different patterns of behaviour during feeding in both sexes of two genetic groups of fowl.

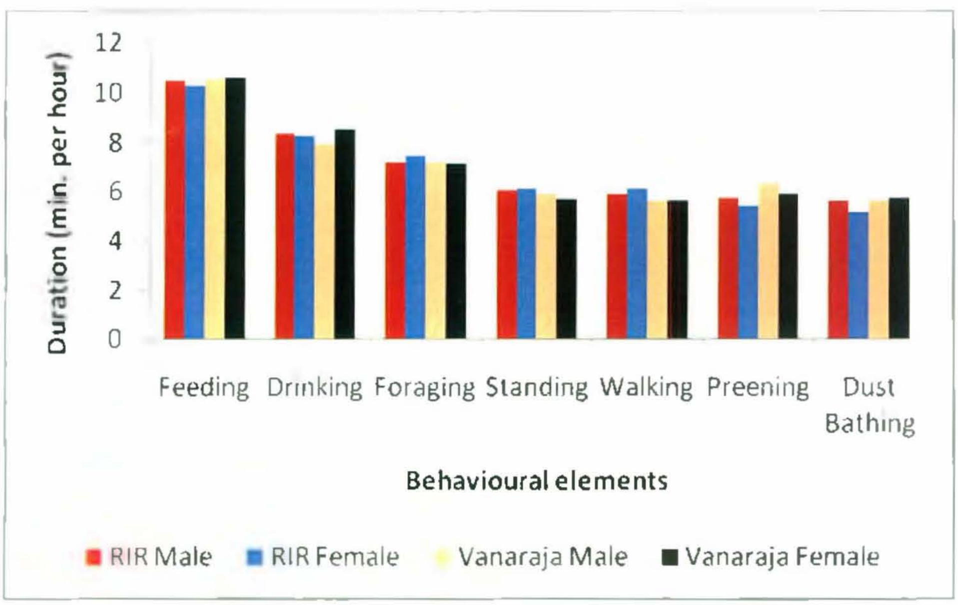

Fig-4.1.2 Duration (min. per hour) of different patterns of behaviour during feeding in both sexes of two genetic groups of fowl.

Table-4.1.4 Relative duration (percentage) of different patterns of behaviour during feeding of 60 minutes in both sexes of two genetic-groups of fowl (Mean ± SE)

Genetic group	Sex	Patterns of Behaviour						
		Feeding	Drinking	Foraging	Standing	Walking	Preening	Dust Bathing
Rhode Island Red	Male	$41.80^{a} \pm 0.46$	$22.75^{a} \pm 0.46$	14.30 ± 0.53	$6.73^{ab} \pm 0.51$	5.67 ± 0.46	4.57 ± 0.47	$4.18^{ac} \pm 0.53$
	Female	$40.95^{b} \pm 0.51$	$22.29^{a} \pm 0.47$	15.81 ± 0.49	$7.18^{a} \pm 0.52$	6.87 ± 0.47	2.70 ± 0.32	$1.10^{b} \pm 0.24$
	Overall	$41.37^{B} \pm 0.42$	22.52 ± 0.23	$15.05^{A} \pm 0.75$	$6.95^{A} \pm 0.22$	$6.27^{A} \pm 0.60$	$3.63^{B} \pm 0.93$	$2.64^{B} \pm 0.54$
Vanaraja	Male	$43.22^{c} \pm 0.06$	$19.51^{b} \pm 0.57$	14.22 ± 0.06	$5.72^{b} \pm 0.47$	4.06 ± 0.41	8.92 ± 0.06	$4.38^{d} \pm 0.55$
	Female	$43.53^{c} \pm 0.49$	$24.19^{c} \pm 0.44$	13.80 ± 0.58	$4.26^{ab} \pm 0.42$	3.86 ± 0.42	5.63 ± 0.52	$4.88^{c} \pm 0.56$
	Overall	$43.37^{A} \pm 0.15$	21.85 ± 0.34	$14.01^{B} \pm 0.21$	$4.99^{B} \pm 0.73$	$3.96^{B} \pm 0.10$	$7.27^{A} \pm 0.64$	$4.63^{A} \pm 0.25$
Overall	Male	44.50 ± 0.00	$21.30^{Y} \pm 0.00$	14.30 ± 0.04	6.23 ± 0.03	4.87 ± 0.03	$6.74^{X} \pm 0.04$	$4.28^{X} \pm 0.03$
	Female	43.70 ± 0.04	$23.20^{X} \pm 0.03$	14.80 ± 0.04	5.72 ± 0.03	5.37 ± 0.03	$4.17^{Y} \pm 0.04$	$2.99^{Y} \pm 0.03$

Means with common or without superscript in same column are not significantly different.

Table-4.1.5 Analysis of variance for relative duration of different patterns of behaviour during feeding time in two genetic-groups of fowl

Source of Variation	df	Ms						
		Feeding	Drinking	Foraging	Standing	Walking	Preening	Dust bathing
Genetic group	1	0.156 **	0.068 NS	0.027 *	0.096 **	0.133 **	0.331 **	0.099 **
Sex	1	0.014 NS	0.095 **	0.072 NS	0.063 NS	0.063 NS	0.166 **	0.041 **
Genetic group × sex interaction	1	0.029 *	0.147 **	0.023 NS	0.022 *	0.012 NS	0.012 NS	0.080 **
Error	996	0.073	0.061	0.080	0.059	0.049	0.064	0.061

NS = Non-significant

* = ($P \leq 0.05$) significant at 5% level

** = ($P \leq 0.01$) significant at 1% level

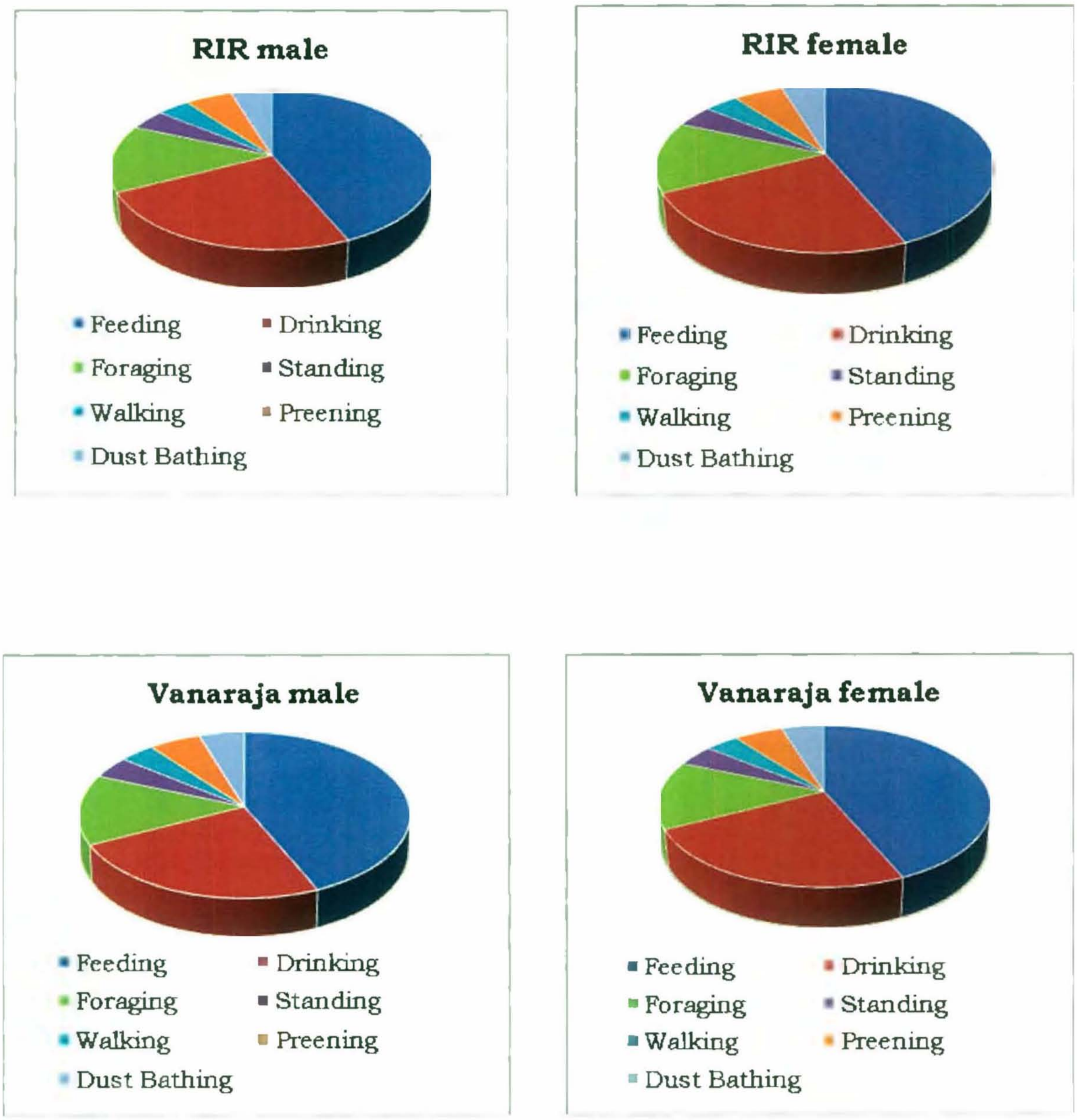

Fig-4.1.3 Relative duration (percentage) of different patterns of behaviour during feeding of 60 minutes in both sexes of two genetic groups of fowl.

the females are found to spend more time in feeding activity than the males which contradicts the findings of Lee and Chen (2007).

4.1.2 Drinking

The pattern of drinking by fowl during feeding time has been recorded. Drinking is the act of taking water with the beak at assigned areas (Chicken-yard newsletter, 2001).

a) Frequency of drinking

Frequencies of drinking per hour of feeding time exhibited by RIR male and female birds are 2.49 ± 0.01 and 2.47 ± 0.01 respectively, whereas overall genetic group value for RIR is 2.48 ± 0.01. The respective values in Vanaraja are 2.37 ± 0.02, 2.54 ± 0.01 and 2.45 ± 0.08. The overall mean value for male and female irrespective of genetic group are 2.43 ± 0.01 and 2.51 ± 0.01 respectively. Effect of genetic group on frequency of drinking is non significant. However frequency in RIR (2.48 ± 0.01) is slightly higher than that of Vanaraja (2.45 ± 0.08). Irrespective of genetic group frequency of drinking is significantly ($P \leq 0.01$) higher in female (2.51 ± 0.01) than that in male (2.43 ± 0.01).

The genetic group x sex interaction effect on frequency of drinking per hour of feeding time is found to be significant ($P \leq 0.01$). Except the difference between sexes within RIR, all other differences are significant.

b) Duration of drinking

Duration (min) of drinking per hour exhibited by RIR male and female birds are 8.32 ± 0.08 and 8.26 ± 0.08 min respectively, whereas overall genetic group value for RIR is 8.29 ± 0.30 min. The respective values in Vanaraja are 7.92 ± 0.10, 8.49 ± 0.07 and 8.20 ± 0.28 min. The effect of genetic group on duration of drinking is non significant statistically. Duration of drinking per hour of feeding time by male and female birds irrespective of genetic group is 8.01 ± 0.03 and 8.28 ± 0.03 min respectively. The effect of sex is found to be significant ($P \leq 0.01$).

The genetic group x sex interaction effect on duration of drinking per hour of feeding time is found to be significant ($P \le 0.01$). Except the difference between sexes within RIR, all other differences are significant.

c) Relative duration (percentage) of drinking

Mean values for relative duration of drinking for male, female and overall of RIR are 22.75 ± 0.46, 22.29 ± 0.47 and 22.52 ± 0.23 percent respectively. Likewise, in Vanaraja these values are 19.51 ± 0.57, 24.19 ± 0.44 and 21.85 ± 0.34 percent in that order. The overall mean value for male and female are 21.30 ± 0.00 and 23.20 ± 0.03 percent respectively, the difference being significant ($P \le 0.01$) statistically. However, the effect of genetic group on relative duration of drinking is found to be non significant.

The genetic group x sex interaction effect on relative duration of drinking per hour of feeding time is found to be significant ($P \le 0.01$) in all differences except the difference between sexes within RIR.

In the present study it is revealed that the RIR birds spent more time in drinking than Vanaraja birds. However it is not known why RIR being smaller in body size devotes more time in drinking. It is also noticed that male of RIR engaged in drinking more frequently and spent more time than male of Vanaraja, but it is reverse in case of female birds where Vanaraja females spent more time in drinking than the RIR females. It is also observed that the males spent more time in drinking than females in RIR but in case of Vanaraja females spent more time than male birds.

The present findings corroborate with the finding of Lee and Chen (2007), where they observed on Taiwan country chicken, Beijing fatty chicken, pure Silkies and commercial Silkies that males had significantly higher drinking activity than females, whereas in the present study it has been noticed that in RIR, males engaged more frequently and spent more time in drinking than females. But the findings are just reverse in case of Vanaraja, where females spent more time in drinking than males which contradicts with the findings of Lee and Chen (2007).

4.1.3 Foraging

Foraging is one pattern of behaviour during feeding time. Foraging behaviour consists of pecking and ground scratching followed by ingestion (Folsch and Vestergaard, 1981).

a) Frequency of foraging

Frequency of foraging per hour in RIR are 2.16 ± 0.02 and 2.22 ± 0.02 for male and female respectively and overall genetic group value is 2.19 ± 0.03. The respective values in Vanaraja are 2.14 ± 0.02, 2.13 ± 0.02 and 2.13 ± 0.05. The overall mean values for male and female irrespective of genetic group are 2.15 ± 0.01 and 2.18 ± 0.01 respectively. The effect of sex is found to be non significant statistically. Comparison of values between the two genetic groups reveals a significantly ($P \leq 0.05$) higher frequency in RIR (2.19 ± 0.03) than that in Vanaraja (2.13 ± 0.05).

The genetic group x sex interaction effect on frequency of foraging per hour of feeding time is found to be non significant statistically.

b) Duration of foraging

For RIR, duration of foraging by male and female are 7.20 ± 0.11 and 7.43 ± 0.10 min respectively and overall genetic group value is 7.31 ± 0.11 min. For Vanaraja, these values are 7.16 ± 0.13, 7.12 ± 0.12 and 7.14 ± 0.02 min in that order. The overall duration for male and female irrespective of genetic group are 7.09 ± 0.05 and 7.19 ± 0.05 min respectively. The effect of sex is found to be non significant statistically. Comparison of overall values between the two genetic groups reveals a significantly ($P \leq 0.05$) higher value in RIR (7.31 ± 0.11 min) than that in Vanaraja (7.14 ± 0.02 min).

The genetic group x sex interaction effect on duration of foraging per hour of feeding time is found to be non significant statistically.

c) Relative Duration (percentage) of foraging

For RIR, relative duration of foraging by male, female and overall are 14.30 ± 0.53 15.81 ± 0.49 and 15.05 ± 0.75 percent respectively. The respective values in Vanaraja are 14.22 ± 0.06, 13.80 ± 0.52 and 14.01 ±

0.21 percent. Comparison of overall genetic group values indicates a significantly ($P \leq 0.05$) higher value in RIR (15.05 ± 0.75%) than that by Vanaraja (14.01 ± 0.21%). Analysis of variance indicates a non significant effect of sex, though the value by female (14.80 ± 0.04%) is slightly higher than by male (14.30 ± 0.04%).

The genetic group x sex interaction effect on relative duration of foraging per hour of feeding time is found to be non significant statistically in all the differences.

In the present study it is revealed that RIR birds spent more time in foraging than Vanaraja birds by both sexes. It may be due to smaller body size of RIR than Vanaraja, as Lee & Chen (2007) reported that smaller sized birds devote more time in foraging than large sized birds. Also it is noticed that frequency of foraging and relative duration of foraging is more in RIR. The females of RIR spent more time in foraging than the male birds, but in Vanaraja, males spent more time in foraging than female counterparts.

Lee & Chen (2007) observed that some breed used to display higher frequency of foraging than others. In their study, they found that pure Silkies displayed a higher frequency of foraging than the other breeds viz. Taiwan country chicken, Beijing fatty chicken and commercial Silkies. In the present study RIR exhibited more frequency of foraging than Vanaraja. It may be due to that some breeds are more active during feeding time and display a higher rate of activity i.e. foraging.

In the present study, it is found that in RIR females had higher frequency of foraging and spent more time than males, which is in agreement with the findings of Lee & Chen (2007). On the contrary, Vanaraja males have higher frequency of foraging and spent more time than females.

4.1.4 Standing during Feeding Time

The pattern of standing by fowl during feeding time has been recorded which is actually a resting behavioural pattern of fowl. When birds maintain an upright position on extended legs, then it terms as standing behaviour (Cornetto and Estevez, 2001).

a) Frequency of standing

The frequency of standing for male, female and overall in RIR are 1.82 ± 0.02, 1.84 ± 0.02 and 1.83 ± 0.01 respectively. These values for Vanaraja are 1.77 ± 0.02, 1.70 ± 0.02 and 1.73 ± 0.03 in that order. The overall mean value for male and female irrespective of genetic group are 1.79 ± 0.01 and 1.77 ± 0.01 respectively. The effect of sex is found to be non significant statistically. Comparison of overall genetic group values reveals a significantly ($P \leq 0.01$) higher value in RIR (1.83 ± 0.01) than that in Vanaraja (1.73 ± 0.03).

The genetic group x sex interaction effect on frequency of standing per hour of feeding time is found to be significant ($P \leq 0.05$). But except the difference between RIR female and Vanaraja male, all other differences are found to be non significant statistically.

b) Duration of standing

The duration of standing for male, female and overall genetic group value in RIR are 6.07 ± 0.11, 6.14 ± 0.12 and 6.10 ± 0.03 min respectively. These values for Vanaraja are 5.91 ± 0.11, 5.69 ± 0.10 and 5.80 ± 0.10 min in that order. The overall mean value for male and female irrespective of genetic group are 5.90 ± 0.05 and 5.84 ± 0.05 min respectively, the difference being non significant statistically. Comparison of overall genetic group values indicates a significantly ($P \leq 0.01$) higher value in RIR (6.10 ± 0.03 min) than that in Vanaraja (5.80 ± 0.10 min).

The genetic group x sex interaction effect on duration (min) of standing per hour of feeding time is found to be significant ($P \leq 0.05$). But except the difference between RIR female and Vanaraja male, all other differences are found to be non significant statistically.

c) Relative duration (percentage) of standing

The relative duration for male, female and overall in RIR are 6.73 ± 0.51, 7.18 ± 0.52 and 6.95 ± 0.22 percent respectively. The respective values for Vanaraja are 5.72 ± 0.47, 4.26 ± 0.42 and 4.99 ± 0.73 percent. The overall mean value for male and female irrespective of genetic group are 6.23

± 0.01 and 5.72 ± 0.03 percent respectively. The effect of sex is found to be non significant statistically. Comparison of overall relative duration (%) of standing between the two genetic groups indicates a significantly ($P \leq 0.01$) higher value in RIR (6.95 ± 0.22%) than that in Vanaraja (4.99 ± 0.73%).

The genetic group x sex interaction effect on relative duration of standing per hour of feeding time is found to be significant ($P \leq 0.05$). But all the differences are found to be non significant except the difference between RIR female and Vanaraja male,

It is revealed from the present study that RIR birds spent more time in standing during feeding time than Vanaraja in both sexes. Also the frequency of standing and the relative duration of standing are higher in case of RIR birds. It is also noticed that female of RIR used to stand more time during feeding and also frequency and relative duration of standing is more than the male birds. On the other hand, in Vanaraja, males spent more time in standing than female birds.

In the present study it is also found that Vanaraja males used to stand more time during feeding period than that by females, which is in agreement with the findings of Andrews *et al.* (1997) where they reported that male birds stood for longer than female birds. On the contrary, RIR females used to stand more time than the males.

The present observation for behaviours during feeding time was done in the morning time, when it was noticed that birds spent more time in standing than other behaviours during feeding time rather than feeding, drinking and foraging activities. This finding coincides well with the findings of Lee & Chen (2007) where they depicted that birds showed more standing in early morning and late afternoon.

