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POULTRY SCIENCE RESEARCH AND EXTENSION-A REVIEW

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Poultry Science Research and Extension got a tremendous support during 1980s and continue to grow faster than other sectors. The research in associated institutes was supported by both the Governments while the private poultry R&D had a steady progress. The interest, enthusiasm, situation of all the stakeholders in this mega business has led to tremendous improvement in the productivity of poultry which was not even imaginable in 1970s. The improvement was in more body weight in short period of growth with an excellent feed efficiency and livability. Hen day egg production of 335+ is common under optimal layer cage management. A relative increase in broiler price and egg price over the years has supported the sustained growth. Apart from hybrid poultry, now there is a shift from commercial chicken meat and eggs to desi chicken meat and eggs. This growing consumer trend is supported by selling desi chicken meat in large numbers by the retailers. Some myths, false propaganda might possibly driven to this situation. However, now there are improved varieties of desi chicken. All the associated institutes in the country continue their journey in poultry science research to harvest more and more for a sustainable, economical productivity.

While it is believed that all the relevant institutions are actively engaged in poultry research and extension, some of the works being carried out in Tamilnadu Veterinary and Animal Sciences University (TANUVAS) and the Directorate of Poultry Research (DPR), Hyderabad are reviewed hereunder.

Chicken

Poultry Research and Extension works of TANUVAS to cater the needs of interested poultry farmers and to educate the people on poultry farming on commercial venture throughout Taminadu was started during 1980s through establishment of Poultry Research and Development Centres (PRDC). Later this capacity building works was diversified through Livestock Research and Development Centres (LRDC), Farmers Training Centres (FTC) and Krishi Vigyan Kendras (KVK) apart from Poultry Research Station (PRS) and Veterinary Colleges in TANUVAS.

Nandanam Gold, Nandanam B2, Nandanam Chicken 4, Nandanam B3 and TANUVAS Aseel Chicken were evolved by the team of scientists of PRS over the years. Nandanam B2 developed first and improving its productive traits Nandanam B3 was evolved. Both are meat variety and

widely preferred for both backyard and commercial system by the farmers. The rate of growth is so ideal for marketing in about 3 months with a body weight of about 1400 g. Foraging in back yard and supplementing home grown grains would support to sustain their satisfactory productivity. They possess the unique meat taste. Nandanam Chicken 4 is a egg type developed for backyard and also for commercial purpose yielding about 140 eggs per annum with foraging and a little feed support. Nandanam Gold was developed as a dual purpose chicken satisfying the need of rural community. Slow growth and satisfactory egg number are the advantages of this variety. Recently TANUVAS Aseel Chicken was released for the benefit of farmers and rural women. This strain is an improved one from the Aseel breed developed with the objective of improving the egg production. Under optimal management, this TANUVAS Aseel Chicken can lay about 160 eggs, almost double than the Aseel chicken. The feed efficiency, livability and good flightiness are the advantages. Pulse magnetic field exposure of hatching eggs has improved hatchability and livability of young birds (Pers.communication, 2017). The results were more significant in Japanese quails possibly due to thin shell when compared to other avian shell eggs. Research on domestic fly control through specially designed fly capture devise is being attempted.

TANUVAS scientists has innovated Artificial Vagina to collect semen from flight less birds Ostrich and Emu and was successful in collection, storage and preservation. They have also attempted a few assisted reproductive technologies to improve fertility in poultry. Currently the

researchers here are contemplating to evolve a heat tolerant strain in colour plumage broiler chicken by pooling the Naked Neck and Frizzle germplasm.

In ovo administration of 0.5 ml Normal saline; 0.5 ml each of 10 per cent glucose and 0.5 per cent Lysine; 0.5 per cent Threonine and 0.5 per cent hydroxyl beta methylbutarate in to amniotic fluid os 18 day old chicken embryos has resulted in significant ($P < 0.05$) improvement in hatch weight (47.85 to 48.79g) than control(47.25g). Total hatchability was increased by *in ovo* treatment by 4.60 per cent. *In ovo* feeding produced significantly ($P < 0.05$) higher body weights (2168.69 to 2412.28 g) at sixth week of age in broilers than control (2151.50 g). Early chick nutritional supplements (ECNS) which are egg white protein glucose based; corn soyabean fish meal based; with steaming; without steaming and broiler pre starter diet have been tried alone or in chicks administered *in ovo* feeding to 18th day embryo produced appreciable results in post hatch performance (Kanagaraju, 2013).