4.1.5 Walking During Feeding Time

This behaviour during feeding time has been quantified here in terms of walking i.e. relatively a low speed displacement of the bird on the ground in which the propulsive force is derived from the action of the legs (Cornetto and Estevez, 2001).

a) Frequency of walking

The frequency per hour of walking in male and female of RIR are 1.77 ± 0.02 and 1.83 ± 0.02 respectively and 1.80 ± 0.30 is the overall value for RIR. In Vanaraja these values are 1.69 ± 0.01, 1.69 ± 0.01 and 1.69 ± 0.01 respectively. The overall mean value for male and female irrespective of genetic group are 1.73 ± 0.01 and 1.75 ± 0.01 respectively. The effect of sex is found to be non significant statistically. Comparison between the overall genetic group values reveals significantly ($P \leq 0.01$) higher value in RIR (1.80 ± 0.30) than that of Vanaraja (1.69 ± 0.01).

Genetic group x sex interaction effect on frequency of walking per hour of feeding time is found to be non significant statistically.

b) Duration of walking

The duration for walking in male and female of RIR are 5.91 ± 0.10 and 6.10 ± 0.11 min respectively and 6.00 ± 0.09 min is the overall value for RIR. In Vanaraja these values are 5.65 ± 0.09, 5.64 ± 0.09 and 5.64 ± 0.00 min respectively. Duration of walking per hour of feeding time by male and female birds irrespective of genetic group are 5.70 ± 0.04 and 5.77 ± 0.04 min respectively. The effect of sex is however found to be non significant statistically. The overall genetic group value in RIR (6.00 ± 0.09 min) is significantly ($P \leq 0.01$) higher than that of Vanaraja (5.64 ± 0.00 min).

Genetic group x sex interaction effect on duration of walking per hour of feeding time is found to be non significant statistically in all the differences.

c) Relative duration (percentage) of walking

The relative duration of walking in male, female and overall of RIR are 5.67 ± 0.46, 6.87 ± 0.47 and 6.27 ± 0.60 percent respectively. These values in Vanaraja are 4.06 ± 0.41, 3.86 ± 0.42 and 3.96 ± 0.10 percent in that order. The overall mean value for male and female irrespective of genetic group are 4.87 ± 0.03 and 5.37 ± 0.03 percent respectively the difference being non significant statistically. Comparison between the overall genetic group values reveals a significantly ($P \leq 0.01$) higher value in RIR ($6.27 \pm 0.60\%$) than that of Vanaraja ($3.96 \pm 0.10\%$).

Genetic group x sex interaction effect on relative duration of walking per hour of feeding time is found to be non significant statistically.

Findings of the present study reveal that the RIR birds spent more time in walking during feeding time than Vanaraja birds in both sexes. It might be due to the fact that RIR birds are active, hardy and friendly and have smaller body size than Vanaraja birds. Also the frequency and relative duration of walking is more in RIR. It is also noticed that in RIR female birds used to walk more frequently and spent more time than the males. But in case of Vanaraja, males and females spent same time in walking during feeding time.

Present findings also reveal that in RIR, males walked less time than females which is in agreement with the findings of Lee *et al.* (2007) where they noticed that males had less walking than females. On the contrary, in Vanaraja there was no significant difference in time that male and female spent in walking.

The finding of the present study contradicts with the findings of Andrews *et al.* (1997) where they observed that male birds walked longer than female birds in their studies on broiler chicken. Whereas in the present study it is observed that in RIR, females used to walk longer than males and in case of Vanaraja the walking time in male and female is same. This difference may be due to the reason that present study has been conducted on layer birds, not on broilers as in case of Andrews *et al.* (1997).

Present study also shows that birds spent more time in walking along with standing during feeding time than other patterns of behaviours rather than feeding, drinking and foraging, which is in agreement with the findings of Lee & Chen (2007) where they found that birds showed more walking in early morning. Present observation on walking behaviour during feeding time has been carried out during morning feeding.

4.1.6 Preening During Feeding Time

During the time of feeding the preening behaviour of fowl also has been observed. The grooming habits of birds are called preening (Cornetto and Estevez, 2001).

a) Frequency of preening during feeding time

Frequency of preening behaviour during one hour of feeding for RIR male and female birds are 1.71 ± 0.02 and 1.63 ± 0.01 and the overall genetic group value is 1.67 ± 0.04. These values for Vanaraja are 1.90 ± 0.02, 1.76 ± 0.02 and 1.83 ± 0.07 respectively. The overall mean values for male and female birds irrespective of genetic group are 1.81 ± 0.01 and 1.69 ± 0.01 respectively. Comparison between the overall genetic group values reveals a significantly ($P \leq 0.01$) higher value in Vanaraja (1.83 ± 0.07) to that of RIR (1.67 ± 0.04). Irrespective of genetic group frequency of preening during feeding time of one hour is significantly ($P \leq 0.01$) higher in male (1.81 ± 0.01) than that in female (1.69 ± 0.01).

The genetic group x sex interaction effect on frequency of preening per hour of feeding time is found to be non significant statistically in all the differences like difference between sexes within RIR and between sexes within Vanaraja, difference within males between genetic groups and females between genetic groups, difference between RIR male and Vanaraja female and between RIR female and Vanaraja male.

b) Duration of preening during feeding time

Duration of preening behaviour per hour for RIR male and female birds are 5.72 ± 0.10 and 5.44 ± 0.08 min respectively and 5.58 ± 0.14 min is the overall genetic group value. The respective values in Vanaraja are 6.35 ± 0.14, 5.88 ± 0.11 and 6.11 ± 0.23 min. Duration of preening per hour of feeding time by male and female irrespective of genetic group are 5.97 ± 0.05 and 5.57 ± 0.05 min respectively. The effect of sex is found to be significant ($P \leq 0.01$). Comparison of overall genetic group values reveals a significantly ($P \leq 0.01$) higher value in Vanaraja (6.11 ± 0.23 min) than that of RIR (5.58 ± 0.14 min).

The genetic group x sex interaction effect on duration of preening per hour of feeding time is found to be non significant statistically.

c) Relative duration (percentage) of preening during feeding time

Relative duration of preening behaviour exhibited by RIR male and female birds are 4.57 ± 0.47 and 2.70 ± 0.32 percent respectively and the overall value is 3.63 ± 0.93 percent. The respective values for Vanaraja are 8.92 ± 0.00, 5.63 ± 0.52 and 7.27 ± 0.64 percent. The overall mean values for male and female irrespective of genetic group are 6.74 ± 0.00 and 4.17 ± 0.04 percent respectively, the difference being significant ($P \leq 0.01$) statistically. The effect of genetic group on relative duration of preening reveals a significantly ($P \leq 0.01$) higher value in Vanaraja (7.27 ± 0.64%) than that of RIR (3.63 ± 0.93%).

The genetic group x sex interaction effect on relative duration of preening per hour of feeding time is found to be non significant statistically in all differences like between sexes within genetic groups, within sexes between genetic groups and between sexes between genetic groups.

Present findings reveal that during feeding time Vanaraja birds spent more time in preening than the RIR in both sexes. Also the frequency of preening and relative duration of preening during feeding time is more in Vanaraja than RIR in both sexes. It is also found that the male birds spent more time in preening than female in both the genetic groups. This finding contradicts with the finding of Lee & Chen (2007) where they found that females had significantly higher preening behaviour than males.

Andrews *et al.* (1997) also observed in broiler chicken that male bird spent more time in preening than its female counterpart.

Lee & Chen (2007) also observed that some breeds used to show less preening activity than other breeds. They found that commercial Silkies showed less preening activity than the other breeds viz. Taiwan country chicken, Beijing fatty chicken and pure Silkies. In the present study, RIR birds exhibit less preening activity than Vanaraja during feeding time.

4.1.7 Dust Bathing During Feeding Time

During time of feeding the pattern of dust bathing by fowl has been recorded. Dust bathing is the act of building a dirt mound using feet, wings and beak and then lying on the ground and tossing dirt on its back and wings (Cornetto and Estevez, 2001).

a) Frequency of dust bathing during feeding time

The frequency of dust bathing per hour exhibited by RIR male and female are 1.68 ± 0.02 and 1.55 ± 0.01 respectively and 1.61 ± 0.06 is the overall genetic group value. The respective values for Vanaraja are 1.69 ± 0.02, 1.72 ± 0.02 and 1.70 ± 0.01. The overall mean value for male and female irrespective of genetic group are 1.69 ± 0.01 and 1.63 ± 0.01 respectively. The effect of sex is found to be significant ($P \leq 0.01$). Comparison of values between both the genetic groups reveals a significantly ($P \leq 0.01$) higher value in Vanaraja (1.70 ± 0.01) than that of RIR (1.61 ± 0.06).

The genetic group x sex interaction effect on frequency of dust bathing per hour of feeding time is found to be significant ($P \leq 0.01$). Except the difference between Vanaraja female and RIR male, all other differences are found to be significant.

b) Duration of dust bathing during feeding time

Duration of dust bathing per hour during feeding time exhibited by RIR male and female are 5.63 ± 0.11 and 5.17 ± 0.05 min respectively and 5.40 ± 0.23 min is the overall genetic group value. The respective values for Vanaraja are 5.66 ± 0.12, 5.73 ± 0.12 and 5.69 ± 0.03 min. The overall mean value for male and female irrespective of genetic group are 5.77 ± 0.04 and 5.37 ± 0.04 min respectively, the difference being significant ($P \leq 0.01$). Comparison between the overall genetic group values reveals a significantly ($P \leq 0.01$) higher value in Vanaraja (5.69 ± 0.03 min) to that of RIR (5.40 ± 0.23 min).

The genetic group x sex interaction effect on duration of dust bathing per hour of feeding time is found to be significant ($P \leq 0.01$). Except the difference between Vanaraja female and RIR male, all other differences are found to be significant.

c) Relative duration (percentage) of dust bathing during feeding time

Relative durations of dust bathing during feeding time by RIR are 4.18 ± 0.53 percent in male and 1.10 ± 0.24 percent in female and 2.64 ± 0.54 percent is the overall genetic group value. The respective values for Vanaraja are 4.38 ± 0.55, 4.88 ± 0.56 and 4.63 ± 0.25 percent. The overall mean value for male and female irrespective of genetic group are 4.28 ± 0.03 and 2.99 ± 0.03 percent respectively. Comparison of overall values between both the genetic groups reveal a significantly ($P \leq 0.01$) higher value in Vanaraja (4.63 ± 0.25%) than that in RIR (2.64 ± 0.54%). Irrespective of genetic group relative duration of dust bathing is significantly ($P \leq 0.01$) higher in male (4.28 ± 0.00%) than that in female (2.99 ± 0.00%).

The genetic group x sex interaction effect on relative duration of dust bathing per hour of feeding time is found to be significant ($P \leq 0.01$) in all the differences except the difference between Vanaraja female and RIR male.

The findings of the present study reveal that Vanaraja birds spent significantly more time in dust bathing during feeding time than RIR in both sexes. Also frequency and relative duration of dust bathing is more in Vanaraja in both sexes than RIR. It might be due to larger body size of Vanaraja birds than RIR birds. It is also observed that in RIR, males spent significantly more time in dust bathing than females. On the other hand in Vanaraja, females used to spend more time in dust bathing during feeding time than males.

In the present study, it is found that male birds used to show higher dust bathing activity than females in RIR, which corroborate well with the findings of Lee & Chen (2007) where they stated that male birds tended to have higher dust bathing activity than female birds. On the contrary, in Vanaraja, females spent more time in dust bathing than males for which no explanation is yet available.

Relative importance of different patterns of behaviour during feeding time

Time motion analysis of different patterns of behaviour of bird during feeding time depicts that feeding is the prime activity during this period consuming 42.3 percent of one hour time. This is followed by drinking (22.1%), foraging (14.5%), standing (5.9%), preening (5.4%), walking (5.1%), and dust bathing (3.6%). The birds spent considerable time in foraging (14.5%) despite presence of feed in the feed hopper. This could be due to their natural instinct of foraging. The birds spent a very little time in standing (5.6%), thereby clearly showing that they are highly active during feeding time. The preening (5.4%) and dust bathing (3.63%) during feeding time in all probability are expression of their satisfaction and playfulness.

4.2 Social and Resting Behaviour

The social and resting behaviour of a flock depends on the physiological, psychological and physical state of each member and is influenced by the appearance of the individual (Folsch *et al.* 1988). In the present study, the social and resting behaviour of fowl have been categorized under different patterns of behaviour. The results obtained are tabulated in terms of frequency (per hour) of different patterns, their absolute and relative (percentage) duration (min. per hour). The results on frequency (per hour) are presented in Table-4.2.1 and graphically in Fig.4.2.1 and on duration (min. per hour) are presented in Table-4.2.2 and graphically in Fig.4.2.2. Analysis of variance for frequency and duration is shown in Table-4.2.3. The results on relative (percentage) duration are presented in Table-4.2.4 and in Fig.4.2.3. Analysis of variance for relative duration is shown in Table-4.2.5. Findings are discussed in following sections.

4.2.1 Preening

Preening is one of the main patterns of social behaviour in fowl. Preening refers as the grooming habits of birds i.e. act of pecking, nibbling, storking or combing plumage with the beak (Cornetto and Estevez, 2001).

a) Frequency of preening

The frequencies of preening per hour exhibited by RIR are 2.20 ± 0.02 in male, 2.24 ± 0.02 in female and 2.22 ± 0.02 is the overall genetic group value. The respective values in Vanaraja are 2.41 ± 0.02, 2.40 ± 0.02 and 2.40 ± 0.05. The overall mean value for male and female irrespective of genetic breed are 2.31 ± 0.03 and 2.32 ± 0.03 respectively. The effect of sex is found to be non significant statistically. Comparison of values between the two genetic groups reveals a significantly ($P \leq 0.01$) higher value in Vanaraja (2.04 ± 0.05) than that in RIR (2.22 ± 0.02).

The genetic group x sex interaction effect on frequency of preening per hour is found to be non significant statistically.

b) Duration of preening

Duration of preening per hour by RIR are 7.53 ± 0.14 min in male, 7.47 ± 0.13 min in female and 7.41 ± 0.06 min is the overall genetic group value. The respective values in Vanaraja are 8.04 ± 0.14, 8.02 ± 0.13 and 8.03 ± 0.10 min. The overall mean value for male and female irrespective of genetic group are 7.62 ± 0.09 and 7.65 ± 0.09 min respectively. The effect of sex is found to be non significant statistically. Comparison of values between the two genetic groups reveals a significantly ($P \leq 0.01$) higher value in Vanaraja (8.03 ± 0.10 min) than that in RIR (7.41 ± 0.06 min).

The genetic group x sex interaction effect on durations (min) of preening per hour is found to be non significant statistically.

c) Relative duration (percentage) of preening

Relative duration of preening for male, female and overall in RIR are 17.64 ± 0.12, 17.94 ± 0.02 and 17.79 ± 0.15 percent respectively. The values in Vanaraja are 22.53 ± 0.23, 22.33 ± 0.08 and 22.43 ± 0.10 percent in that order. The overall mean value for male and female irrespective of genetic group are 20.50 ± 0.08 and 20.20 ± 0.08 percent respectively though the effect of sex is found to be non significant statistically. A significantly ($P \leq 0.01$) higher value is observed in Vanaraja (22.43 ± 0.10%) than that in RIR (17.79 ± 0.15%). Effect of genetic group on relative duration of preening is found to be significant ($P \leq 0.01$).

The genetic group x sex interaction effect on relative duration (%) of preening per hour is found to be non significant statistically.

The findings from the present study reveal that Vanaraja spent more time in preening than RIR in both sexes. Also the frequency of preening and relative duration are more in Vanaraja than that in RIR in both sexes. It is also observed that in RIR, females performed preening more frequently and also spent more time in doing so than that by its male counterparts. Present findings coincide with the observation of Lee *et al.* (2007) where they observed that females had significantly higher preening activity than male birds. On the other hand, it is noticed that in Vanaraja, males showed more preening activities than its female counterparts which is in agreement with the findings of Andrews *et al.* (1997) where they reported that in broiler chicken male bird spent more time in preening than its female counterparts.

Lee & Chen (2007) also observed that some breeds use to show less preening activity than other breeds. They found that commercial Silkies showed less preening activity than the other breeds viz. Taiwan country chicken, Beijing fatty chicken and pure Silkies. In the present study, it is also noticed that RIR exhibits less preening activity than the Vanaraja.

4.2.2 Dust bathing

Dust bathing is another type of social behaviour of fowl which means the act of building a dirt mound using feet, wings and beak and then lying on the ground and tossing dirt on its back and wings (Cornetto and Estevez, 2001).

a) Frequency of dust bathing

The frequency per hour of dust bathing in male and female of RIR are 2.24 ± 0.02 and 2.39 ± 0.02 respectively and the overall genetic group value is 2.31 ± 0.07. The respective values in Vanaraja are 2.28 ± 0.02, 2.27 ± 0.02 and 2.27 ± 0.05. The overall mean value for male and female irrespective of genetic group are 2.26 ± 0.02 and 2.32 ± 0.02 respectively. The effect of sex is found to be non significant statistically. Effect of genetic

Table-4.2.1 Frequency (per hour) of different patterns of social and resting behaviour in both sexes of two genetic-groups of fowl (Mean ± SE)

Genetic group	Sex	Patterns of Behaviour						
		Preening	Dust Bathing	Lying	Sleeping	Dozing	Sitting	Standing
Rhode Island Red	Male	2.20 ± 0.02	2.24^{b} ± 0.02	2.29 ± 0.01	1.65^{a} ± 0.01	2.00 ± 0.01	2.31 ± 0.01	2.12 ± 0.02
	Female	2.24 ± 0.02	2.39^{a} ± 0.02	2.26 ± 0.02	1.59^{ab} ± 0.09	1.94 ± 0.02	2.23 ± 0.02	2.16 ± 0.02
	Overall	2.22^{B} ± 0.02	2.31 ± 0.07	2.27^{A} ± 0.01	1.62^{A} ± 0.03	1.97^{A} ± 0.03	2.27^{B} ± 0.04	2.14 ± 0.02
Vanaraja	Male	2.41 ± 0.02	2.28^{b} ± 0.02	2.20 ± 0.02	1.54^{b} ± 0.09	1.74 ± 0.01	2.40 ± 0.02	2.12 ± 0.02
	Female	2.40 ± 0.02	2.27^{b} ± 0.02	2.15 ± 0.02	1.58^{b} ± 0.01	1.79 ± 0.01	2.37 ± 0.02	2.22 ± 0.02
	Overall	2.40^{A} ± 0.05	2.27 ± 0.05	2.17^{B} ± 0.25	1.56^{B} ± 0.02	1.76^{B} ± 0.25	2.38^{A} ± 0.01	2.17 ± 0.05
Overall	Male	2.31 ± 0.03	2.26 ± 0.02	2.25 ± 0.02	1.60 ± 0.01	1.87 ± 0.01	2.35 ± 0.02	2.11 ± 0.02
	Female	2.32 ± 0.03	2.32 ± 0.02	2.21 ± 0.02	1.58 ± 0.01	1.86 ± 0.01	2.29 ± 0.02	2.19 ± 0.02

Means with common or without superscript in same column are not significantly different.

Table-4.2.2 Duration (min. per hour) of different patterns of social and resting behaviour in both sexes of two genetic-groups of fowl (Mean ± SE)

Genetic group	Sex	Patterns of Behaviour						
		Preening	Dust Bathing	Lying	Sleeping	Dozing	Sitting	Standing
Rhode Island Red	Male	7.35 ± 0.14	7.49^{b} ± 0.12	7.66 ± 0.09	5.52^{a} ± 0.07	6.68 ± 0.09	7.71 ± 0.09	7.07 ± 0.11
	Female	7.47 ± 0.13	7.97^{a} ± 0.12	7.56 ± 0.10	5.30^{ab} ± 0.04	6.47 ± 0.10	7.45 ± 0.10	7.20 ± 0.12
	Overall	7.41^{B} ± 0.06	7.73 ± 0.24	7.61^{A} ± 0.04	5.41^{A} ± 0.10	6.57^{A} ± 0.10	7.58^{B} ± 0.12	7.13 ± 0.06
Vanaraja	Male	8.04 ± 0.14	7.63^{b} ± 0.14	7.35 ± 0.11	5.16^{b} ± 0.04	5.82 ± 0.08	8.02 ± 0.10	7.07 ± 0.12
	Female	8.02 ± 0.13	7.57^{b} ± 0.12	7.17 ± 0.11	5.28^{B} ± 0.05	5.99 ± 0.08	7.91 ± 0.10	7.41 ± 0.11
	Overall	8.03^{A} ± 0.10	7.60 ± 0.02	7.26^{B} ± 0.09	5.22^{b} ± 0.05	5.90^{B} ± 0.08	7.96^{A} ± 0.05	7.24 ± 0.17
Overall	Male	7.62 ± 0.09	7.45 ± 0.09	7.42 ± 0.07	5.28 ± 0.03	6.17 ± 0.06	7.75 ± 0.06	6.96 ± 0.08
	Female	7.65 ± 0.09	7.65 ± 0.09	7.29 ± 0.07	5.21 ± 0.03	6.13 ± 0.06	7.55 ± 0.06	7.22 ± 0.08

Means with common or without superscript in same column are not significantly different.

Table-4.2.3 Analysis of variance for frequency and duration of different patterns of social and resting behaviour in two genetic-groups of fowl

Source of Variation	df	Ms						
		Preening	Dust Bathing	Lying	Sleeping	Dozing	Sitting	Standing
Genetic group	1	0.038 **	0.166 NS	0.012 **	0.355 **	0.044 **	1.470 **	0.100 NS
Sex	1	0.021 NS	0.439 NS	0.186 NS	0.021 NS	0.063 NS	0.349 NS	0.554 NS
Genetic group × sex interaction	1	0.051 NS	0.729 *	0.014 NS	0.286 **	0.348 NS	0.066 NS	0.109 NS
Error	996	0.197	0.176	0.115	0.032	0.085	0.104	0.145

NS = Non-significant

* = ($P \leq 0.05$) significant at 5% level

** = ($P \leq 0.01$) significant at 1% level

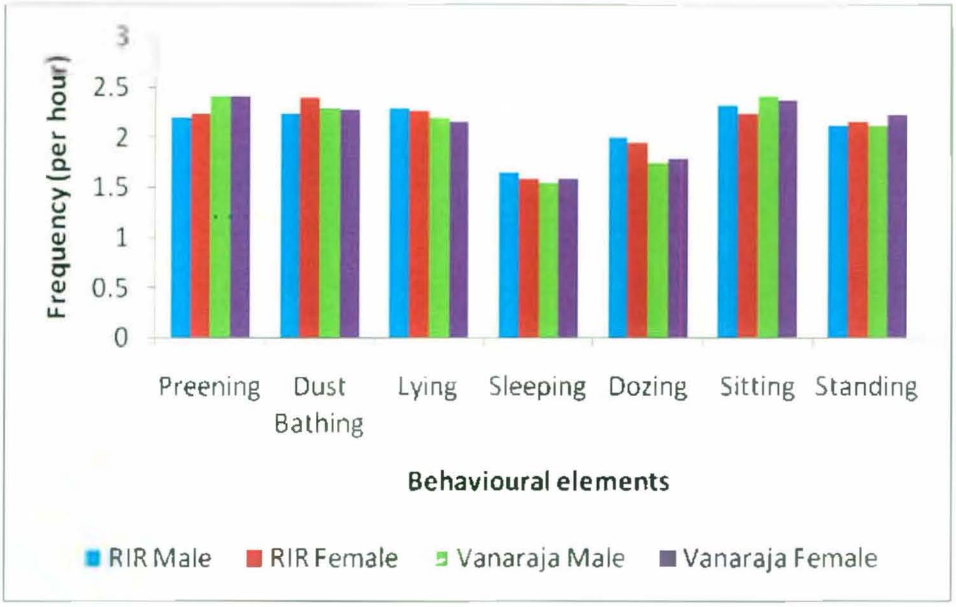

Fig-4.2.1 Frequency (per hour) of different patterns of social and resting behaviour in both sexes of two genetic groups of fowl.

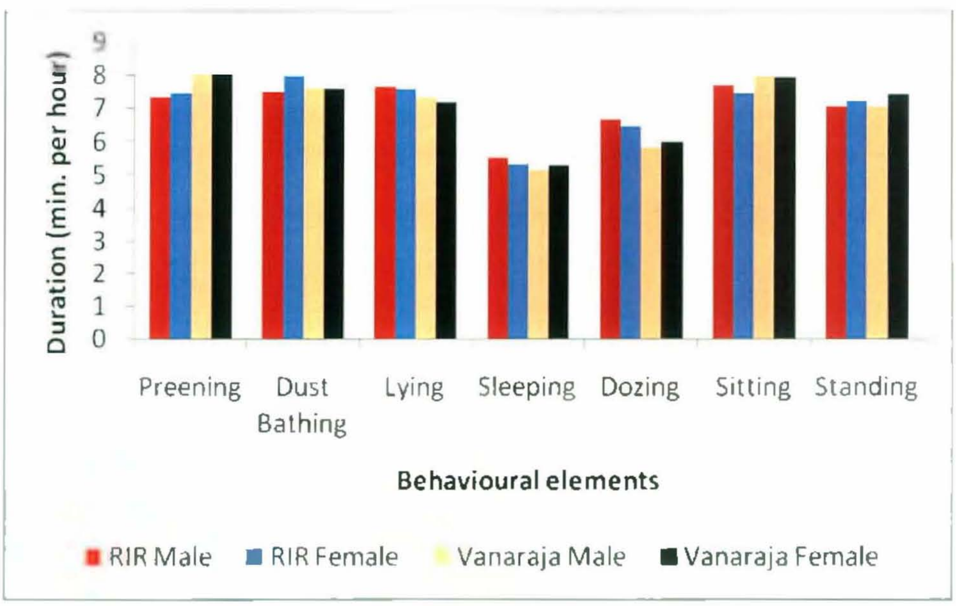

Fig-4.2.2 Duration (min. per hour) of different patterns of social and resting behaviour in both sexes of two genetic groups of fowl.

Table-4.2.4 Relative duration (percentage) of 60 minutes of different patterns of social and resting behaviour in both sexes of two genetic-groups of fowl (Mean ± SE)

Genetic group	Sex	Patterns of Behaviour						
		Preening	Dust Bathing	Lying	Sleeping	Dozing	Sitting	Standing
Rhode Island Red	Male	17.64 ± 0.12	17.60^{b} ± 0.95	18.23 ± 0.73	4.08^{a} ± 0.48	10.99 ± 0.64	18.37 ± 0.71	14.50 ± 0.87
	Female	17.94 ± 0.02	21.66^{a} ± 0.98	17.71 ± 0.75	1.74^{ab} ± 0.90	7.89 ± 0.71	16.89 ± 0.82	15.54 ± 0.91
	Overall	17.79^{B} ± 0.15	19.63 ± 0.03	17.97^{A} ± 0.26	2.91^{A} ± 0.17	9.44^{A} ± 0.55	17.63^{B} ± 0.74	15.02 ± 0.52
Vanaraja	Male	22.53 ± 0.23	19.83^{b} ± 0.18	16.34 ± 0.86	1.37^{b} ± 0.61	3.38 ± 0.92	21.52 ± 0.82	14.50 ± 0.95
	Female	22.33 ± 0.08	18.62^{b} ± 0.01	14.97 ± 0.86	1.58^{b} ± 0.64	4.43 ± 0.70	20.45 ± 0.78	16.96 ± 0.88
	Overall	22.43^{A} ± 0.10	19.22 ± 0.60	15.65^{B} ± 0.68	1.47^{B} ± 0.10	3.90^{B} ± 0.52	20.98^{A} ± 0.53	15.81 ± 0.15
Overall	Male	20.50 ± 0.08	18.90 ± 0.07	17.30 ± 0.06	2.29 ± 0.03	8.19 ± 0.04	19.90 ± 0.06	14.60 ± 0.06
	Female	20.20 ± 0.08	20.10 ± 0.07	16.30 ± 0.06	1.85 ± 0.03	8.17 ± 0.04	18.70 ± 0.06	16.20 ± 0.06

Means with common or without superscript in same column are not significantly different.

Table-4.2.5 Analysis of variance for relative duration of different patterns of social and resting behaviour in two genetic-groups of fowl

Source of Variation	df	Ms						
		Preening	Dust Bathing	Lying	Sleeping	Dozing	Sitting	Standing
Genetic group	1	0.668 **	0.007 NS	0.134 **	0.034 **	0.511 **	0.281 **	0.015 NS
Sex	1	0.001 NS	0.041 NS	0.022 NS	0.004 NS	0.009 NS	0.040 NS	0.069 NS
Genetic group × sex interaction	1	0.008 NS	0.154 *	0.004 NS	0.035 **	0.029 NS	0.001 NS	0.009 NS
Error	996	0.031	0.027	0.016	0.003	0.009	0.015	0.020

NS = Non-significant

* = ($P \leq 0.05$) significant at 5% level

** = ($P \leq 0.01$) significant at 1% level

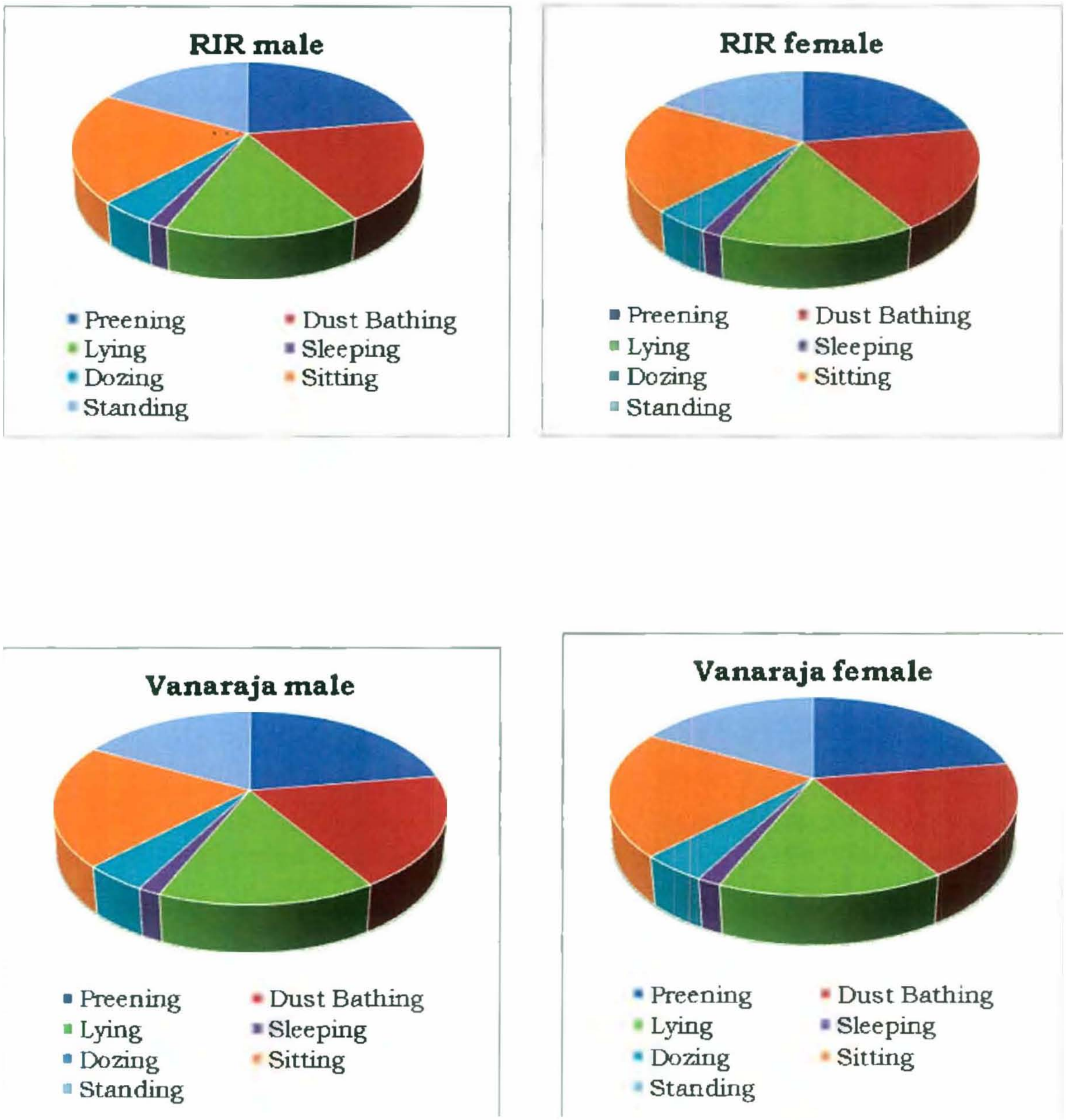

Fig-4.2.3 Relative duration (percentage) of 60 minutes of different patterns of social and resting behaviour in both sexes of two genetic groups of fowl.

group on frequency of dust bathing is non significant. However, frequency in RIR (2.31 ± 0.07) is higher than that in Vanaraja (2.27 ± 0.00).

The genetic group x sex interaction effect on frequency of dust bathing per hour is found to be significant (P≤0.05) only between sex of RIR.

b) Duration of dust bathing

Duration (min) of dust bathing per hour in male and female of RIR are 7.49 ± 0.12 and 7.97 ± 0.12 min respectively and the overall genetic group value is 7.73 ± 0.24 min. The respective values in Vanaraja are 7.63 ± 0.14, 7.57 ± 0.12 and 7.60 ± 0.02 min. The effect of genetic group on duration of dust bathing is non significant statistically. The overall mean values for male and female irrespective of genetic group are 7.45 ± 0.09 and 7.65 ± 0.09 min respectively though the difference is found to be non significant statistically.

The genetic group x sex interaction effect on duration (min) per hour of dust bathing is found to be significant (P≤0.05) except between sexes within Vanaraja, between Vanaraja male and RIR male and between Vanaraja female and RIR male.

c) Relative duration (percentage) of dust bathing

Relative duration of dust bathing in male and female of RIR are 17.60 ± 0.95 and 21.66 ± 0.98 percent respectively and the overall genetic group value is 19.63 ± 0.03 percent. The respective values in Vanaraja are 19.83 ± 0.18, 18.62 ± 0.01 and 19.22 ± 0.60 percent. The overall mean values for male and female irrespective of genetic group are 18.90 ± 0.07 and 20.10 ± 0.07 percent respectively, the difference being non significant statistically. Also the effect of genetic group on relative duration of dust bathing is found to be non significant statistically.

The genetic group x sex interaction effect on relative duration of dust bathing is found to be significant (P≤0.05) except between sexes within Vanaraja, between Vanaraja male and RIR male and between Vanaraja female and RIR male.

From the findings of the present study it is revealed that RIR resorts dust bathing more frequently than that by Vanaraja and spent more time in dust bathing activity. Also the relative duration of dust bathing is more in

RIR. In case of female birds, it is noticed that RIR females dust bath more frequently and spent more time in this activity than that by Vanaraja females. On the other hand, it is just reverse in case of male birds. It might be due to larger body size of Vanaraja males than RIR males.

The findings of the present study reveal that male birds show higher dust bathing activity than females in Vanaraja which is in agreement with the findings of Lee & Chen (2007) where they stated that male birds tended to have higher dust bathing activity than female birds. On the contrary, it is noticed that in RIR, females spent more time in dust bathing.

4.2.3 Lying

Lying behaviour comes under the resting behaviours of fowl, which refers as the cessation of movement while the breast of bird is in contact with the floor (Cornetto and Estevez, 2001).

a) Frequency of lying

Frequency of lying per hour exhibited by RIR are 2.29 ± 0.01 and 2.26 ± 0.02 for male and female respectively and overall genetic group value is 2.27 ± 0.01. The respective values in Vanaraja are 2.20 ± 0.02, 2.15 ± 0.02 and 2.17 ± 0.25. The overall mean values for male and female irrespective of genetic group are 2.25 ± 0.02 and 2.21 ± 0.02 respectively. The effect of sex is found to be non significant statistically. Comparison of values between the two genetic groups reveals a significantly ($P \leq 0.01$) higher value in RIR (2.27 ± 0.01) than that of Vanaraja (2.17 ± 0.25).

The genetic group x sex interaction effect on frequency of lying per hour of feeding time is found to be non significant statistically.

b) Duration of lying

Duration of lying (min) by male and female of RIR are 7.66 ± 0.09 and 7.56 ± 0.10 min respectively and overall genetic group value is 7.61 ± 0.04 min. For Vanaraja these values are 7.35 ± 0.11, 7.17 ± 0.11 and 7.26 ± 0.09 min in that order. The overall mean values for male and female irrespective of genetic group are 7.42 ± 0.07 and 7.29 ± 0.07 min respectively. The effect of sex is found to be non significant statistically. Comparison of values between the two genetic groups reveals a significantly ($P \leq 0.01$) higher value in RIR (7.61 ± 0.04 min) than that of Vanaraja (7.26 ± 0.09 min).

The genetic group x sex interaction effect on durations (min) of lying per hour of feeding time is found to be non significant statistically.

c) Relative duration (percentage) of lying

For RIR, relative duration (per hour) of lying in male, female and overall are 18.23 ± 0.73, 17.71 ± 0.75 and 17.97 ± 0.26 percent respectively. The respective values in Vanaraja are 16.34 ± 0.86, 14.97 ± 0.86 and 15.65 ± 0.68 percent. Comparison of overall genetic group values reveals a significantly ($P \leq 0.01$) higher value in RIR (17.97 ± 0.26%) than that in Vanaraja (15.65 ± 0.68%). Analysis of variance indicates a non significant effect of sex, though the value of male (17.30 ± 0.06%) is higher than that of female (16.30 ± 0.06%).

The genetic group x sex interaction effect on relative duration (%) of lying per hour of feeding time is found to be non significant statistically in all differences.

It is apparent from the findings of the present study that RIR birds spent more time in lying than Vanaraja in both sexes. Also it is seen that frequency of lying and relative duration of lying is more in RIR. It is not known why RIR devote more time in lying. It is also observed that the male birds spend more time in lying than the female birds in both the genetic groups i.e. RIR and Vanaraja.

From the present study it is apparent that the birds of both the genetic groups spent more time in lying than other patterns of behaviour viz. sleeping, dozing, sitting and standing which is in agreement with the findings of Preston and Murphy (1989) and Estevez (1994) where they stated that chickens spent considerable time in lying.

4.2.4 Sleeping

Sleeping is one type of resting behaviour in fowl, in which they put their heads under the feathers and fall asleep with their eyes closed (Chicken-yard Newsletter, 2001).

a) Frequency of sleeping

Frequency per hour of sleeping for RIR male and female are 1.65 ± 0.01 and 1.59 ± 0.09 respectively and the overall genetic group value is 1.62 ± 0.03. The respective values in Vanaraja are 1.54 ± 0.09, 1.58 ± 0.01 and 1.56 ± 0.02. The overall values for male and female irrespective of genetic group are 1.60 ± 0.01 and 1.58 ± 0.01 respectively. The effect of sex is found to be non significant statistically. Comparison of overall genetic group values reveals a significantly ($P \leq 0.01$) higher frequency in RIR (1.60 ± 0.03) than that in Vanaraja (1.56 ± 0.02).

The genetic group x sex interaction effect on frequency per hour of sleeping is found to be significant ($P \leq 0.01$) except between sexes within Vanaraja, RIR and between males of Vanaraja and RIR.

b) Duration of sleeping

The duration (min) of sleeping per hour for male, female and overall genetic group values for RIR are 5.52 ± 0.07, 5.30 ± 0.04 and 5.41 ± 0.10 min respectively. These values in Vanaraja are 5.16 ± 0.04, 5.28 ± 0.05 and 5.22 ± 0.05 min in that order. The overall mean duration for male and female irrespective of genetic group are 5.28 ± 0.03 and 5.21 ± 0.03 min respectively, the difference being non significant statistically. Comparison of overall genetic group values reveals a significantly ($P \leq 0.01$) higher value in RIR (5.41 ± 0.10 min) than that in Vanaraja (5.22 ± 0.05 min).