Inclusion of 1 per cent soya lecithin in broilers diet produced higher body weight than control up to 5th week of age and at 5 per cent level up to 6th week of age has resulted in heavier broiler body weight than control. Soya lecithin in the diets of broiler chicken has reduced feed consumption and also reduced breast muscle lipids marginally (Ramesh, 2007).

The Poultry Science department, Veterinary College and Research Institute, Namakkal, TANUVAS has also developed a new strain to suit the rural and commercial

poultry farmers. The department has developed a multicolor plumage chicken "TANUVAS Namakkal Chicken-1" suitable for rural backyard with low input system of rearing. This bird will lay about 150 eggs, brown shell colour and almost nil broodiness.

Gramapriya, another improved native chicken variety, developed by the Directorate of Poultry Research (DPR), ICAR, Hyderabad with the objectives of providing more eggs to rural people particularly tribals. Gramapriya looks like native chicken, adapts well in backyard, with a low input management yields about 180 eggs. Male Gramapriya chicken has been rated as the best for dishes like Tandoori. Good immunity conferred to this bird against Newcastle disease, which is an added advantage for its suitability in rural backyard. Gramapriya are brooded up to 6 weeks of age and then distributed to the rural farmers for backyard rearing. In many villages even brooding is done by a few rural women and share among themselves after 6 week of age.

DPR's Krishibro, a unique colored broiler chicken which is hardy and grows satisfactorily under sub optimal management in rural and tribal areas. Vanaraja birds are light to dark brown plumage with black tail feathers. In about 6 week of age Krishibro consumes about 3 kg of feed and attains a body weight of 2 kg with an excellent survival rate. DPR also has evolved two more varieties for rural and tribal people's livelihood security viz. Vanaraja and Srinidhi. Vanaraja birds capable of attaining a good market weight need to be reared under brooders for 6 weeks and then to be

reared in back yard for dual purpose. If the back yard ambience is rich in natural feed resources 10 to 20 Vanaraja birds can be grown as layers for egg purpose under free range system. If the demand in the farmers locality is for meat, then Vanaraja birds can be reared in intensive or semi intensive system, providing balanced diet till the desired market weight.

Srinidhi is another improved dual purpose bird developed by DPR to suit tribal and rural area. However, up to 4 to 6 week of age Srinidhi birds are to be reared as brooders. At 6 week of age the live body weight would be 600 to 650 g. After wards, about a dozen birds can be reared in backyard. Foraging during time and providing shelter at night would be good for survivability and performance. Depending upon the demand, Srinidhi birds may be reared for either meat or eggs.

TANUVAS is one of the implementing centre of PSP of DPR, ICAR from its College of Poultry Production and Management, Hosur. More number of Vanaraja and Gramapriya chicks were distributed to the farmers, rural women through TANUVAS peripheral centres during last year than the stipulated target of one lakh. Field performance data were also collected and it was found to be highly satisfactory. Considering the huge demand from farmers in and around Tirunelveli, the Veterinary College and Research Institute started procuring hatching eggs of Vanaraja and Gramapriya, incubating them in their facilities and distributing to the farmers. The performance of these birds in this area also are highly encouraging.

Japanese quail

Poultry Research Station obtained Japanese quail germplasm from Central Avian Research Institute (CARI) during early 80s and improved its performance. Over the years it has developed Nandanam quail 1, Nandanam quail 2 and Nandanam quail 3. Performance was enhanced in body weight, reduced growing period, improved feed efficiency and high survivability. Egg number and egg weight were substantially increased. Nandanam Breeder Quail was released recently for the benefit of Japanese quail breeders. It is calculated from the commercial Japanese quail farming activities in Tamilnadu that over 4 lakh chicks are hatched every week. Many J.quail farmers have established small hatchery unit in their farm to meet their own demand of chicks. Several varieties were evolved at VCRI, Namakkal also. Namakkal Quail 1, TANUVAS Namakkal Gold quail and TANUVAS meat quail were the varieties developed. Namakkal Quail 1 and TANUVAS meat quail are meat strains. TANUVAS meat quail average day old chick weight is 8 g, 3 week body weight is 165 g in males and 180 g in females and 2.1 is the feed efficiency at 21 days of age. The other meat variety Namakkal quail 1, male attains an average live body weight of 228 g at 30 days of age while the females 247 g at the same age. TANUVAS Namakkal Gold quail is the egg type variety developed attaining sexual maturity at 40 d of age, yields 257 eggs in a year with a mean egg weight of 13.2 g. CARI also has developed many Japanese quail varieties suitable for meat and egg purpose.