The genetic group x sex interaction effect on duration (min) per hour of sleeping is found to be significant ($P \leq 0.01$), though the difference between sexes within Vanaraja and RIR and difference between males of Vanaraja and RIR are be non significant.

c) Relative duration (percentage) of sleeping

The relative duration (per hour) of sleeping for RIR male and female are 4.08 ± 0.12 and 1.74 ± 0.90 percent respectively and the overall genetic group value is 2.91 ± 0.17 percent. The respective values in Vanaraja are 1.37 ± 0.61, 1.58 ± 0.64 and 1.47 ± 0.10 percent. The overall mean value for male and female irrespective of genetic group are 2.29 ± 0.03 and 1.85 ± 0.03 percent respectively. The effect of sex is found to be non significant statistically. Comparison of overall relative duration (%) between the two genetic groups reveals a significantly (P≤0.01) higher value in RIR (2.91 ± 0.17%) than that in Vanaraja (1.47 ± 0.10%).

The genetic group x sex interaction effect on relative duration (%) of sleeping is found to be significant (P≤0.01) between male of RIR and two sexes of Vanaraja.

The findings of the present study reveal that RIR birds sleep more than Vanaraja birds in both the sexes. Also it is seen that frequency of sleeping and relative duration of sleeping is more in RIR. It might be due to the fact that RIR are less active and lazy in comparison to Vanaraja. It is also noticed that in RIR, males spent more time in sleeping than its female counterparts, whereas in case of Vanaraja it is just reverse.

The findings of the present study on Vanaraja reveals that female birds slept more than male birds which is supported by the findings of Andrews *et al.* (1997) where they observed that male birds slept less than females. On the contrary, in RIR, males slept more than females.

4.2.5 Dozing

When birds take rest with eyes half open or closed with flickering, it is termed as dozing (Andrews *et al.*, 1997).

a) Frequency of dozing

Frequency per hour of dozing for RIR male and female are 2.00 ± 0.01 and 1.94 ± 0.02 respectively and the overall genetic group value is 1.97 ± 0.03. The respective values in Vanaraja are 1.74 ± 0.01, 1.79 ± 0.01 and 1.76 ± 0.25. The overall mean frequency of dozing for male and female irrespective of genetic group are 1.87 ± 0.01 and 1.86 ± 0.01 respectively. The effect of sex is found to be non significant statistically. Comparison between the overall genetic group values reveals a significantly (P≤0.01) higher value in RIR (1.97 ± 0.03) than that in Vanaraja (1.76 ± 0.25).

Genetic group x sex interaction effect on frequency per hour of dozing is found to be non significant statistically.

b) Duration of dozing

The duration of dozing in male and female of RIR are 6.68 ± 0.09 and 6.47 ± 0.10 min respectively and the overall genetic group value is 6.57 ± 0.10 min. In Vanaraja these values are 5.82 ± 0.08, 5.99 ± 0.08 and 5.90 ± 0.08 min respectively. Duration (min) of dozing per hour by male and female birds irrespective of genetic group are 6.17 ± 0.06 and 6.13 ± 0.06 min respectively though the effect of sex is found to be non significant statistically. The overall genetic group value in RIR (6.57 ± 0.10 min) is significantly ($P \leq 0.01$) higher than that in Vanaraja (5.90 ± 0.08 min).

Genetic group x sex interaction effect on duration (min) per hour of dozing is found to be non significant.

c) Relative duration (percentage) of dozing

The relative duration of dozing in RIR male and female are 10.99 ± 0.64 and 7.89 ± 0.71 percent respectively and the overall genetic group value is 9.44 ± 0.55 percent. The respective values in Vanaraja are 3.38 ± 0.92, 4.43 ± 0.70 and 3.90 ± 0.52 percent. The overall mean value for male and female irrespective of genetic group are 8.19 ± 0.04 and 8.17 ± 0.04 percent respectively. The effect of sex is found to be non significant statistically. Comparison between the overall genetic group values reveals a significantly ($P \leq 0.01$) higher value in RIR (9.44 ± 0.55%) than that in Vanaraja (3.90 ± 0.52%).

Genetic group x sex interaction effect on relative duration of dozing is found to be non significant.

The findings of the present study reveal that frequency of dozing and the relative duration of dozing is more in RIR than those in Vanaraja in both sexes. Also it is noticed that RIR birds spent more time in dozing than Vanaraja in both sexes. It might be due to the fact that RIR are less active and lazy bird in comparison to Vanaraja birds. It is also observed that in RIR the male spent more time in dozing than its female counterpart, whereas in Vanaraja female spent more time in dozing than its male counterpart.

4.2.6 Sitting

The pattern of sitting by fowl has been recorded. While sitting, eyes are fully open in birds (Andrews *et al.*, 1997) which indicates a resting behaviour.

a) Frequency of sitting

Frequency per hour of sitting in RIR are 2.31 ± 0.01 in male, 2.23 ± 0.02 in female and 2.27 ± 0.04 is the overall genetic group value. The respective values in Vanaraja are 2.40 ± 0.02, 2.37 ± 0.02 and 2.38 ± 0.01. The overall mean values for male and female irrespective of genetic group are 2.35 ± 0.02 and 2.29 ± 0.02 respectively. The effect of sex is found to be non significant statistically. Comparison between the overall genetic group values reveals a significantly (P≤0.01) higher value in Vanaraja (2.38 ± 0.01) than that in RIR (2.27 ± 0.04).

The genetic group x sex interaction effect on frequency per hour of sitting is found to be non significant statistically.

b) Duration of sitting

Duration of sitting for male and female of RIR are 7.71 ± 0.09 and 7.45 ± 0.10 min respectively and 7.58 ± 0.12 min is the overall genetic group value of RIR. The respective values in Vanaraja are 8.02 ± 0.10, 7.91 ± 0.10 and 7.96 ± 0.05 min. Duration of sitting by male and female irrespective of genetic group are 7.75 ± 0.06 and 7.55 ± 0.06 min respectively, though the effect of sex is found to be non significant statistically. Comparison of overall values between the two genetic groups reveals a significantly (P≤0.01) higher value in Vanaraja (7.96 ± 0.05 min) than that in RIR (7.58 ± 0.12 min).

The genetic group x sex interaction effect on duration (min) per hour of sitting is found to be non significant.

c) Relative duration (percentage) of sitting

Relative duration of sitting in RIR are 18.37 ± 0.71 percent in male, 16.89 ± 0.82 percent in female and the overall genetic group value is 17.63 ± 0.74 percent. The respective values in Vanaraja are 21.52 ± 0.82, 20.45 ± 0.78 and 20.98 ± 0.53 percent. The effect of genetic group on relative duration of sitting is found to be significant (P≤0.01). The overall mean value for male and female irrespective of genetic group are 19.90 ± 0.06 and 18.70 ± 0.06 percent respectively. The effect of sex is found to be non significant statistically.

The genetic group x sex interaction effect on relative duration (%) per hour of sitting is found to be non significant.

Findings of the present study reveal that Vanaraja birds spent more time in sitting than RIR birds. Also frequency of sitting and relative duration of sitting is more in Vanaraja than RIR in both sexes. It may be due to the fact that Vanaraja birds have larger body size and heavier than RIR birds in both sexes requiring more rest than lighter ones. It is also noticed that the male birds sit more frequently, spend more time in sitting. Frequency of sitting is also more in males than female birds in both the genetic groups. However, it is not known why males sit more frequently than females.

4.2.7 Standing

When birds maintain an upright position on extended legs, then it terms as standing behaviour (Cornetto and Estevez, 2001).

a) Frequency of standing

Frequency per hour of standing in RIR male and female are 2.12 ± 0.02 and 2.16 ± 0.02 respectively and overall genetic group value is 2.14 ± 0.02. The respective values in Vanaraja are 2.12 ± 0.02, 2.22 ± 0.02 and 2.17 ± 0.05. The overall mean value of male and female irrespective of genetic group are 2.11 ± 0.02 and 2.19 ± 0.02 respectively. The effect of sex is found to be non significant statistically. Comparison of overall genetic group values reveals a non significant effect of genetic group, though the value in Vanaraja (2.17 ± 0.05) is marginally higher than that of RIR (2.14 ± 0.02).

The genetic group x sex interaction on frequency of standing is found to be non significant statistically.

b) Duration of standing

Duration (min) per hour of standing in male and female of RIR are 7.07 ± 0.11 and 7.20 ± 0.12 min respectively and 7.13 ± 0.06 min is the overall genetic group value. The values in Vanaraja are 7.07 ± 0.12, 7.41 ± 0.11 and 7.24 ± 0.17 min respectively. The overall mean value of male and female irrespective of genetic group are 6.96 ± 0.08 and 7.22 ± 0.08 min respectively. Effect of genetic group on duration of standing is non significant. However duration in Vanaraja (7.24 ± 0.17 min) is slightly higher than that in RIR (7.13 ± 0.06 min). Irrespective of genetic group duration of standing in female (7.22 ± 0.08 min) is higher than that of male (6.96 ± 0.08 min) though the effect of sex is found to be non significant statistically.

The genetic group x sex interaction on durations (min) of standing is found to be non significant statistically.

c) Relative duration (percentage) of standing

The relative duration of standing in RIR male and female are 14.50 ± 0.87 and 15.54 ± 0.91 percent respectively and overall genetic group value is 15.02 ± 0.52 percent. The respective values in Vanaraja are 14.50 ± 0.95, 16.96 ± 0.88 and 15.81 ± 0.15 percent. The overall mean value of male and female irrespective of genetic group are 14.60 ± 0.06 and 16.20 ± 0.06 percent respectively. The effect of sex is found to be non significant statistically. Comparison of values between the two genetic groups reveals a non significant effect of genetic group, though the value in Vanaraja (15.81 ± 0.15%) is marginally higher than that in RIR (15.02 ± 0.52%).

The genetic group x sex interaction on relative duration (%) of standing is found to be non significant.

From the results of the present study it is revealed that Vanaraja birds stand for longer time than by RIR birds, but in case of male birds it is seen that males of both Vanaraja and RIR spent same time in standing. While in case of female birds, Vanaraja female spent more time in standing than RIR female. It is not known why in male birds of Vanaraja and RIR spent same time in standing but in case of females, Vanaraja spent more time than RIR.

The findings of the present study contradict with the findings of Andrews *et al.* (1997) where they reported on broiler chicken that male birds stood for longer than female birds. In the present study, in both the genetic groups females are found to stand longer than males. This contradiction may be due to that the present observation is done in layer birds.

Relative importance of different patterns of social and resting behaviour

Time motion analysis of different patterns of social and resting behaviour of bird during one hour of observation depicts that preening is the prime activity during this period consuming 20.1% of one hour time. This is followed by dust bathing (19.4%), sitting (19.3%), lying (16.8%), standing (15.4%), dozing (6.6%) and sleeping (2.1%). The birds spent more time in preening (20.1%) and dust bathing (19.4%) as expression of their social activity and playfulness. The birds spent considerable time in sitting (19.3%), standing (15.4%) and lying (16.8%) besides dozing (6.6%) and sleeping (2.1%), thereby clearly indicating that they are relaxed at that time.

4.3 Agonistic Behaviour of Fowl

Agonistic behaviour of fowl is defined as the behaviour associated with fighting, escape, defensive and passive interactions between the individuals (Scott and Frederickson, 1951). In the present study, the agonistic interactions among fowls have been categorised under different patterns of behaviour. The results obtained are tabulated in terms of frequency (per hour) of different patterns, their absolute and relative (percentage) duration (min. per hour). The results for frequency (per hour) are presented in Table-4.3.1 and graphically in Fig.4.3.1 and for duration (min. per hour) are presented in Table-4.3.2 and graphically in Fig.4.3.2. Analysis of variance for frequency and duration is shown in Table-4.3.3. The results for relative (percentage) duration are presented in Table-4.3.4 and in Fig.4.3.3. Analysis of variance for relative duration is shown in Table-4.3.5. Findings are discussed in following sections.

4.3.1 Pushes

The agonistic interactions of fowl have been quantified in terms of pushes which refers to as the pushing of one another with head, body etc. when they are too close to each other (O'Keefe *et al.*, 1988).

a) Frequency of pushes

Frequency per hour of pushes for RIR are 1.66 ± 0.01 in male, 1.69 ± 0.01 in female and the overall genetic group value is 1.67 ± 0.01. Respective values in Vanaraja are 2.01 ± 0.01, 1.98 ± 0.01 and 1.97 ± 0.03. Overall mean values for male and female irrespective of genetic group are 1.83 ± 0.01 and 1.81 ± 0.01 respectively. Effect of sex is found to be non significant statistically. Comparison of values between the two genetic groups reveals a significantly ($P \leq 0.01$) higher value in Vanaraja (1.97 ± 0.03) than that in RIR (1.67 ± 0.01).

The genetic group x sex interaction effect on frequency of pushes per hour is found to be significant ($P \leq 0.05$). Except the difference between sexes within RIR, all other differences are found to be significant.

b) Duration of pushes

Duration (min) of pushes per hour by RIR are 5.54 ± 0.06 min in male, 5.65 ± 0.06 min in female and the overall genetic group value is 5.59 ± 0.05 min. Respective values in Vanaraja are 6.70 ± 0.09, 6.45 ± 0.09 and 6.57 ± 0.12 min. The overall mean value for male and female irrespective of genetic group are 6.03 ± 0.05 and 5.97 ± 0.05 min respectively. Effect of sex is found to be non significant statistically. Comparison of values between the two genetic groups reveals a significantly ($P \leq 0.01$) higher value in Vanaraja (6.57 ± 0.12 min) than that in RIR (5.59 ± 0.05 min).

The genetic group x sex interaction effect on duration (min) of pushes per hour is found to be significant ($P \leq 0.05$). Except the difference between sexes within RIR, all other differences are found to be significant.

c) Relative duration (percentage) of pushes

Relative duration (per hour) of pushes for male, female and overall of RIR are 3.64 ± 0.40, 4.28 ± 0.40 and 3.69 ± 0.32 percent respectively. Likewise, in Vanaraja these values are 11.40 ± 0.06, 9.74 ± 0.06 and 10.57 ±

0.12 percent in that order. The overall mean value for male and female irrespective of genetic group are 7.38 ± 0.04 and 7.01 ± 0.04 percent respectively. Comparison of overall genetic group values reveals a significantly ($P \leq 0.01$) higher value in Vanaraja (10.57 ± 0.12%) than that in RIR (3.69 ± 0.32%). Analysis of variance indicates a non significant effect of sex, though the value for male (7.38 ± 0.04%) is slightly higher than that of female (7.01 ± 0.04%).

The genetic group x sex interaction effect on relative duration of pushes is found to be significant ($P \leq 0.05$). Except the difference between sexes within RIR, all other differences are found to be significant.

The findings of the present study reveal that Vanaraja birds resort to more frequent pushes towards other birds than by RIR birds. Absolute and relative durations of this activity have been found more in Vanaraja than those in RIR of both sexes. It might be due to that though the RIR birds are more active but they are friendlier (Skinner, 1978). Again it has been found that in RIR, females show more frequency of pushing activity and spent more time than their male counterparts. On the other hand, it is just reverse in case of Vanaraja for which no explanation is yet available.

4.3.2 Chasing

The pattern of chasing by fowl has been recorded. Chasing refers to one or more birds pursue another bird across the enclosures and keeps away from a limited food source (O'Keefe *et al.*, 1988).

a) Frequency of chasing

Frequencies of chasing per hour in RIR male and female birds are 2.13 ± 0.01 and 1.86 ± 0.01 respectively, whereas overall genetic group value for RIR is 1.99 ± 0.13. The respective values in Vanaraja are 2.11 ± 0.01, 2.19 ± 0.02 and 2.15 ± 0.03. The overall mean values for male and female irrespective of genetic group are 2.31 ± 0.01 and 2.02 ± 0.01 respectively. Comparison of overall genetic group values reveals a significantly ($P \leq 0.01$) higher value in Vanaraja (2.15 ± 0.03) than that in RIR (1.99 ± 0.13). Irrespective of genetic group frequency of chasing is significantly (P≤0.01) higher in male (2.31 ± 0.01) than that in female (2.02 ± 0.01).

The genetic group x sex interaction effect on frequency of chasing per hour is found to be significant (P≤0.01). Except the difference between males of RIR and Vanaraja and difference between RIR male and Vanaraja female, all other differences are found to be significant.

b) Duration of chasing

Duration (min) of chasing in RIR male and female birds are 7.10 ± 0.08 and 6.20 ± 0.08 min respectively and the overall genetic group value is 6.65 ± 0.45 min. The respective values in Vanaraja are 7.05 ± 0.09, 7.30 ± 0.10 and 7.17 ± 0.12 min. Duration of chasing by male and female irrespective of genetic group are 7.02 ± 0.06 and 6.66 ± 0.06 min respectively. The effect of sex is found to be significant (P≤0.01). Effect of genetic group on duration of chasing is found to be significant (P≤0.01) with higher value in Vanaraja (7.17 ± 0.12 min) than that in RIR (6.65 ± 0.45 min).

The genetic group x sex interaction effect on duration (min) of chasing per hour is found to be significant (P≤0.01) except the difference between males of RIR and Vanaraja and difference between RIR male and Vanaraja female.

c) Relative duration (percentage) of chasing

The relative durations of chasing for male, female and overall of RIR are 14.11 ± 0.62, 7.74 ± 0.56 and 10.92 ± 0.35 percent respectively. The respective values in Vanaraja are 13.74 ± 0.07, 15.90 ± 0.07 and 14.82 ± 0.37 percent. The overall mean value for male and female irrespective of genetic group are 13.90 ± 0.05 and 11.80 ± 0.05 percent respectively, the difference being significant (P≤0.01) statistically. Comparison of relative duration of chasing between the two genetic groups reveals a significantly (P≤0.01) higher value in Vanaraja (14.82 ± 0.37%) than that in RIR (10.92 ± 0.35%).

The genetic group x sex interaction effect on relative duration (%) of chasing per hour is found to be significant (P≤0.01). Except the difference between males of RIR and Vanaraja and difference between RIR male and Vanaraja female, all other differences are significant statistically.

From the findings of the present study, it appears that the frequency of chasing and relative duration of chasing are more in Vanaraja than those in RIR. As the RIR birds are friendlier than the birds of other breeds (Skinner, 1978), act of aggressive chase is less in RIR birds. The study also reveals that males are more active, chase more frequently and spent more time in chasing than females.

The findings of the present study corroborate with the findings of Millman *et al.* (2000) where they reported that chasing behaviour in females were extremely rare with laying strain.

Millman and Duncan (2000b) observed that chasing was performed more frequently by game strain females. In the present study, it is observed that females of Vanaraja chase more frequently than its male counterparts. On the contrary, incidence of chase is more in RIR males.

4.3.3 Threatening

Threatening refers to any behaviour that signifies hostility or intends to attack another animal. Threat behaviour is meant to cause the opponent to back down and leave (Barrows, 2001).

a) Frequency of threatening

Frequency per hour of threatening for male, female and overall in RIR are 2.04 ± 0.01, 2.05 ± 0.01 and 2.04 ± 0.00 respectively. The values in Vanaraja are 2.17 ± 0.01, 2.07 ± 0.02 and 2.12 ± 0.04 respectively. The overall mean values for male and female irrespective of genetic group are 2.11 ± 0.02 and 2.05 ± 0.02 respectively. The effect of sex is found to be non significant statistically. The overall genetic group value of Vanaraja (2.12 ± 0.04) is significantly ($P \leq 0.01$) higher than that of RIR (2.04 ± 0.00).

The genetic group x sex interaction effect on frequency of threatening per hour is found to be significant ($P \leq 0.05$) only due to highest frequency of threatening by Vanaraja males than others.

b) Duration of threatening

The durations of threatening for male, female and overall in RIR are 6.80 ± 0.09, 6.85 ± 0.09 and 6.82 ± 0.02 min respectively. The values in Vanaraja are 7.25 ± 0.09, 6.90 ± 0.10 and 7.07 ± 0.15 min in that order. The overall mean value for male and female irrespective of genetic group are 6.96 ± 0.06 and 6.76 ± 0.06 min respectively though the effect of sex is found to be non significant statistically. As the effect of genetic group on duration of threatening is significant ($P \leq 0.01$), higher value in Vanaraja (7.07 ± 0.15 min) is observed than that in RIR (6.82 ± 0.02 min).

The genetic group x sex interaction effect on duration (min) per hour of threatening is found to be significant ($P \leq 0.05$) except the difference between sexes within RIR, difference between Vanaraja male and RIR female and difference between Vanaraja female and RIR male.

c) Relative duration (percentage) of threatening

Relative durations of threatening for male, female and overall for RIR are 12.05 ± 0.63, 12.41 ± 0.06 and 12.23 ± 0.18 percent respectively. The respective values in Vanaraja are 15.46 ± 0.07, 12.89 ± 0.07 and 14.17 ± 0.57 percent. The overall mean values for male and female irrespective of genetic group are 13.80 ± 0.05 and 12.60 ± 0.05 percent respectively. The effect of sex is found to be non significant statistically. The relative duration (%) of threatening in Vanaraja (14.17 ± 0.57%) is significantly ($P \leq 0.01$) higher than that in RIR (12.23 ± 0.18%).

The genetic group x sex interaction effect on relative duration (%) per hour of threatening is found to be significant ($P \leq 0.05$) only between Vanaraja male and other subgroups.

Findings of the present study reveal that aggressive threat is seen more frequently in Vanaraja than in RIR in both the sexes. It is also observed that frequency of threat towards other birds and relative duration of threat behaviour is higher in case of Vanaraja in both sexes than RIR. It might be due to the fact that Vanaraja birds are more aggressive than RIR birds, as previous report suggested that RIR birds are friendlier than other breeds (Skinner, 1978).

Findings of the present study on Vanaraja reveal that females are less frequently engaged in threat activity than males, which is in agreement with the findings of Oden *et al.* (1999) where they observed on laying hens that aggressive threat among females was significantly less frequent in groups that also included males.

4.3.4 Fighting

Fighting is the principal pattern of agonistic interaction in fowl. During fighting, two hens face up each other and aim pecks with their beaks and kicks with their feet and spurs (O'Keefe *et al.,* 1988).

a) Frequency of fighting

Frequency of fighting in RIR male and female birds are 2.40 ± 0.01 and 2.41 ± 0.01 respectively, whereas overall genetic group value for RIR is 2.40 ± 0.04. These values in Vanaraja are 2.31 ± 0.02, 2.19 ± 0.02 and 2.25 ± 0.05 respectively. The overall frequency of fighting for male and female irrespective of genetic group are 2.35 ± 0.01 and 2.31 ± 0.01 respectively. The effect of sex on frequency of fighting is found to be significant ($P \leq 0.05$). Comparison of overall genetic group values reveals a significantly ($P \leq 0.01$) higher value in RIR (2.40 ± 0.04) than that in Vanaraja (2.25 ± 0.05).

The genetic group x sex interaction effect on frequency of fighting per hour is found to be significant ($P \leq 0.05$). Except the difference between sexes within RIR, all other differences are found to be significant.

b) Duration of fighting

Durations (min) of fighting per hour in RIR male and female are 8.00 ± 0.08 and 8.05 ± 0.08 min respectively and the overall genetic group value is 8.02 ± 0.02 min. The values in Vanaraja are 7.70 ± 0.10, 7.30 ± 0.10 and 7.50 ± 0.20 min respectively. The overall mean values for male and female irrespective of genetic group are 7.75 ± 0.06 and 7.62 ± 0.06 min respectively. The effect of sex is found to be significant ($P \leq 0.05$) statistically. As the effect of genetic group on duration of fighting is significant ($P \leq 0.01$), a higher value is observed in RIR (8.02 ± 0.02 min) than that in Vanaraja (7.50 ± 0.20 min).

The genetic group x sex interaction effect on duration (min) of fighting per hour is found to be significant ($P \leq 0.05$) except the difference between sexes within RIR.

c) Relative duration (percentage) of fighting

The relative duration of fighting for male, female and overall of RIR are 21.04 ± 0.07, 21.05 ± 0.62 and 21.04 ± 0.04 percent respectively. Likewise, in Vanaraja these values are 19.07 ± 0.07, 16.05 ± 0.070 and 17.56 ± 0.09 percent in that order. The overall mean value for male and female irrespective of genetic group are 20.10 ± 0.05 and 18.50 ± 0.05 percent respectively, the difference being significant ($P \leq 0.05$). Comparison of relative duration of fighting between the two genetic groups reveals a significantly ($P \leq 0.01$) higher value in RIR (21.04 ± 0.04%) than that in Vanaraja (17.56 ± 0.09%).

The genetic group x sex interaction effect on relative duration (%) of fighting per hour is found to be significant ($P \leq 0.05$). Except the difference between sexes within RIR, all other differences are found significant.

From the findings of the present study, it is apparent that RIR birds engaged for more time in aggressive fight than that by Vanaraja in both the sexes. Frequency and relative duration of fighting are also more in RIR than in Vanaraja. However it is difficult to explain why RIR is engaged more in fighting while they are reported as friendly than other breeds (Skinner, 1978). Male of Vanaraja appears to be more aggressive.

Scott (1975) stated that fighting is more pronounced in the male birds. The finding of the present study also coincides well with the findings of Oden *et al.* (1999), where they reported that females exhibited fighting behaviour less frequently when they were grouped with the males.

4.3.5 Wing Flapping

The agonistic behaviour displayed as wing flapping occurs in varying levels of intensity, in which wings were clapped together while the head and body of the bird remained level (Millman *et al.,* 2000).

a) Frequency of wing flapping

Frequencies of wing flapping in RIR male and female are 2.43 ± 0.01 and 2.46 ± 0.01 respectively and the overall genetic group value is 2.44 ± 0.01. In Vanaraja, these values are 2.14 ± 0.02, 2.32 ± 0.02 and 2.23 ± 0.09 respectively. The overall mean values for male and female irrespective of genetic group are 2.29 ± 0.02 and 2.40 ± 0.02 respectively. Comparison of frequencies of wing flapping between the two genetic groups reveals a significantly ($P \leq 0.01$) higher value in RIR (2.44 ± 0.01) than that in Vanaraja (2.23 ± 0.09). Irrespective of genetic group a significantly ($P \leq 0.01$) higher value is observed in female (2.40 ± 0.02) than that in male (2.29 ± 0.02).

The genetic group x sex interaction effect on frequency of wing flapping per hour is found to be significant ($P \leq 0.05$). Except the difference between sexes within RIR, all other differences are significant.

b) Duration of wing flapping

Duration (min) of wing flapping in RIR male and female birds are 8.10 ± 0.09 and 8.20 ± 0.09 min respectively, whereas overall genetic group value for RIR is 8.15 ± 0.04 min. The respective values in Vanaraja are 7.15 ± 0.12, 7.75 ± 0.11 and 7.45 ± 0.30 min. Duration of wing flapping by male and female birds irrespective of genetic group are 7.55 ± 0.07 and 7.92 ± 0.07 min respectively. The effect of sex is found to be significant ($P \leq 0.01$). Comparison of overall duration of wing flapping between the two genetic groups reveals a significantly ($P \leq 0.01$) higher value in RIR (8.15 ± 0.04 min) than that in Vanaraja (7.45 ± 0.30 min).

The genetic group x sex interaction effect on duration of wing flapping per hour is found to be significant ($P \leq 0.05$) in all the differences except the difference between sexes within RIR.

c) Relative duration (percentage) of wing flapping

Relative duration of wing flapping for male, female and overall of RIR are 22.14 ± 0.07, 22.73 ± 0.07 and 22.43 ± 0.29 percent respectively. Likewise, in Vanaraja these values are 15.34 ± 0.09, 19.69 ± 0.09 and 17.51 ± 0.05 percent in that order. The overall mean value for male and female irrespective of genetic group are 18.70 ± 0.06 and 21.20 ± 0.06 percent respectively, the difference being significant ($P \leq 0.01$). Comparison of overall genetic group values reveals a significantly ($P \le 0.01$) higher value in RIR ($22.43 \pm 0.29\%$) than that in Vanaraja ($17.51 \pm 0.05\%$).

The genetic group x sex interaction effect on relative duration of wing flapping per hour is found to be significant ($P \le 0.05$) except the difference between sexes within RIR.

In the present study, the findings reveal that RIR birds of both sexes perform wing flapping more frequently and spent more time in wing flapping activity than Vanaraja birds. Also the relative duration of wing flapping is more in RIR than Vanaraja in both sexes. It might be due to the fact that RIR birds are more active and hardy than other breeds (Skinner, 1978). It has also been noticed that wing flapping in females occurred most frequently than males in both the genetic groups of fowl. Females spent more time in wing flapping and relative duration is also more in females than that in males of both the genetic groups. However it is not known why the females exhibit more wing flapping than males in both the genetic groups.

The finding of the present study is not in agreement with the findings of Duncan (1970) where he reported that males performed more wing flapping.

In the present study, it has been observed that males of RIR perform wing flapping more frequently than the males of Vanaraja, which is in agreement with the findings of Millman and Duncan (2000b) where they observed in game strain, broiler and layer breeder strain that wing flapping by males occurred most frequently in game strain birds.

Millman and Duncan (2000b) also reported that wing flapping by males occurred most frequently in game strain birds when they were housed with females. But in the present study it is observed that females of both the genetic groups perform wing flapping most frequently than their male counterparts. This finding contradicts with the finding of Millman and Duncan (2000b) where they reported more wing flapping in male birds.

4.3.6 Feather Pecking

Feather pecking is interpreted as an abnormal behaviour where fowls peck the feathers of conspecifics, damage the plumage or even injured the skin (Ramadan and Von Borell, 2008).

a) Frequency of feather pecking

The frequency per hour of feather pecking for male and female as well as the overall genetic group value in RIR are 2.04 ± 0.01, 2.20 ± 0.02 and 2.12 ± 0.08 respectively. The respective values in Vanaraja are 1.93 ± 0.02, 1.92 ± 0.02 and 1.92 ± 0.04. The overall mean values for male and female irrespective of genetic group are 1.98 ± 0.02 and 2.05 ± 0.02 respectively. The effect of sex is found to be significant ($P \leq 0.01$). Comparison of values between both the genetic groups reveals a significantly ($P \leq 0.01$) higher value in RIR (2.12 ± 0.08) than that in Vanaraja (1.92 ± 0.04).

The genetic group x sex interaction effect on frequency of feather pecking is found to be significant ($P \leq 0.01$). Except the difference between sexes within Vanaraja, all other differences are significant.

b) Duration of feather pecking

Duration of feather pecking in RIR male, female and overall genetic group value are 6.80 ± 0.08, 7.35 ± 0.10 and 7.07 ± 0.27 min respectively. The values in Vanaraja are 6.45 ± 0.10, 6.40 ± 0.10 and 6.42 ± 0.02 min respectively. The overall mean value for male and female irrespective of genetic group are 6.53 ± 0.06 and 6.76 ± 0.06 min respectively, the difference being significant ($P \leq 0.01$). Comparison between the overall genetic group values reveals a significantly ($P \leq 0.01$) higher value in RIR (7.07 ± 0.27 min) than that in Vanaraja (6.42 ± 0.02 min).

The genetic group x sex interaction effect on duration (min) of feather pecking is found to be significant ($P \leq 0.01$) in all the differences except the difference between sexes within Vanaraja.

c) Relative duration (percentage) of feather pecking

Relative duration of feather pecking for male and female as well as the overall genetic group value in RIR are 11.63 ± 0.59, 16.13 ± 0.07 and 13.88 ± 0.12 percent respectively. These values in Vanaraja are 9.74 ± 0.07, 9.66 ± 0.07 and 9.70 ± 0.04 percent respectively. The overall mean value for male and female irrespective of genetic group are 10.70 ± 0.05 and 12.90 ± 0.05 percent respectively. Comparison of overall value of both the genetic groups reveals a significantly ($P \leq 0.01$) higher value in RIR (13.88 ± 0.12%) than that in Vanaraja (9.70 ± 0.04%). Irrespective of genetic group relative duration of feather pecking is significantly ($P \leq 0.01$) higher in female (12.90 ± 0.05%) than that in male (10.70 ± 0.05%).

The genetic group x sex interaction effect on relative duration (%) of feather pecking is found to be significant ($P \leq 0.01$) except the difference between sexes within Vanaraja.

From the findings of the present study it reveals that feather pecking activity is seen more frequently in RIR than in Vanaraja of both sexes. Also RIR birds spent more time in feather pecking and relative duration is also higher in RIR than those in Vanaraja. It might be due to the fact that RIR birds are more active than Vanaraja birds. It has been also noticed that females of RIR pecks feather more frequently than its male counterparts, but it is just reverse in case of Vanaraja for which no explanation is yet available.

Lee & Chen (2007) reported that some birds showed more feather pecking behaviour than others. They observed that Taiwan country chickens displayed more feather pecking behaviour than other breeds viz. Beijing fatty chicken, commercial Silkies and pure Silkies. In the present study, it is observed that RIR birds perform more feather pecking than that by Vanaraja birds.

4.3.7 Head Pecking

Delivering sharp blow with the beak to the head or body of another bird is termed as head pecking (O'Keefe *et al.,* 1988).

a) Frequency of head pecking

Frequency per hour of head pecking in RIR male and female are 1.71 ± 0.01 and 1.66 ± 0.01 respectively and the overall genetic group value is 1.68 ± 0.02. For Vanaraja these values are 1.72 ± 0.01, 1.65 ± 0.01 and 1.68

± 0.03 respectively. The overall mean value for male and female irrespective of genetic group are 1.72 ± 0.01 and 1.66 ± 0.01 respectively. The effect of sex is found to be significant ($P \leq 0.01$) statistically.

The genetic group and genetic group x sex interaction effect on frequency per hour of feather pecking is found to be non significant statistically.

b) Duration of head pecking

Durations (min) of head pecking exhibited by RIR male and female are 5.70 ± 0.06 and 5.55 ± 0.06 min respectively and the overall genetic group value is 5.62 ± 0.07 min. For Vanaraja these values are 5.75 ± 0.08, 5.50 ± 0.06 and 5.62 ± 0.12 min respectively. The effect of genetic group on duration of head pecking is found to be non significant statistically. The overall mean value for male and female irrespective of genetic group are 5.67 ± 0.04 and 5.47 ± 0.04 min respectively. Irrespective of genetic group significantly ($P \leq 0.01$) higher value is observed in male (5.67 ± 0.04 min) than that in female (5.47 ± 0.04 min).

The genetic group x sex interaction effect on duration (min) per hour of head pecking is found to be non significant statistically.

c) Relative duration (percentage) of head pecking

Relative duration of head pecking for RIR male and female are 4.41 ± 0.37 and 3.51 ± 0.38 percent respectively and the overall genetic group value is 3.96 ± 0.45 percent. For Vanaraja these values are 5.08 ± 0.56, 3.21 ± 0.42 and 4.14 ± 0.22 percent respectively. The overall mean value for male and female irrespective of genetic group are 4.75 ± 0.03 and 3.36 ± 0.03 percent respectively, the difference being significant ($P \leq 0.01$) statistically. Comparison of overall genetic group values reveals a non significant effect, though the value of Vanaraja (4.14 ± 0.22%) is higher than that of RIR (3.96 ± 0.45%).

The genetic group x sex interaction effect on relative duration (%) per hour of head pecking is found to be non significant.

The findings of the present study reveal that there is no significant difference in frequency of head pecking activity between both the genetic groups. Also the time spent by birds of both the genetic groups is same.

4.3.8 Tidbiting

Tidbiting is a pattern of threat display, in which the bird repeatedly pecked at the ground with his beak, with or without ground scratching with his feet (Millman *et al.*, 2000).

a) Frequency of tidbiting

The frequency per hour of tidbiting for male, female and overall in RIR are 1.86 ± 0.01, 1.92 ± 0.02 and 1.89 ± 0.02 respectively. The respective values in Vanaraja are 1.93 ± 0.02, 2.02 ± 0.02 and 1.97 ± 0.04. The overall mean value for male and female irrespective of genetic group are 1.90 ± 0.02 and 1.98 ± 0.02 respectively. The value of Vanaraja (1.97 ± 0.04) is significantly ($P \leq 0.01$) higher than that of RIR (1.89 ± 0.02). Irrespective of genetic group significantly ($P \leq 0.01$) higher value is observed in female (1.98 ± 0.02) than that in male (1.90 ± 0.02).

The genetic group x sex interaction effect on frequency per hour of tidbiting is found to be non significant statistically.

b) Duration of tidbiting

Durations (min) per hour of tidbiting exhibited by RIR male and female are 6.20 ± 0.08 and 6.40 ± 0.10 min respectively and the overall genetic group value is 6.30 ± 0.10 min. The values in Vanaraja are 6.45 ± 0.10, 6.75 ± 0.11 and 6.60 ± 0.15 min in that order. The overall mean value for male and female irrespective of genetic group are 6.27 ± 0.06 and 6.53 ± 0.06 min respectively. The effect of sex on duration of tidbiting is found to be significant ($P \leq 0.01$) statistically. The value of Vanaraja (6.60 ± 0.15 min) is significantly ($P \leq 0.01$) higher than that of RIR (6.30 ± 0.10 min).

The genetic group x sex interaction effect on duration (min) per hour of tidbiting is found to be non significant statistically in all the differences.

c) Relative duration (percentage) of tidbiting

The relative duration of tidbiting for RIR male and female are 8.00 ± 0.58 and 9.48 ± 0.06 percent respectively and 8.74 ± 0.03 percent is the overall genetic group value. The values in Vanaraja are 9.84 ± 0.06, 12.27 ± 0.08 and 11.05 ± 0.50 percent respectively. The overall mean value for male and female irrespective of genetic group are 8.92 ± 0.05 and 10.90 ± 0.05 percent respectively, the difference being significant ($P \leq 0.01$) statistically. The overall genetic group value for Vanaraja (11.05 ± 0.50) is significantly ($P \leq 0.01$) higher than that for RIR (8.74 ± 0.03).

The genetic group x sex interaction effect on relative duration (%) per hour of tidbiting is found to be non significant statistically.

The findings of the present study reveal that the tidbiting activity is performed by Vanaraja birds more frequently than that by RIR birds in both sexes. Also Vanaraja birds spent more time in tidbiting activity than RIR birds and relative duration is also seen to be higher in Vanaraja in both sexes than that by RIR. It is also noticed that females of both the genetic groups show more tidbiting activity than their respective male counterparts. The relative duration of tidbiting is also higher in female birds of both the genetic groups. It is not known why Vanaraja birds performed more tidbiting than RIR birds in both sexes and also the reason for more activity of tidbiting by females in comparison to males is not known.

In the present study it is observed that in both the layer birds, females used to perform more tidbiting activity than males which contradicts with the findings of Millman *et al.* (2000) where they reported that laying strain males performed tidbiting twice as frequently as did broiler breeder strain.

4.3.9 Crowing

Crowing is defined as a stereotyped vocalization emitted as the bird maintained an upright posture (Millman *et al.,* 2000). The pattern of crowing by fowl has been recorded.

a) Frequency of crowing

The frequency per hour of crowing in male and female of RIR are 1.71 ± 0.01 and 1.66 ± 0.01 respectively and the overall genetic group value is 1.68 ± 0.02. In Vanaraja these values are 1.56 ± 0.08, 1.57 ± 0.07 and 1.56 ± 0.04 respectively. The effect of genetic group on frequency of crowing is found to be significant (P≤0.01) statistically. The overall mean value for male and female irrespective of genetic group are 1.63 ± 0.01 and 1.63 ± 0.01 respectively. The effect of sex is found to be non significant statistically.

The genetic group x sex interaction on frequency per hour of crowing is found to be non significant statistically in all the differences.

b) Duration of crowing

The duration of crowing for male, female and overall of RIR are 5.70 ± 0.06, 5.55 ± 0.07 and 5.62 ± 0.07 min respectively. In Vanaraja these values are 5.20 ± 0.04, 5.25 ± 0.03 and 5.22 ± 0.02 min in that order. The overall mean value for male and female irrespective of genetic group are 5.37 ± 0.03 and 5.37 ± 0.03 min respectively, though the effect of sex is found to be non significant statistically. Comparison of overall genetic group values reveals that RIR birds has a significantly (P≤0.01) higher value (5.62 ± 0.07 min) than that of Vanaraja birds (5.22 ± 0.02 min).

The genetic group x sex interaction on duration (min) per hour of crowing is found to be non significant statistically.

c) Relative duration (percentage) of crowing

The relative duration of crowing for male and female in RIR are 4.26 ± 0.37 and 3.67 ± 0.46 percent respectively and the overall genetic group value is 3.96 ± 0.29 percent. In Vanaraja the respective values are 1.40 ± 0.27, 1.91 ± 0.37 and 1.65 ± 0.25 percent. The overall mean value for male and female irrespective of genetic group are 2.83 ± 0.03 and 2.79 ± 0.03 percent respectively, being the difference is non significant statistically. A significantly (P≤0.01) higher value is observed in RIR (3.96 ± 0.29%) than that in Vanaraja birds (1.65 ± 0.25%). The effect of genetic group on relative duration of crowing is found to be significant (P≤0.01).