Dietary Nano Selenium at the dose of 10 ppm up to 5th week of age in Japanese quail has improved body weight to the extent of 10 per cent (Pratheeba, 2014) She has also recorded improved feed conversion ratio by dietary supplementation of Nano Selenium. Dietary supplementation of Se, vitamin E, *Ocimum sanctum* either alone or in combination has significantly increased antibody titre against New castle disease in J.quails upto 12 week of age (Sujatha, 2012). J.quail egg production, fertility, total hatchability, fertile hatchability, hatch weight were improved in antioxidants treatments than control. J.qua supplemented with Se, vitamin E, *Ocimum sanctum* either alone or in combination has reduced total cholesterol, triglyceride in eggs and improved egg weight. The treatment J.quails has shown improved productive and reproductive performance.

Gandhimathi (2011) studied the influence of nest box on the reproductive performance of Japanese quail upto 20 week of age in deep litter system of management. Control quails were reared in pens with out nest boxes. Treatment J.quails were provided with green, blue, white painted and natural mud pots as nest boxes. Also the number of nest boxes as one for every 5 or 10 number of female J.quail layers. The overall mean egg production of Japanese quails was significantly higher (61.38 per cent) in more nest box treatment, followed by 57.05 per cent in less number of nest boxes and control (54.71 per cent) without nest boxes. More number of eggs were laid in nest boxes than floor. J.quail's significantly preferred to lay more eggs in white colour nest box than others. Eggs laid on floor were heavier than eggs laid in

nest boxes. Fertility and hatchability were higher in treatment with nest box group than control. Providing nest box was economical and yielded higher returns. Many J.quail farmers are adopting this.

Supplementation of direct fed microbials on productive and reproductive performance in Japanese quails was studied by Mithu .A. Prince(2012) to explore the possibilities of replacing antibiotics as a growth promoter.She used a commercial product ‘cloSTAT’ which is claimed to contain *Bacillus subtilis* because of its spore forming nature, that enables the bacteria to survive extremes of environmental conditions. This is a probiotic incorporated in the diet of Japanese quail. The 5th week body weight of J.quails supplemented with *Bacillus subtilis* has not shown any significant difference. However, inclusion at 1 g/kg diet has reduced serum cholesterol and triglyceride concentration significantly. Her research concluded that the supplementation of *Bacillus subtilis* in J.quail grower mash (3 to 5 week of age) at a dose of 1 g/kg of diet was advantageous in improving body weight compared to antibiotic supplements. No difference in feed consumption or feed efficiency. In J.quail layers, feeding *Bacillus subtilis* from 10 to 13 week of age at the same dose with prebiotic improved egg production, but no effect on feed efficiency and egg quality.

Turkey

Research research and extension is showing improvement. Though the turkey meat was considered as a delicacy of festive season, there seems to be a shift as it is available during off season period.

Research in turkey has led to development of Nandanam turkey 1 and Nandanam turkey 2 by the researchers of Poultry Research Station, TANUVAS. Nandanam turkey 1 was the cross between native turkey and Beltsville Small white with improved productive and reproductive performance. This was crossed again with Beltsville Small white, Nandanam turkey 2 was developed with more improved performance.

Research trial conducted in Nandanam turkey 2 at Regional Research Centre, Pudukottai, TANUVAS with supplementation of Azolla at the dose of 10, 20 and 30 g per turkey per day from 6th week to 16th week of age. No difference in body weight were recorded. However, the feed consumption was low, lower and the lowest in 10, 20 and 30 g Azolla supplemented turkeys than control. It was concluded that Azolla supplementation in turkeys has reduced feed cost.(Clement Ebenezer Henri, 2015).

Guinea fowl

PRS, TANUVAS has developed an improved Guinea fowl variety named Nandanam Guinea fowl 1. It is pearl variety with improved body weight and egg production in backyard with low or zero input system.