The genetic group x sex interaction on relative duration (%) per hour of crowing is found to be non significant statistically.

The findings of the present study reveal that crowing occurred more frequently in RIR birds than Vanaraja in both sexes. It is noticed that RIR birds spent more time in crowing than Vanaraja birds and also relative duration is more in RIR than Vanaraja birds. It has also observed that in RIR, males used to crow more frequently and spent more time than its female counterparts. On the other hand, Vanaraja females spent more time in crowing and crowed more frequently than its male counterparts. It is not known why crowing occurred more in RIR birds than Vanaraja and frequency of crowing is different between sexes of either breeds.

Relative importance of different patterns of agonistic interaction

Time motion analysis of different patterns of agonistic interaction of bird depicts that wing flapping is the prime pattern of agonistic interaction which consuming 19.9% of one hour time for observation recording. This is followed by fighting (19.3%), threatening (13.2%), chasing (12.8%), feather pecking (11.7%), tidbiting (9.8%), pushes (7.2%), head pecking (4.0%) and crowing (2.8%).

4.4 Sexual behaviour of fowl

A number of behavioural patterns are associated with sexual behaviour of fowl. These patterns that function in the initiation, progression and culmination of the stimulus response sequence are most significant (Guhl and Fischer, 1975). These patterns of sexual behaviour of fowl were categorised and discussed under two main subheadings i.e. male sexual behaviour and female sexual behaviour.

4.4.1 Male sexual behaviour

The sexual behaviour of male has been categorised under different patterns of behaviour, some may be normal or some may display aggression towards females. These behavioural patterns are observed and tabulated in terms of frequency per hour of different patterns in Table-4.4.1 and graphically in Fig.4.4.1 for both the genetic groups. Relevant analysis of variance is shown in Table-4.4.2. Findings are discussed in following subsections.

4.4.1.1 Mounting

Mounting is the principal pattern of sexual behaviour in male. Mounting refers as male approaches a female gently and place one or both feet on her back (Millman *et al.*, 2000).

Frequency of mounting

The frequency per hour of mounting for both RIR and Vanaraja males are 1.80 ± 0.01 and 1.78 ± 0.01 respectively. The effect of genetic group is found to be non significant statistically though the value in RIR is slightly higher (1.80 ± 0.01) than that of Vanaraja (1.78 ± 0.01).

From these findings it is revealed that male of Vanaraja performed more mounting activity than RIR though it does not differ significantly which is in agreement with the findings of Millman *et al.* (2000) where they found that broiler breeder male performed more mounting females significantly more frequently than laying strain males. Because in the present study also no significant difference was noticed among the two layer bird males i.e. RIR and Vanaraja.

4.4.1.2 Forced mounting

Forced mounting means the male approach the female forcefully to mount over her when the female avoided the male and no further elements of copulatory sequence were performed (Millman *et al.*, 2000).

Frequency of forced mounting

The frequency of forced mounting for both RIR and Vanaraja males are 1.77 ± 0.01 and 1.93 ± 0.02 respectively. Comparison of values of frequency between both the genetic groups reveals that value in Vanaraja is

Table-4.4.1 Frequency (per hour) of different patterns of male sexual behaviour in two genetic-groups of fowl

(Mean ± SE)

Patterns of Behaviour	Rhode Island Red	Vanaraja
Mounting	1.80 ± 0.01	1.78 ± 0.01
Forced Mounting	1.77^{b} ± 0.01	1.93^{a} ± 0.02
Copulation	1.87 ± 0.01	1.84 ± 0.01
Forced Copulation	1.62 ± 0.01	1.63 ± 0.01
Male to male aggression	2.29 ± 0.03	2.29 ± 0.03
Male to female aggression	2.56^{b} ± 0.02	2.64^{a} ± 0.02
Waltzing	2.10^{a} ± 0.02	1.95^{b} ± 0.02
High step advance	2.06 ± 0.02	1.99 ± 0.02
Steps off	2.00^{a} ± 0.01	1.94^{b} ± 0.01

Means with different superscript within the same row differ significantly.

Table-4.4.2 Analysis of variance of different patterns of male sexual behaviour in two genetic-groups of fowl

Source of Variation	df	Ms								
		Mounting	Forced mounting	Copulation	Forced copulation	Male to male aggression	Male to female aggression	Waltzing	High step advance	Steps off
Genetic group	1	0.023 NS	1.593 **	0.069 NS	0.007 NS	0.036 NS	0.395 *	1.102 **	0.245 NS	0.218 **
Error	498	0.043	0.052	0.042	0.029	0.121	0.072	0.072	0.089	0.031

NS = Non-significant

* = ($P \le 0.05$) significant at 5% level

** = ($P \le 0.01$) significant at 1% level

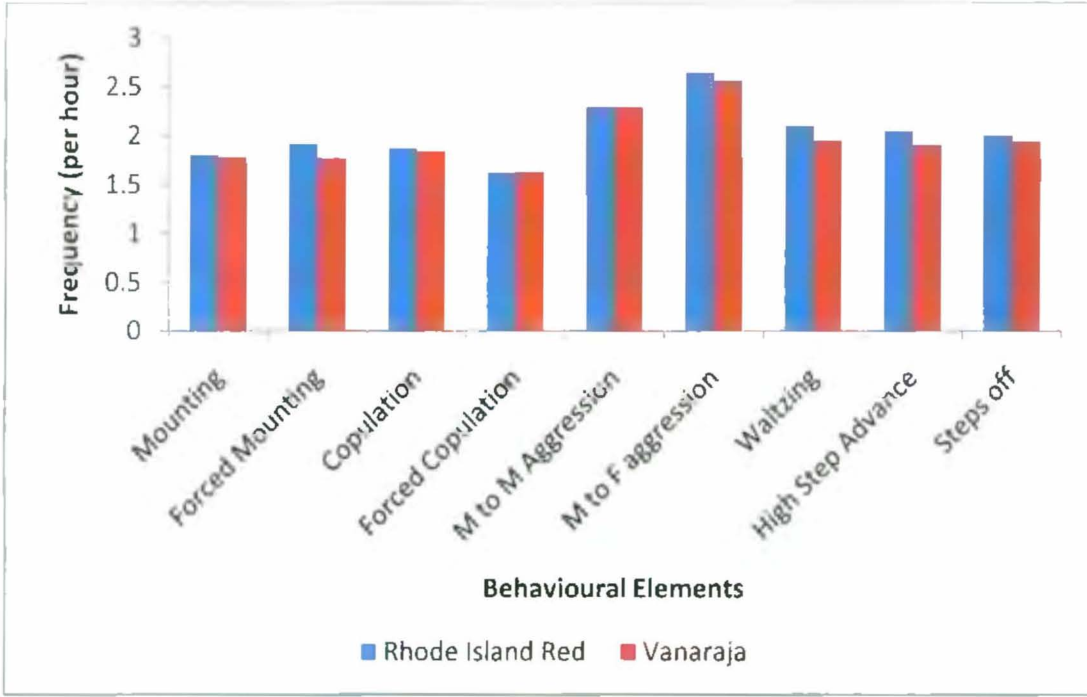

Fig-4.4.1 Frequency (per hour) of different patterns of male sexual behaviour in two genetic groups of fowl.

significantly (P≤0.01) higher (1.93 ± 0.02) than that of RIR (1.77 ± 0.01). The effect of genetic group is found to be significant (P≤0.01).

From this finding, it is revealed that males of Vanaraja attempts significantly more forced mounting than the males of RIR. It shows that males of Vanaraja are more aggressive during mating time than males of RIR. This may be due to that the females of Vanaraja avoid their male counterparts more frequently than did by the females of RIR (Refer Table-4.4.3.) which is supported by the findings of Millman *et al.*, (2000) where they found that when female avoided the males more than males used to mount forcefully over female.

4.4.1.3 Copulation

Copulation defined as the male mounted, gripped and trod a female and appeared to achieve cloacal contact (Millman *et al.*, 2000). The male sexual behaviours are quantified here in terms of copulation and the results are discussed below.

Frequency of copulation

Frequency per hour of copulation for both RIR and Vanaraja are 1.87 ± 0.11 and 1.84 ± 0.01 respectively. The effect of genetic group on frequency of copulation is found to be non significant statistically though the value in RIR (1.87 ± 0.11) is slightly higher than that in Vanaraja (1.84 ± 0.01).

From these findings it is revealed that the males of RIR perform more copulation than the Vanaraja males though it does not differ significantly, which is supported by the findings of Millman and Duncan (2000b) where they reported that some breeds perform copulation more frequently than others. They observed that broiler breeder strain males copulated more frequently than others viz. Game strain and layer breeders.

4.4.1.4 Forced copulation

The sexual behaviour of male have been quantified here in terms of forced copulation in which the male mounted a female and appeared to achieve cloacal contact following a struggle (Millman *et al.*, 2000).

Frequency of forced copulation

The frequency per hour of forced copulation exhibited by both RIR and Vanaraja are 1.62 ± 0.01 and 1.63 ± 0.01 respectively. Comparison of mean values of frequency of forced copulation for both the genetic groups reveals a non significant effect of genetic group though the value of frequency of forced copulation is slightly higher in Vanaraja (1.63 ± 0.01) than that in RIR (1.62 ± 0.01).

From the above finding it is noticed that males of Vanaraja forced more copulation than males of RIR which is in agreement with the findings of Millman *et al.* (1996) where they stated that some breeds perform more forced copulation than others. They found that broiler breeder males forced more copulation than commercial laying strain males. In the present study on laying strain males, it is found that Vanaraja males performed more forced copulation than RIR males.

The findings of the present study reveal that males of both the genetic groups show forced copulation towards females which is in agreement with the findings of Mench (1993) where he reported that males are extremely rough during mating, forcing copulation and often injuring or killing females, though in the present study there is no incidence of killing females by male was observed.

4.4.1.5 Male to male aggression

The pattern of male to male aggression has been recorded where the male chased, pecked and jumped at other male in the pen (Millman *et al.*, 2000).

Frequency of male to male aggression

The frequency of male to male aggression exhibited by both RIR and Vanaraja males are 2.29 ± 0.03 and 2.29 ± 0.03 respectively. It is noticed that the values of frequency of male to male aggression in both the genetic groups are same (2.29 ± 0.03 in RIR and 2.29 ± 0.02 in Vanaraja). Effect of genetic group on frequency of male to male aggression is found to be non significant statistically.

From the above findings it is revealed that both the laying strain males display aggression towards other males in the pen during the performance of sexual courting. There is no significant difference noticed in the male to male aggression display between the two genetic groups. However it is not known why the male to male aggression is found to be the same in both the genetic groups.

4.4.1.6 Male to female aggression

The male pecked a female with a downward blow of the beak, usually directed at her head at the time of courtship display which refers as male to female aggression (Millman *et al.*, 2000). The sexual behaviours of male are quantified here in terms of male to female aggression and results are discussed below.

Frequency of male to female aggression

The frequency per hour of male to female aggression for both the genetic groups are 2.56 ± 0.02 in RIR and 2.64 ± 0.02 in Vanaraja. Comparison of frequency of male to female aggression between both the genetic groups reveals a significantly ($P \leq 0.05$) higher value in Vanaraja (2.64 ± 0.02) than that in RIR (2.56 ± 0.02).

From these findings it is revealed that the males of Vanaraja attempt more aggression towards females than do the males of RIR. It shows that male of Vanaraja is more aggressive towards females during mating time.

The above finding reveals that in both the genetic groups males showed aggression towards females which is supported by the findings of Mench (1993) and Brake (1998) where they reported that males behaved aggressively towards females during mating time though they observed it in commercial broiler breeder strain.

It is observed from the above findings that males of Vanaraja are more aggressive towards females during mating time. This may be due to that the females of Vanaraja avoids their male counterparts more frequently (refer table-4.4.3.) which is in agreement with the findings of Millman *et al.* (2000) where they found that when female avoided the males more, then males behaved more aggressively towards females.

4.4.1.7 Waltzing

The pattern of waltzing by males during courting time has been recorded. Waltzing refers as the male approached the female in a sideways or circling path with his far wing lowered and feet made a rasping sound as they passed through the primary feathers of the wing (Millman *et al.*, 2000).

Frequency of waltzing

Frequency per hour of waltzing display exhibited by RIR and Vanaraja are 2.10 ± 0.02 and 1.95 ± 0.02 respectively. Comparison of frequency of waltzing between both the genetic groups reveals a significantly ($P \leq 0.01$) higher value in RIR (2.10 ± 0.02) than that in Vanaraja (1.15 ± 0.02).

From the above findings it is revealed that males of RIR waltzed significantly more frequently than males of Vanaraja which is supported by the findings of Millman and Duncan (2000b) where they observed that males of some breed performed waltzing more frequently than the males of other breeds. They found that male of game type strain waltzed more than ten times as frequently as did males of other strain viz. broiler breeder and layer strain.

The above finding also reveals that the males of both the genetic groups perform waltzing as frequently to females which is in agreement with the findings of Millman and Duncan (2000b) where they reported that males performed waltzing as frequently to females of either strain.

Also from the above findings it is noticed that waltzing display in RIR male differ significantly than that in Vanaraja male which contradicts with the findings of Millman *et al.* (2000) where they stated that waltzing did not differ significantly between strains.

4.4.1.8 High step advance

High step advance is a courtship display, in which the male approached the female with a strutting walk (Millman *et al.*, 2000).

Frequency of high step advance display

Frequency of high step advance for both RIR and Vanaraja are 2.06 ± 0.02 and 1.99 ± 0.02 respectively. The effect of genetic group on frequency per hour of high step advance reveals a non significant effect, though the value in RIR is higher (2.06 ± 0.02) than that of Vanaraja (1.99 ± 0.02).

From the above findings it is revealed that the males of RIR approach its female counterparts with more frequency of high step advance display than do the males of Vanaraja.

The findings of the present study also reveals that in both the layer birds viz. RIR and Vanaraja, males show considerable frequency of high step advance display which is supported by the findings of Millman *et al.*(2000) where they reported that laying strain males displayed high step advance much more frequently than did broiler breeder males.

4.4.1.9 Steps off

This display occurs in males after completion of mating, where usually males walked in forward direction i.e. steps off in forward direction after mating (Guhl and Fischer, 1975). The pattern of steps off display by males of both the genetic groups has been recorded.

Frequency of steps off display

Frequency of steps off display exhibited by both RIR and Vanaraja are 2.00 ± 0.01 and 1.94 ± 0.01 respectively. Comparison of values of frequency of steps off between both the genetic groups reveals that value in RIR (2.00 ± 0.01) is significantly ($P \leq 0.01$) higher than that in Vanaraja male (1.94 ± 0.01).

The findings of the present study reveals that males of RIR show significantly more steps off than the Vanaraja males. This may be due to the fact that males of RIR showed more frequency of mounting and copulation than the Vanaraja males (refer Table-4.4.1) which means RIR males perform more successful mating, which is in agreement with the report of Guhl and Fischer (1975) where they stated that after mating is over the males usually steps off in forward direction and execute a waltz.

4.4.2 Female sexual behaviour

The sexual behaviour in the hen is largely triggered by external stimuli emanating from the rooster (Wood-Gush, 1954, 1956 and 1958). A hen may respond negatively, positively or be indifferent to courting (Guhl and Fischer, 1975). In the present study the sexual behaviours of female have been categorised under different patterns of behaviour and are observed and tabulated in terms of frequency (per hour) of behaviour in Table-4.4.3 and graphically in Fig.4.4.3 for both the genetic groups. Relevant analysis of variance is shown in Table-4.4.4 for both the genetic groups. Findings are discussed in following subsections.

4.4.2.1 Crouching

Crouching is one pattern of sexual behaviour in female in which the hen dips her head and body with wings spread to indicate receptiveness to the male (Guhl and Fischer, 1975).

Frequency of crouching

The frequency per hour of crouching for RIR and Vanaraja are 1.88 ± 0.01 and 1.86 ± 0.01 respectively. The effect of genetic group on frequency of crouching is found to be non significant statistically though the value in RIR (1.88 ± 0.01) is slightly higher than that in Vanaraja (1.86 ± 0.01).

The finding of the present study reveals that female of RIR performed more crouching display than the Vanaraja females although it does not differ significantly.

From these findings it is revealed that females of both the genetic groups crouched frequently prior to courtship by the male which is in agreement with the findings of Millman and Duncan (2000b) where they reported that females often crouched prior to courtship by the males.

Millman *et al.* (2000) reported that females housed with broiler breeder males rarely adopt a sexual crouch, but in the present study on layer breeder fowls it is noticed in both the genetic groups viz. RIR and Vanaraja that females often adopt sexual crouch when they housed along with males, as in the present study the observations done in the pens where males and females housed together.

4.4.2.2 Interference

Interference refers as a female attacked or threatened the male while he was attempting to copulate with another female, disrupting the copulatory sequence (Millman and Duncan, 2000b).

Frequency of interference

Frequency per hour of interference in RIR and Vanaraja are 1.94 ± 0.02 and 2.00 ± 0.02 respectively. Comparison of frequency of interference between both the genetic groups reveals a non significant effect though the value in Vanaraja is higher (2.00 ± 0.02) than that of RIR (1.94 ± 0.02).

The findings of the present study reveal that females of Vanaraja interfered more frequently than the females of RIR though the result does not differ significantly.

From these findings it is revealed that females of both the genetic groups interfered with males frequently which are in agreement with the findings of Millman and Duncan (2000b) where they reported that females interfered with males of all strains viz. game strain, broiler and layer breeder strains.

4.4.4.3 Allopecking

The sexual behaviours of female have been quantified here in terms of allopecking in which female pecked gently at the comb, wattles or face of the male allowing him for courtship display (Millman and Duncan, 2000b).

Frequency of allopecking

The frequency of allopecking in RIR and Vanaraja females are 1.84 ± 0.02 and 1.75 ± 0.02 respectively. As effect of genetic group on frequency of allopecking is significant ($P \leq 0.01$) a higher value is recorded in RIR (1.84 ± 0.02) than that in Vanaraja (1.75 ± 0.02).

From this finding it is revealed that females of RIR allopeck significantly more frequently than that of Vanaraja which is in agreement with the findings of Millman and Duncan (2000b) where they reported that females of some breed performed more allopecking than the females of other breeds. They observed that laying strain females allopecked more frequently than the other breeds viz. game strain and broiler breeder strain. They also noticed that broiler breeder females allopecked more than game strain females.

Findings of the present study also reveal that females of both the genetic groups allopeck males frequently which coincides with the findings of Millman and Duncan (2000b) where they reported that females performed allopeck to males of all strain.

4.4.2.4 Avoidance by female

The sexual behaviour of female have been quantified here in terms of avoidance by female which may be indicated by merely moving the head away from the flock mates during social as well as sexual interactions (Guhl and Fischer, 1975).

Frequency of avoidance by female

The frequency per hour of avoidance by female for RIR and Vanaraja are 2.27 ± 0.02 and 2.56 ± 0.02 respectively. Comparison of values for both

Table-4.4.4 Analysis of variance of different patterns of female sexual behaviour in two genetic-groups of fowl

Source of Variation	df	Ms							
		Crouching	Interference	Allopecking	Avoidance by female	Approach by female	Female to male aggression	Female to female aggression	Stands & shakes
Genetic group	1	0.012 NS	0.185 NS	0.512 **	4.471 **	0.739 **	3.342 **	0.289 NS	0.012 NS
Error	498	0.041	0.076	0.049	0.082	0.092	0.097	0.120	0.041

NS = Non-significant

* = ($P \leq 0.05$) significant at 5% level

** = ($P \leq 0.01$) significant at 1% level

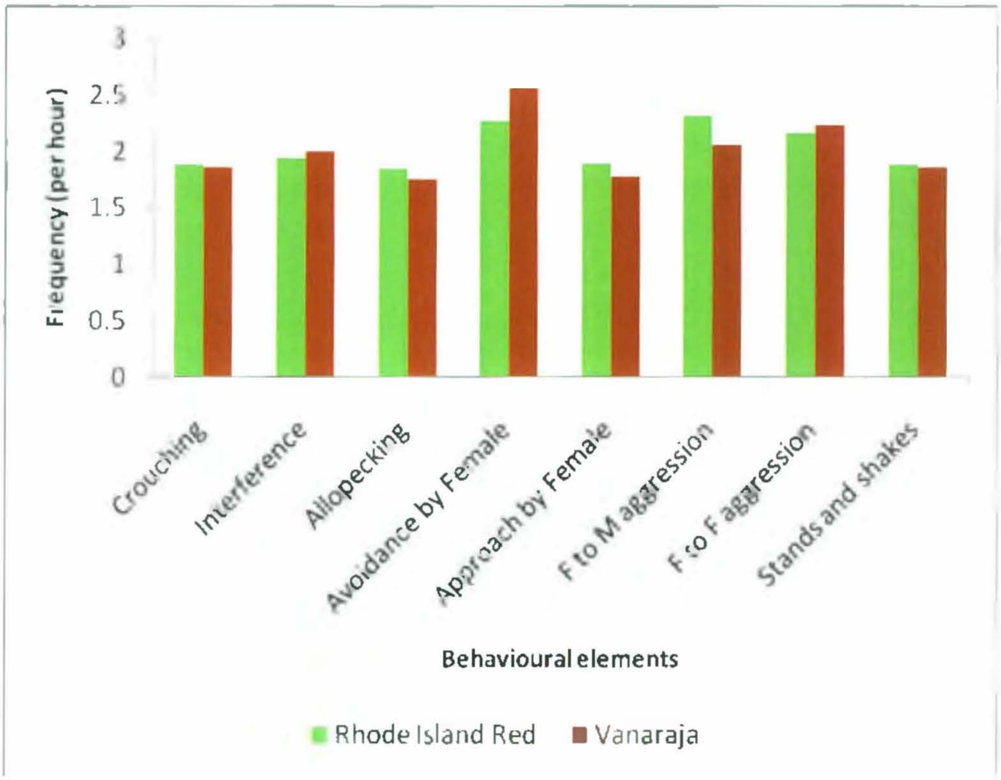

Fig-4.4.3 Frequency (per hour) of different patterns of female sexual behaviour in two genetic groups of fowl.

the genetic groups reveals that value in Vanaraja (2.56 ± 0.02) is significantly ($P \leq 0.01$) higher than that of RIR.

The findings of the present study reveal that females of the Vanaraja avoid their male counterparts more frequently than by the females of RIR which is in agreement with the findings of Millman and Duncan (2000b) where they reported that females of some breeds used to avoid males more frequently than other breeds. They observed that game strain females avoided males more frequently than other strains viz. broiler and layer breeder strain.

From these findings it is revealed that females of Vanaraja avoid males more frequently than do the females of RIR. This may be due to that male of Vanaraja performed more forced copulation than the males of RIR (refer table-4.4.1.), which is supported by the findings of Mench (1993) where he stated that when forced copulation was executed by males, females used to avoid males by running away, by hiding in nest boxes and remaining on raised slatted areas.

4.4.2.5 Approach by female

The male's behaviour resulted in one or more females walking or running towards him (Millman *et al.*, 2000). The pattern of approach by female has been recorded.

Frequency of approach by female

The frequency per hour of approach by female for RIR and Vanaraja are 1.89 ± 0.02 and 1.78 ± 0.02 respectively. Comparison of values of frequency for both the genetic groups reveal that value in RIR (1.89 ± 0.02) is significantly ($P \leq 0.01$) higher than that in Vanaraja (1.78 ± 0.02).

From these findings it is revealed that females of RIR approach males more frequently than by the females of Vanaraja. Findings of the present study reveal that in both the laying strain birds females approach the males frequently although the frequency of approach was different for both the genetic groups which is in agreement with the findings of Millman *et* *al.*(2000) where they reported that females were found to approach laying strain males much more frequently than broiler breeder males.

4.4.2.6 Female to male aggression

Female to male aggression refers as female pecked the male usually directed at his head and also jumped over him, kicking with her feet (Millman and Duncan, 2000b).

Frequency of female to male aggression

The values of frequency of female to male aggression for RIR and Vanaraja are 2.31 ± 0.02 and 2.06 ± 0.03 respectively, the difference being significant ($P \leq 0.01$) statistically.

Findings of the present study reveal that females of RIR used to behave aggressively towards its male counterparts than by the females of Vanaraja.

The findings of the present study also reveal that in both the genetic groups of fowl, females behave aggressively towards its male counterparts which is in agreement with the findings of Wood-Gush (1956) where he reported that female to male aggression was found to occur in situations where males were of similar age and size to females. In the present study also, the age of female and male birds of both the genetic groups are similar and also in size.

RIR females behave aggressively towards males than by the Vanaraja females in the present study which contradicts with the findings of Millman and Duncan (2000b) where they reported that no difference in frequencies of female to male aggression between the strains.

4.4.2.7 Female to female aggression

Female to male aggression refers as a female pecked another female with a downward blow of her beak, usually directed at her head and also jumped at the female, kicking with her feet (Millman and Duncan, 2000b).

Frequency of female to female aggression

The values of frequency per hour of female to female aggression in RIR and Vanaraja are 2.16 ± 0.03 and 2.23 ± 0.03 respectively. Comparison of frequencies for both the genetic groups reveals a non significant effect of genetic groups though the value in Vanaraja (2.23 ± 0.03) is higher than that in RIR (2.16 ± 0.03).

Findings of the present study reveal that in Vanaraja, female to female aggression is higher than that in RIR though it does not differ significantly.

The findings of the present study reveal that in both the genetic groups' females behave aggressively towards other females which is in agreement with the findings of Wood-Gush (1956) where he stated that female to female aggression reported to have between similar age group of birds. In the present study also the age of the birds within the same group was similar.

4.4.2.8 Stands and shakes

After mating is over the hen ruffles her feathers as she gets to her feet and may run in a circle which refers as stands and shakes display in female birds (Guhl and Fischer, 1975). The sexual behaviours of female have been quantified here in terms of stands and shakes.

Frequency of stands and shakes

The values of frequency per hour of stand and shakes for both RIR and Vanaraja are 1.88 ± 0.01 and 1.86 ± 0.01 respectively. Comparison of frequency of stands and shakes for both the genetic groups reveals a non significant effect though the value in RIR (1.88 ± 0.01) is slightly higher than that of Vanaraja (1.86 ± 0.01).

The findings of the present study reveals that stands and shakes is more in RIR females than Vanaraja females, though difference is found to be non significant statistically. In support of this no explanation is yet available.

Chapter- 05

Summary and Conclusion

SUMMARY AND CONCLUSION

Poultry is one of the fastest growing segments of the agricultural sector in India with an average growth rate of 8-10%, production level of 41 billion eggs and 1.4 million ton broilers per annum. India is now the world's 3rd largest egg producer and the 5th largest chicken producer. This expansion has resulted due to combination of certain factors viz., growth in per capita income, a growing urban population and falling real poultry price. The pattern of growth has resulted in a highly competitive market. Behaviour is the way in which an animal establishes and maintain itself in its ecological niche and also is a key link between an animal and its environment. Behaviour is the way that fowls respond to the different stimuli they encounter in their environment. Knowledge of behaviour of the stock and the application of that knowledge in the care of the stock play an important part in the maximization of production efficiency of a poultry production enterprise.

Knowledge of ingestive behaviour has its own importance in respect to poultry welfare and production efficiency. Ingestive behaviour refers to any action of an animal or bird that is directed towards the procurement of nutrients. Because much of animal evolution involves adaptation for the procurement of food, the extent of the meaning of the term ingestive behaviour is not clear (Encyclopaedia Britannica, 2011). Social behaviour provides an organizational frame work for relationship among members of a group (Siegel, 2000). Knowledge of social behaviour of fowl plays an important role in poultry production enterprise. There are a number of factors that influence social behaviour. These include individual recognition, communication and pecking and peck order (Poultryhub.org., 2000). Laying hens have complex interrelationship involving social rank, aggression, feeding behaviour and egg production (Mench and Keeling, 2001) studies on agonistic interactions also have an important consideration from management point of view. Most aggression is seen at the feed trough, where there is some competition among the chickens (Mench and Keeling, 2001). Once a social group become organised, the incidence of agonistic interactions decreases (Mauldin, 1992). Displays play an important part in mating behaviour. A series of displays occur before mating, based on a stimulus response sequence initiated by male (Fischer, 1975). An understanding of sexual behaviour in chickens can help to assess whether the flock fertility is good, average or poor.

With the view in end, the present study was undertaken to study the system of ingestive, social, resting, agonistic and sexual behaviour of Rhode Island Red and Vanaraja fowl parent stock managed under deep litter system and to suggest modification in management practices under deep litter system keeping in view of the present findings.

The study has been conducted at the Department of Livestock Production Management, West Bengal University of Animal and Fishery Science, Mohanpur campus, Nadia, West Bengal, on two genetic groups of fowl viz. Rhode Island Red and Vanaraja. The experimental birds of Rhode Island Red and Vanaraja were reared in two different farms Viz. Haringhata poultry farm, Govt. of West Bengal and Poultry Seed Project (ICAR) farm, West Bengal University Animal and Fishery Sciences, respectively located at Mohanpur, Nadia, West Bengal. The birds were kept under deep litter systems of rearing with 2.5 sq. ft. per bird floor space. Standard poultry feed (mash)was given according to the age and body weight in hanging feeder. Fresh and potable water was supplied *ad libitum* in bell shaped automatic drinker. Main source of illumination was natural light. There were 20 male and 200 female birds in each pen. In the present study 10 males and 10 females of each genetic group were selected randomly belonging to age and body weight ranges of 36-48 weeks & 2.8-4.5 kg respectively. They were given identification mark with coloured ribbon at shank for quick and easy identification. Every pen was observed six days per week alternatively for each sex and scanned four times per day. Duration of each observation session was 60 minutes. A tabulated data for each of the behaviour was obtained from each observation by summing the number of frequency, the birds engaged in that behaviour over the entire 60 minutes time. The data frequency per hour, duration (min) and relative duration (%) of walking in RIR are 1.80 ± 0.30, 6.00 ± 0.09 min and 6.27 ± 0.60% respectively. These values in Vanaraja are 1.69 ± 0.01, 5.64 ± 0.01 min and 3.96 ± 0.10% in that order. During feeding time, male birds show more frequency per hour (1.81 ± 0.01) of preening than female birds (1.69 ± 0.01). Duration (min) and relative duration (%) of preening are also more in males (5.97 ± 0.05 min and 6.74 ± 0.04% respectively) than those in females (5.57 ± 0.05 min and 4.17 ± 0.04% respectively). Statistical analysis reveals that the differences are significant ($P \leq 0.01$). Irrespective of sex, Vanaraja shows significantly ($P \leq 0.01$) more preening activity than RIR birds. Dust bathing activity during feeding time is seen more in Vanaraja birds in both sexes. The statistical analysis reveals significant ($P \leq 0.01$) effect of genetic group. Irrespective of genetic group, males show significantly ($P \leq 0.01$) more dust bathing during feeding time than females.

Studies on social and resting behaviour reveal that Vanaraja spent more time in preening (8.03 ± 0.10 min) than RIR (7.41 ± 0.06 min). Frequency and relative duration of preening is more in Vanaraja (2.40 ± 0.05 and 22.33 ± 0.08% respectively) than those in RIR (2.22 ± 0.02 and 17.79 ± 0.15% respectively). The effect of genetic group on preening activity is found to be significant ($P \leq 0.01$). Dust bathing activity is significantly ($P \leq 0.05$) more in females than in males of RIR. Frequency (per hour), duration (min) and relative duration (%) of dust bathing in RIR female are 2.39 ± 0.02, 7.97 ± 0.12 min and 21.66 ± 0.98% respectively. These values in RIR males are 2.24 ± 0.02, 7.49 ± 0.12 min and 17.60 ± 0.01% respectively. RIR female has significantly ($P \leq 0.05$) higher value of frequency, duration (min) and relative duration (%) of dust bathing than Vanaraja female. The respective values in Vanaraja female are 2.27 ± 0.02, 7.57 ± 0.12 min and 18.62 ± 0.01%. It is evident from the present study that RIR birds spent more time (7.61 ± 0.04 min) in lying than Vanaraja (7.26 ± 0.09 min). Statistically the genetic group difference is found to be significant ($P \leq 0.01$). Frequency and relative duration of lying is significantly ($P \leq 0.01$) more in RIR (2.27 ± 0.01 and 17.97 ± 0.26%) than that in Vanaraja (2.17 ± 0.25 and 15.65 ± 0.68%). It is also found that RIR birds sleep significantly ($P \leq 0.01$) more than Vanaraja birds irrespective of sexes. Males of RIR devote more time in sleeping than males of Vanaraja the difference is found to be significant (P≤0.01) statistically. Act of dozing is found to be significantly (P≤0.01) more in RIR birds than that in Vanaraja birds irrespective of sexes. The frequency per hour, duration (min) and relative duration (%) of dozing in RIR are 1.97 ± 0.03, 6.57 ± 0.10 min and 9.44 ± 0.55% respectively, while these values are 1.76 ± 0.25, 5.90 ± 0.08 min and 3.90 ± 0.52% in Vanaraja in that order. Vanaraja birds spent more time in sitting (7.96 ± 0.05 min) than RIR birds (7.58 ± 0.12 min), the difference is statistically significant (P≤0.01). Frequency (per hour) and relative duration of sitting in Vanaraja (2.38 ± 0.01 and 20.98 ± 0.53%) is significantly (P≤0.01) more than that in RIR (2.27 ± 0.04 and 17.63 ± 0.63%). Pattern of standing is observed in both the genetic groups of fowl. The effect of genetic group are found to be statistically non significant.

Findings of the present study on different patterns of agonistic interaction depict that Vanaraja birds of both sexes involved in push activity significantly (P≤0.01) more frequently than by RIR birds. Likewise, chasing pattern is also seen more in Vanaraja birds than that in RIR birds of both sexes. The difference due to genetic groups is found to be statistically significant (P≤0.01). It is observed that Vanaraja birds irrespective of sexes involved significantly (P≤0.01) more number in threatening activity towards other pen mates than is done by RIR birds. Male birds show significantly (P≤0.05) more threatening pattern than females in Vanaraja. Frequency of threatening per hour, duration (min) and relative duration (%) of threatening is more in Vanaraja male than RIR male which is found to be statistically significant (P≤0.05). Frequency (per hour) of fighting, duration (min) and relative duration (%) of fighting in male birds irrespective of genetic group are 2.35 ± 0.01, 7.75 ± 0.06 min and 20.10 ± 0.05% respectively. These values in females irrespective of genetic group are 2.31 ± 0.01, 7.62 ± 0.06 min and 18.50 ± 0.05% in that order. Statistical analysis reveals significant (P≤0.05). Also it is seen that Vanaraja birds fights more than RIR birds in both sexes which is statistically significant (P≤0.05). Incidence of wing flapping is seen significantly (P≤0.01) more in RIR birds of both sexes than in Vanaraja birds. Irrespective of genetic group females used to perform more wing flapping than that by male birds. Statistical analysis revealed a significant ($P \leq 0.01$) effect of sex. Feather pecking is seen significantly ($P \leq 0.01$) more in females of both genetic groups than that in males. RIR birds peck feather more ($P \leq 0.01$) both sexes than that by Vanaraja birds. Males perform more head pecking in respect to frequency (per hour), duration (min) and also relative duration (1.72 ± 0.01, 5.67 ± 0.04 min and 4.75 ± 0.03% respectively) than that by female birds (1.66 ± 0.01, 5.47 ± 0.04 min and 3.36 ± 0.03% respectively) irrespective of genetic group. Tidbiting is seen more in females than that in males. Incidence is more in Vanaraja birds irrespective of sexes than that in RIR birds. Statistical analysis reveals a significant ($P \leq 0.01$) effect of genetic group. It is observed that RIR birds crow more frequently (1.61 ± 0.02) than that by the Vanaraja birds (1.56 ± 0.04). Duration (5.62 ± 0.07 min), relative duration (3.96 ± 0.02%) is more in RIR than in Vanaraja (5.22 ± 0.02 min and 2.83 ± 0.03% respectively). The effect of genetic group is found to be statistically significant ($P \leq 0.01$).

Frequency of mounting in RIR and Vanaraja males are 1.80 ± 0.01 and 1.78 ± 0.01 respectively. The difference is found to be non significant statistically. Frequency (per hour) of forced mounting is seen significantly ($P \leq 0.01$) more in Vanaraja (1.93 ± 0.02) than that in RIR (1.77 ± 0.01). Frequency of copulation and forced copulation in RIR are 1.87 ± 0.01 and 1.62 ± 0.01 respectively; whereas in Vanaraja these values are 1.84 ± 0.01 and 1.63 ± 0.01. Effect of genetic group is found to be non significant statistically in both the patterns. Frequency of male to male aggression does not differ significantly as the values are exactly the same in both genetic groups (2.29 ± 0.03). While considering the male to female aggression it is seen that frequency of male to female aggression in Vanaraja (2.64 ± 0.02) is significantly ($P \leq 0.05$) more than that in RIR (2.56 ± 0.02). Frequency of waltzing pattern is seen significantly ($P \leq 0.01$) more in RIR (2.10 ± 0.02) than in Vanaraja (1.95 ± 0.02). Frequency per hour of high step advance for both RIR and Vanaraja are 2.06 ± 0.02 and 1.9 ± 0.02 respectively; but the effect of genetic group is non significant statistically. Frequency per hour of steps off is seen more in RIR (2.00 ± 0.01) than that in Vanaraja (1.94 ± 0.01).

Statistical analysis revealed significant ($P \leq 0.01$) effect of genetic group on steps off activity. Observations on different patterns of female sexual behaviour reveal that frequency (per hour) of crouching in RIR and Vanaraja are 1.88 ± 0.01 and 1.86 ± 0.01 respectively, but effect of genetic group is found to be non significant. Frequency of interference for RIR and Vanaraja are 1.94 ± 0.02 and 2.00 ± 0.02 respectively though the difference is not significant statistically. Frequency of allopecking is seen significantly ($P \leq 0.01$) more in RIR (1.84 ± 0.02) than in Vanaraja (1.75 ± 0.02). Frequency of copulation in RIR and Vanaraja are 1.88 ± 0.01 and 1.86 ± 0.01 respectively, being the difference is non significant statistically. Frequency (per hour) of avoidance and approach by female of RIR are 2.27 ± 0.02 and 1.89 ± 0.02 respectively, whereas in Vanaraja females these are 2.56 ± 0.02 and 1.78 ± 0.02 respectively. Statistical analysis revealed a significant ($P \leq 0.01$) difference between genetic groups in both the patterns. Frequency of female to male aggression is observed significantly ($P \leq 0.01$) more in RIR (2.31 ± 0.02) than that in Vanaraja (2.06 ± 0.03). Frequency of female to female aggression in RIR and Vanaraja are 2.16 ± 0.03 and 2.23 ± 0.03 respectively though the effect of genetic group is non significant statistically. Frequency per hour of stands and shakes by RIR and Vanaraja females are 1.88 ± 0.01 and 1.86 ± 0.01 respectively. The effect of genetic group on frequency of stands and shakes is non significant statistically.

Thus, from the study it is evident that, RIR is comparatively a less alert and active bird. Its social and resting behaviour pattern are indicative of its amenability to indoor management in large group. Vanaraja is comparatively more alert and active thereby indicating its suitability for backyard management particularly in view of predator problem. Vanaraja also eats faster. This character favours outdoor foraging ability. On the other hand RIR has shown quality of more efficient breeder under flock mating system and likely to be better parent stock than Vanaraja. However, for further confirmation the study need to be extended on more number birds particularly under varying management.

Chapter- 06

Future Scope of the Study

FUTURE SCOPE OF THE STUDY

The outcome of this investigation has opened up the following areas of future investigation on the broad objectives of the present study-

1. Studies need to be conducted on more number of birds and genetic groups to test the variation of the behavioural systems.

2. Studies may be extended to varying management practices to check management system x behaviour interaction if any.

3. Studies can be conducted on birds at the different stages of development to know the process of development of different systems and patterns of behaviour.