Directorate of Poultry Research, ICAR, Hyderabad is implementing All India Co-ordinated Research Project (AICRP) on Poultry Breeding and Poultry Seed Project (PSP) throughout India. The AICRP is functioning with the objectives of developing location specific chicken varieties and their dissemination for village

poultry; conservation, improvement, characterization and application of local native and elite layer and broiler germplasm and packages of practices for village poultry and entrepreneurship in rural, tribal and backyard areas. The AICRP centres are functioning in Anand Agri. University, Anand; Kerala Veterinary and Animal Science University, Mannuthy; Karnataka Veterinary, animal and Fishery Sciences University, Bengaluru; Central Avian Research Institute, Izatnagar; CSK Himachal Pradesh Krishi Viswavidyalaya, Palampur; Birsa Agricultural University, Ranchi; Maharana Pratap University of Agriculture & Technology, Udaipur; Guru Angad Dev Veterinary and Animal Science University, Ludhiana; Odisha University of agriculture and Technology, Bhubaneswar; ICAR Research Complex for NEH region, Agartala; Nanaji Deshmukh Veterinary Science University, Jabalpur and Assam Agricultural University, Guwahati. Poultry Seed Project with the objectives of producing 30000 to 100000 improved poultry seed in each implementing centre every year and distributing in their respective areas and capacity building in SAUs, SVUs and ICAR Institutes to produce poultry seed in each centre on its own. The PSP is implemented in 12 locations viz. College of Poultry Production and Management, Hosur, TANUVAS; Bihar Agricultural University, Patna; Chhattisgarh Kamadhenu Viswa Vidyalaya, Durg; ICAR Regional Research Complex for NEH region, Jharnapani and Imphal; ICAR-National Organic Farming Research Institute, Gangtok; ICAR-Central Coastal Agricultural Research Institute, Panji, Goa; ICAR-Central Island Agricultural Research

Institute, Port Blair; IVRI Regional Station, Mukteswar; ICAR Research Complex for NEH region, Umiam, Parapani and Sher-e-Kashmir University of Agricultural Sciences and Technology, Srinagar. Holistic and continued poultry research would enable the sustained growth and development.

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EFFECT OF ATTRACTION-AGGREGATION-ATTACHMENT PHEROMONE AND KAIROMONE, CARBON DIOXIDE ON BROWN DOG TICK, *RHIPICEPHALUS SANGUINEUS*

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ABSTRACT

In vitro evaluations were made to observe the efficacy of Attraction-Aggregation-Attachment pheromone (AAAP) and the kairomone carbon dioxide on partially fed adult ticks (Both male and female ticks) of *Rhipicephalus sanguineus* using olfactometer bioassay. Bioassays were conducted with 50 adult ticks each using three treatments namely AAAP in combination with carbon dioxide, carbon dioxide alone and AAAP alone. Dichloromethane (DCM), diluents of AAAP served as control. Experimental trials using AAAP along with carbon dioxide resulted in 38 per cent of *R. sanguineus* ticks showing attraction towards the pheromone source. AAAP alone attracted only 30 per cent of ticks while Carbon dioxide alone elicited an attraction of 76 per cent. The effect of AAAP on partially fed adult ticks of *R. sanguineus* was found to be not substantial. However carbon dioxide showed a marked attraction among the partially fed adult male ticks of *R. sanguineus*

Key Words - Attraction-Aggregation-Attachment pheromone (AAAP), carbon dioxide, *Rhipicephalus sanguineus*, olfactometer, (O)- Nitrophenol

INTRODUCTION

Ticks surpass all other arthropods in the number and variety of pathogen they can transmit to domestic animals, and are ranked second next to mosquitoes as

vectors of human diseases (Sonenshine, 1993). For many years, pyrethroids and organophosphates formulated as dusts, dips or collars were used on dogs to control ticks. However the use of acaricides is often accompanied by serious drawbacks such as

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chemical pollution of the food chain and environment (Dipeolu and Ndungu 1991), apart from the worrisome selection of acaricide resistant ticks. These limitations point to an urgent need for novel tick control measure to reduce or to replace the use of acaricides, especially in the regions where extensive tick resistance has occurred.

Although work on control of tick by vaccination and ethno veterinary control has been attempted in India, use of tick pheromones and kairomones in tick control has not been exploited. Generation of data on these compounds in control of ticks thus becomes relevant to the Indian subcontinent. One of the tick pheromones used effectively against ticks in countries other than India includes Attraction-Aggregation-Attachment pheromone (AAAP). The Attraction-Aggregation-Attachment pheromones attract hungry ticks to a tick infested host and induce them to cluster together at a single location probing and attaching to the host skin. This group includes a mixture of organic volatiles secreted from the dermal glands of feeding males which appear to attract both male and female ticks. Schoni *et al.* (1984) first elucidated the chemical composition of AAAP and showed that it consists of a mixture of three organic volatiles namely o-nitrophenol, methyl salicylate and nonanoic acid in a ratio of 2:1:8 respectively. This pheromone has been reported from the genus *Amblyomma* (Obenchain 1984; Sonenshine 1993). No reports are available on its effect on the brown dog tick, *Rhipicephalus sanguineus*. This paper explores the effect of tick pheromone AAAP and kairomone carbon

dioxide on partially fed adult ticks of *R. sanguineus*.

MATERIALS AND METHODS

Ticks - Ticks were located by visual appraisal and by running the hand across the body of the animal. Dog ticks were collected from the animals presented in the Small Animal Clinics of Madras Veterinary College, Chennai. Speciation of collected ticks was performed with key identification of Walker *et al.* (2000). Partially fed male and female ticks were collected from the body of dogs. Ticks with intact first pair of legs were only selected and were used immediately after collection for the bioassays.

Filter Paper - Whatman® qualitative filter paper grade 3 having a diameter of 11 cm (Whatman International Ltd., Maidstone, England) was used to impregnate AAAP (Sonenshine, 2003). Filter paper discs of size 2x2 cms were used in olfactometer bioassays. The discs were handled with a gloved hand. Sterile forceps were used to take the filter paper discs. This ensured that the filter paper discs did not come into contact with human skin lipids which were found attractive to ticks (Yoder *et al.* 1998).

Olfactometer Bioassay - A two choice T-tube olfactometer bioassay was used to assess the tick attraction to the test material or to the control (Figure 1). The olfactometer was designed based on Nchu *et al.* (2009) with minor modifications. It consisted of two square arms of 1x1 x10 cms and a stem of 1x1x5 cms size. The stem was connected tightly to the arms. The extreme ends of each of the arms and stem were connected to a square chamber of size 3x3x3 cms.

Ticks were released at the chamber marked as 'R'. Test and control filter paper discs were placed in each square chamber of the olfactometer namely marked T and C. Controlled air flow was maintained through each odour sources using an air pump with low, medium and high air current settings. For the current study, airflow was maintained at medium level, which was found to be convenient for the ticks. The flow rate at medium level was 5 ml/sec. Purification of the air entering in test and control chambers was ensured by using sterile millipore filters. The air with smell of the pheromone and controls were sucked out using a vacuum pump connected at the release point of the ticks (R). Humidity was maintained in the 'T' chamber (Test Source Chamber) using moistened cotton pads which were kept beneath the test and control odour source. This helped to maintain the relative humidity of the chamber at 70 ± 5 per cent level inside the olfactometer. Ticks were released one at a time into the 'R' chamber. Each tick was allowed a maximum of 5 minutes to respond to the pheromone/kairomones and at the junction of the T-tube ticks choose between the control and treatment arms. Ticks failing to respond after 5 minutes were removed. For each test dose 10 ticks were assayed. Trials were replicated till N=50 for the adult ticks. The position of treatment and control chambers were changed after each trial, by alternating the placement of control and test filter papers. The bioassay was conducted at a temperature of $30 \pm 2^\circ\text{C}$ and a relative humidity of 70 ± 5 per cent.

In the current study olfactometer bioassay was performed for assessing

the efficacy of Attraction – Aggregation – Attachment - Pheromone (AAAP). Dichloromethane (DCM), the diluent of AAAP served as control. The olfactometer was rinsed with DCM and was air dried at room temperature after each trial. The instrument was placed horizontally during the experiment to mimic the natural questing behaviour of ixodid ticks.

Attraction–Aggregation–Attachment Pheromone (AAAP) - Synthetic analogues of AAAP namely (*O*)-nitrophenol (Sigma Alderich, Germany), methyl salicylate (Sipali (1) Pharma, Chennai) and nonanoic acid (Sigma Alderich, Germany) in 2:1:8 ratio were prepared and used for the bioassays. Attraction-Aggregation-Attachment-Pheromone in a concentration of 0.022 mg was made use in the current study in a ratio of 2:1:8 (Nchu *et al.*, 2009).