4. Studies may be extended to different times, season and varying intensity of light to identify the variation

Chapter- 07

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Table-4.3.1 Frequency (per hour) of different patterns of agonistic interaction in both sexes of two genetic-groups of fowl (Mean ± SE)

Genetic group	Sex	Patterns of Behaviour								
		Pushes	Chasing	Threatening	Fighting	Wing Flapping	Feather Pecking	Head Pecking	Tidbiting	Crowing
Rhode Island Red	Male	$1.66^{a} \pm 0.01$	$2.13^{ac} \pm 0.01$	$2.04^{b} \pm 0.01$	$2.40^{a} \pm 0.01$	$2.43^{a} \pm 0.01$	$2.04^{b} \pm 0.01$	1.71 ± 0.01	1.86 ± 0.01	1.71 ± 0.01
	Female	$1.69^{a} \pm 0.01$	$1.86^{b} \pm 0.01$	$2.05^{b} \pm 0.01$	$2.41^{a} \pm 0.01$	$2.46^{a} \pm 0.01$	$2.20^{a} \pm 0.02$	1.66 ± 0.01	1.92 ± 0.02	1.66 ± 0.01
	Overall	$1.67^{B} \pm 0.01$	$1.99^{B} \pm 0.13$	$2.04^{B} \pm 0.00$	$2.40^{A} \pm 0.04$	$2.44^{A} \pm 0.01$	$2.12^{A} \pm 0.08$	1.68 ± 0.02	$1.89^{B} \pm 0.02$	$1.68^{A} \pm 0.02$
Vanaraja	Male	$2.01^{b} \pm 0.01$	$2.11^{a} \pm 0.01$	$2.17^{a} \pm 0.01$	$2.31^{b} \pm 0.02$	$2.14^{c} \pm 0.02$	$1.93^{c} \pm 0.02$	1.72 ± 0.01	1.93 ± 0.02	1.56 ± 0.08
	Female	$1.93^{c} \pm 0.01$	$2.19^{c} \pm 0.02$	$2.07^{b} \pm 0.02$	$2.19^{c} \pm 0.02$	$2.32^{b} \pm 0.02$	$1.92^{c} \pm 0.02$	1.65 ± 0.01	2.02 ± 0.02	1.57 ± 0.07
	Overall	$1.97^{A} \pm 0.03$	$2.15^{A} \pm 0.03$	$2.12^{A} \pm 0.04$	$2.25^{B} \pm 0.05$	$2.23^{B} \pm 0.09$	$1.92^{B} \pm 0.04$	1.68 ± 0.03	$1.97^{A} \pm 0.04$	$1.56^{B} \pm 0.04$
Overall	Male	1.83 ± 0.01	$2.31^{X} \pm 0.01$	2.11 ± 0.02	$2.35^{X} \pm 0.01$	$2.29^{Y} \pm 0.02$	$1.98^{Y} \pm 0.02$	$1.72^{X} \pm 0.01$	$1.90^{Y} \pm 0.02$	1.63 ± 0.01
	Female	1.81 ± 0.01	$2.02^{Y} \pm 0.01$	2.05 ± 0.02	$2.31^{Y} \pm 0.01$	$2.40^{X} \pm 0.02$	$2.05^{X} \pm 0.02$	$1.66^{Y} \pm 0.01$	$1.98^{X} \pm 0.02$	1.63 ± 0.01

Means with common or without superscript in same column are not significantly different.

Table-4.3.2 Duration (min. per hour) of different patterns of agonistic interaction in both sexes of two genetic-groups of fowl (Mean ± SE)

Genetic group	Sex	Patterns of Behaviour								
		Pushes	Chasing	Threatening	Fighting	Wing Flapping	Feather Pecking	Head Pecking	Tidbiting	Crowing
Rhode Island Red	Male	$5.54^{a} \pm 0.06$	$7.10^{ac} \pm 0.08$	$6.80^{b} \pm 0.09$	$8.00^{a} \pm 0.08$	$8.10^{a} \pm 0.09$	$6.80^{b} \pm 0.08$	5.70 ± 0.06	6.20 ± 0.08	5.70 ± 0.06
	Female	$5.65^{a} \pm 0.06$	$6.20^{b} \pm 0.08$	$6.85^{b} \pm 0.09$	$8.05^{a} \pm 0.08$	$8.20^{a} \pm 0.09$	$7.35^{a} \pm 0.10$	5.55 ± 0.06	6.40 ± 0.10	5.55 ± 0.07
	Overall	$5.59^{B} \pm 0.05$	$6.65^{B} \pm 0.45$	$6.82^{B} \pm 0.02$	$8.02^{A} \pm 0.02$	$8.15^{A} \pm 0.04$	$7.07^{A} \pm 0.27$	5.62 ± 0.07	$6.30^{B} \pm 0.10$	$5.62^{A} \pm 0.07$
Vanaraja	Male	$6.70^{b} \pm 0.09$	$7.05^{a} \pm 0.09$	$7.25^{a} \pm 0.09$	$7.70^{b} \pm 0.10$	$7.15^{c} \pm 0.12$	$6.45^{c} \pm 0.10$	5.75 ± 0.08	6.45 ± 0.10	5.20 ± 0.04
	Female	$6.45^{c} \pm 0.09$	$7.30^{c} \pm 0.10$	$6.90^{b} \pm 0.10$	$7.30^{c} \pm 0.10$	$7.75^{b} \pm 0.11$	$6.40^{c} \pm 0.10$	5.50 ± 0.06	6.75 ± 0.11	5.25 ± 0.03
	Overall	$6.57^{A} \pm 0.12$	$7.17^{A} \pm 0.12$	$7.07^{A} \pm 0.15$	$7.50^{B} \pm 0.20$	$7.45^{B} \pm 0.30$	$6.42^{B} \pm 0.02$	5.62 ± 0.12	$6.60^{A} \pm 0.15$	$5.22^{B} \pm 0.02$
Overall	Male	6.03 ± 0.05	$7.02^{X} \pm 0.06$	6.96 ± 0.06	$7.75^{X} \pm 0.06$	$7.55^{Y} \pm 0.07$	$6.53^{Y} \pm 0.06$	$5.67^{X} \pm 0.04$	$6.27^{Y} \pm 0.06$	5.37 ± 0.03
	Female	5.97 ± 0.05	$6.66^{Y} \pm 0.06$	6.76 ± 0.06	$7.62^{Y} \pm 0.06$	$7.92^{X} \pm 0.07$	$6.76^{X} \pm 0.06$	$5.47^{Y} \pm 0.04$	$6.53^{X} \pm 0.06$	5.37 ± 0.03

Means with common or without superscript in same column are not significantly different.

Table-4.3.3 Analysis of variance for frequency and duration of different patterns of agonistic interaction in two genetic-groups of fowl

Source of Variation	df	Ms								
		Pushes	Chasing	Threatening	Fighting	Wing Flapping	Feather pecking	Head pecking	Tidbiting	Crowing
Genetic group	1	9.748 **	2.566 **	0.573 **	2.457 **	4.988 **	4.167 **	0.091 NS	0.845 **	1.441 **
Sex	1	0.027 NS	1.113 **	0.267 NS	0.365 *	1.139 **	0.682 **	0.451 **	0.565 **	0.010 NS
Genetic group × sex interaction	1	0.422 *	3.546 **	0.424 *	0.435 *	0.628 *	0.865 **	0.030 NS	0.032 NS	0.096 NS
Error	996	0.066	0.090	0.091	0.089	0.115	0.102	0.047	0.102	0.034

NS = Non-significant

* = ($P \leq 0.05$) significant at 5% level

** = ($P \leq 0.01$) significant at 1% level

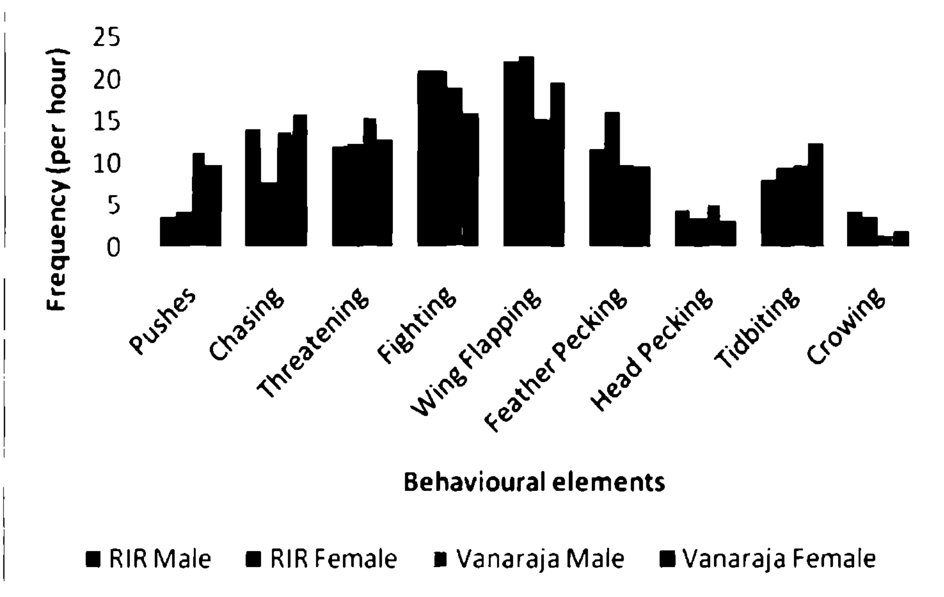

Fig-4.3.1 Frequency (per hour) of different patterns of agonistic interaction in both sexes of two genetic groups of fowl.

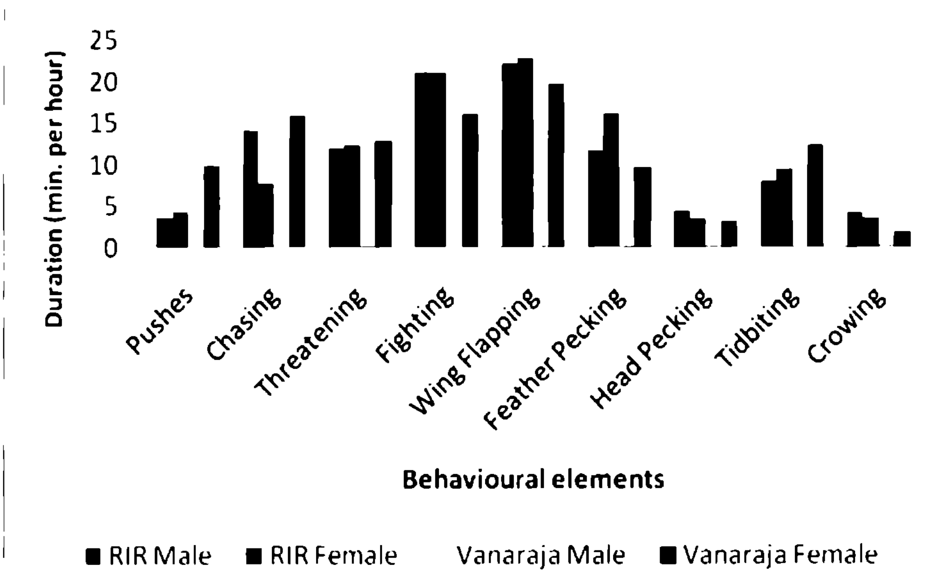

Fig-4.3.2 Duration (min. per hour) of different patterns of agonistic interaction in both sexes of two genetic groups of fowl.

Table-4.3.4 Relative Duration (percentage) of 60 minutes of different patterns of agonistic interaction in both sexes of two genetic-groups of fowl (Mean ± SE)

Genetic group	Sex	Patterns of Behaviour								
		Pushes	Chasing	Threatening	Fighting	Wing Flapping	Feather Pecking	Head Pecking	Tidbiting	Crowing
Rhode Island Red	Male	$3.64^{a} \pm 0.40$	$14.11^{ac} \pm 0.62$	$12.05^{b} \pm 0.63$	$21.04^{a} \pm 0.07$	$22.14^{a} \pm 0.07$	$11.63^{b} \pm 0.59$	4.41 ± 0.37	8.00 ± 0.58	4.26 ± 0.37
	Female	$4.28^{a} \pm 0.40$	$7.74^{b} \pm 0.56$	$12.41^{b} \pm 0.06$	$21.05^{a} \pm 0.62$	$22.73^{a} \pm 0.07$	$16.13^{a} \pm 0.07$	3.51 ± 0.38	9.48 ± 0.06	3.67 ± 0.46
	Overall	$3.96^{B} \pm 0.32$	$10.92^{B} \pm 0.35$	$12.23^{B} \pm 0.18$	$21.04^{A} \pm 0.04$	$22.43^{A} \pm 0.29$	$13.88^{A} \pm 0.12$	3.96 ± 0.45	$8.74^{B} \pm 0.03$	$3.96^{A} \pm 0.29$
Vanaraja	Male	$11.40^{b} \pm 0.06$	$13.74^{a} \pm 0.07$	$15.46^{a} \pm 0.07$	$19.07^{b} \pm 0.07$	$15.34^{c} \pm 0.09$	$9.74^{c} \pm 0.07$	5.08 ± 0.56	9.84 ± 0.06	1.40 ± 0.27
	Female	$9.74^{c} \pm 0.06$	$15.90^{c} \pm 0.07$	$12.89^{b} \pm 0.07$	$16.05^{c} \pm 0.07$	$19.69^{b} \pm 0.09$	$9.66^{c} \pm 0.07$	3.21 ± 0.42	12.27 ± 0.08	1.91 ± 0.37
	Overall	$10.57^{A} \pm 0.12$	$14.82^{A} \pm 0.37$	$14.17^{A} \pm 0.57$	$17.56^{B} \pm 0.09$	$17.51^{B} \pm 0.05$	$9.70^{B} \pm 0.04$	4.14 ± 0.22	$11.05^{A} \pm 0.50$	$1.65^{B} \pm 0.25$
Overall	Male	7.38 ± 0.04	$13.90^{X} \pm 0.05$	13.80 ± 0.05	$20.10^{X} \pm 0.05$	$18.70^{Y} \pm 0.06$	$10.70^{Y} \pm 0.05$	$4.75^{X} \pm 0.03$	$8.92^{Y} \pm 0.05$	2.83 ± 0.03
	Female	7.01 ± 0.04	$11.80^{Y} \pm 0.05$	12.60 ± 0.05	$18.50^{Y} \pm 0.05$	$21.20^{X} \pm 0.06$	$12.90^{X} \pm 0.05$	$3.36^{Y} \pm 0.03$	$10.90^{X} \pm 0.05$	2.79 ± 0.03

Means with common or without superscript in same column are not significantly different.

Table-4.3.5 Analysis of variance for relative duration of different patterns of agonistic interaction in two genetic-groups of fowl

Source of Variation	df	Ms								
		Pushes	Chasing	Threatening	Fighting	Wing Flapping	Feather pecking	Head pecking	Tidbiting	Crowing
Genetic group	1	1.136 **	0.378 **	0.095 **	0.299 **	0.605 **	0.436 **	0.009 NS	0.134 **	0.133 **
Sex	1	0.003 NS	0.111 **	0.030 NS	0.058 *	0.152 **	0.122 **	0.047 **	0.095 **	0.003 NS
Genetic group × sex interaction	1	0.041 *	0.455 **	0.053 *	0.055 *	0.087 *	0.131 **	0.005 NS	0.005 NS	0.007 NS
Error	996	0.007	0.011	0.011	0.013	0.017	0.012	0.004	0.012	0.003

NS = Non-significant

* = ($P \leq 0.05$) significant at 5% level

** = ($P \leq 0.01$) significant at 1% level

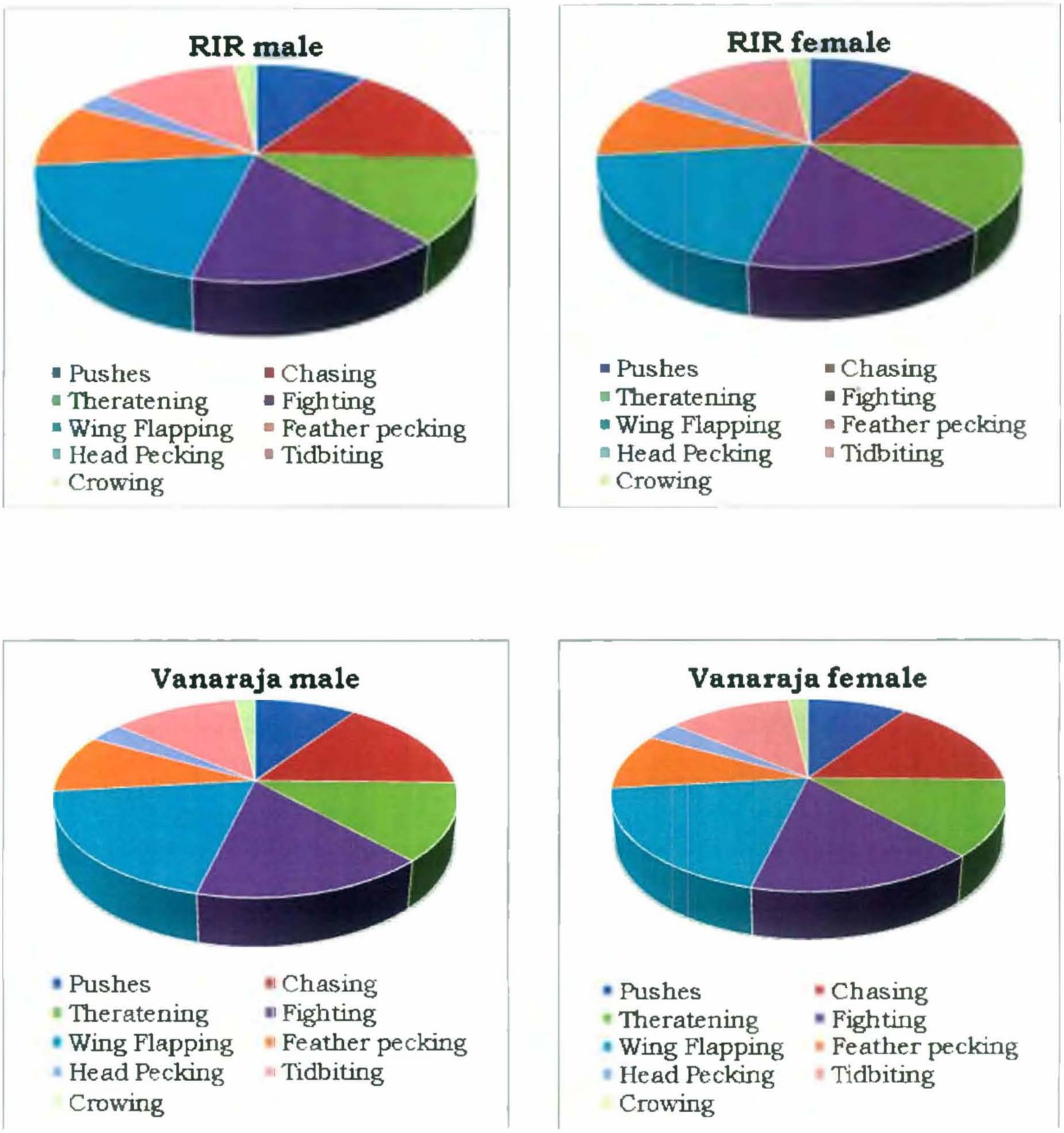

Fig-4.3.3 Relative duration (percentage) of 60 minutes of different patterns of agonistic interaction in both sexes of two genetic groups of fowl.

Table-4.4.3 Frequency (per hour) of different patterns of female sexual behaviour in two genetic-groups of fowl

(Mean ± SE)

Patterns of Behaviour	**Rhode Island Red**	**Vanaraja**
Crouching	1.88 ± 0.01	1.86 ± 0.01
Interference	1.94 ± 0.02	2.00 ± 0.02
Allopecking	$1.84^{a} \pm 0.02$	$1.75^{b} \pm 0.02$
Avoidance by Female	$2.27^{b} \pm 0.02$	$2.56^{a} \pm 0.02$
Approach by Female	$1.89^{a} \pm 0.02$	$1.78^{b} \pm 0.02$
Female to male aggression	$2.31^{a} \pm 0.02$	$2.06^{b} \pm 0.03$
Female to female aggression	2.16 ± 0.03	2.23 ± 0.03
Stands and shakes	1.88 ± 0.01	1.86 ± 0.01

Means with different superscript within the same row differ significantly.