Carbon dioxide - The pheromone was used in combination with 5 per cent carbon dioxide in the current study as per Nchu *et al.* (2009). Carbon dioxide cylinder was connected to the test arm (T) of the olfactometer (Fig. 1). Trials were conducted in the presence of carbon dioxide alone, carbon dioxide–AAAP and AAAP alone. Olfactometer bioassay was conducted with 150 partially fed adult male and female ticks of *R. sanguineus*. Fifty ticks each were used for AAAP alone trials, for AAAP–carbon dioxide trials and for carbon dioxide alone trial.

Statistical analysis - Statistical analysis of the data obtained was done with *chi-square test* (Finney, 1952).

RESULTS

In AAAP along with carbon dioxide trial 38 per cent of *R. sanguineus* ticks showed attraction towards the pheromone source. However AAAP alone attracted only 30 per cent of ticks. Carbon dioxide alone elicited an attraction of 76 per cent of the *R. sanguineus* ticks (Table 1). Statistical analysis revealed that there is a highly significant difference between the three treatments. The effect of AAAP on partially fed adult ticks of *R. sanguineus* was not substantial. However carbon dioxide acts as an effective kairomone in attracting the partially fed adults of *R. sanguineus*.

DISCUSSION

The effect of AAAP was evaluated only on the adult ticks of *R. sanguineus*. Attraction-Aggregation-Attachment-Pheromone is solely secreted by feeding male which attracted both male and female ticks. The female ticks appear to require this pheromone without which they will not attach and feed (Sonenshine 2006). The pheromone has been recorded only in certain species of genus *Amblyomma* (Sonenshine 1985; Obenchain 1984). In the current study, the response obtained to the AAAP alone was only 30 per cent whereas it was enhanced to 38 per cent when combined with carbon dioxide. However carbon dioxide alone resulted in 76 per cent attraction clearly indicating that in *R. sanguineus* AAAP does not play a prominent role while presence of carbon dioxide enhances the speed and proportion with which the ticks respond. Similar to these findings, Barre *et al.* (1997) also found that carbon dioxide itself is a very effective attractant,

producing an attraction of 43-60per cent among *A. variegatum* ticks. Although (O) -nitrophenol is supposed to stimulate searching and aggregation behaviour while methyl salicylate and nonanoic acid are believed to stimulate attachment, these responses were not evident in the dog tick during the current study. Differences in the components of AAAP may vary between ticks and that could be the reason for the unresponsive behaviour of *R.sanguineus* to this pheromone.

In conclusion, carbon dioxide was effective kairomone in attracting the adult ticks of *R. sanguineus*. However the effect of AAAP on partially fed adult ticks of *R. sanguineus* was not substantial. Further investigations using different concentrations of AAAP will reveal the role of this pheromone on the adults of dog ticks.

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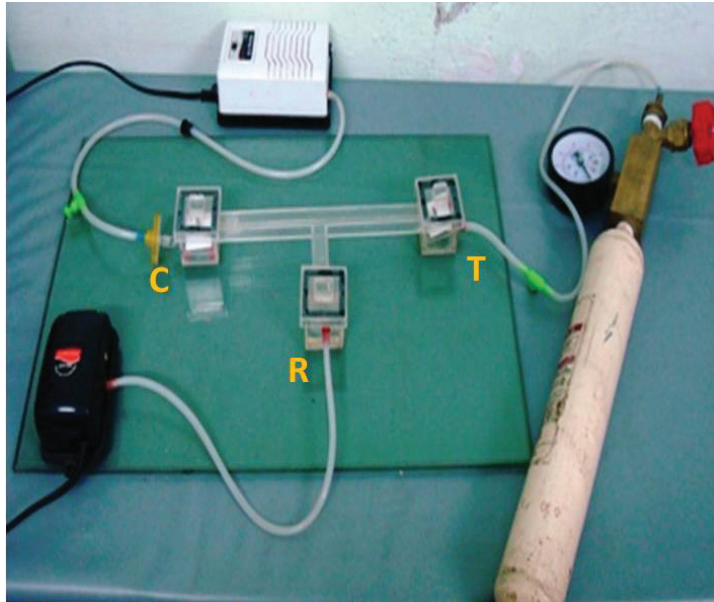
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Table - 1 Effect of attraction – aggregation – attachment pheromone (AAAP) on the adults of *rhipicephalus sanguineus*

Pheromone/Kairomone used	No. of adult ticks attracted towards pheromone/kairomone	No. of adult ticks attracted towards the control
AAAP + Carbon dioxide	19 (38)	31 (62)
AAAP	15 (30)	35 (70)
Carbon dioxide	38 (76)	12 (24)
Chi-square value and significance	24.20**	

**Highly significant ($p \leq 0.01$), Figures in parenthesis indicate percentage

Fig. 1. Olfactometer with Carbon Dioxide



GROWTH, PRODUCTION AND REPRODUCTION PERFORMANCE OF TELLICHERRY GOATS UNDER INTENSIVE AND SEMI-INTENSIVE SYSTEMS OF MANAGEMENT

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ABSTRACT

A study was undertaken on the growth, productive and reproductive performance of Tellicherry goats under intensive and semi-intensive systems of management using 40 kids. The overall body weights at birth, 3, 6, 9 and 12 months of age under intensive system were 2.33 ± 0.10 , 9.51 ± 0.33 , 14.10 ± 0.53 , 19.16 ± 0.75 and 20.13 ± 0.83 Kg, respectively. Similarly, under semi-intensive system the values were 1.96 ± 0.05 , 7.65 ± 0.11 , 14.15 ± 0.52 , 18.46 ± 0.64 and 20.48 ± 0.46 Kg, respectively. Under intensive system, the reproductive performance namely weight at first mating, number of services per conception, weight at first kidding, litter size, gestational weight gain, lactational weight loss, service period, kidding percentage and kidding interval were 18.51 ± 0.86 kg, 1.25 ± 0.13 , 22.87 ± 0.75 kg, 1.08 ± 0.08 , 4.36 ± 0.33 kg, 3.28 ± 0.43 kg, 89.00 ± 1.85 days, 100.00 , 245.01 ± 3.84 days, respectively. The same values for semi-intensive system were 18.13 ± 0.87 kg, 1.50 ± 0.23 , 23.35 ± 0.98 kg, 1.25 ± 0.13 , 5.22 ± 0.50 kg, 2.92 ± 0.72 , 85.30 ± 2.12 days, 100.00 , 243.39 ± 7.19 days, While there was 8.33 percentage twinning noticed in intensive system, the same was observed as 25.00 percentage in semi-intensive system.

Key words- Tellicherry goat, growth, reproductive performance

INTRODUCTION

Goats were among the first farm animals to be domesticated. In developing

countries, goats make a very valuable contribution, especially to the poor people in the rural areas for generating employment, income, capital storage and improving

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household nutrition (Devendra, 1992). Tellicherry goat, originally distributed in Calicut, Cannanore and Malapuram districts of Kerala (Acharya, 1982) is also widely seen in western districts of Tamil Nadu. In the home tract, the climate is hot-wet, whereas, in Tamil Nadu these animals are mostly reared in hot-dry regions. Tellicherry goats are medium sized and highly prolific. They are also capable of producing good quality meat and milk.

The productivity of goats under the prevailing traditional production system is very low (Singh and Kumar, 2007). It is because they are maintained under the extensive system on natural vegetation on degraded common grazing lands and tree lopping. Even these degraded grazing resources are shrinking continuously. Therefore, goat rearing took a shift to intensive system from conventional systems. The aim of the present investigation was, therefore, to study the growth and reproduction performance of Tellicherry goats.

MATERIALS AND METHODS

The present study was conducted to find out the performance of Tellicherry goats under intensive and semi-intensive systems of rearing at Instructional Livestock Farm Complex, Veterinary College and Research Institute, Namakkal, Tamil Nadu from March 2013 to September 2015. A total of 40 Tellicherry kids from the age of three to four months were used under two systems of rearing. All the animals were ear tagged for their identification before the start of experiment. Twenty kids (12 female and 8

male) were kept in one group (T_1) under intensive system and other group of twenty kids (12 female and 8 male) under semi-intensive system of rearing (T_2).

Management

The kids were given an adaptation period of 15 days before the start of the experiment. The group T_2 was sent for grazing. The T_1 group was kept under stall feeding. Stall-fed kids were offered concentrate feed, Co-4 grass (Bajra X Napier hybrid variety), subabul (*Leucaena leucocephala*), sorghum (*Sorghum bicolor*) stover, ground nut haulms (*Arachis hypogaea*) at different times of the day to meet the nutrient requirement as per the nutrient requirements recommended by ICAR (2013). Subabul fodder was cut into small branches of minimum stem portion and fed fresh. Sorghum stover was also chopped and fed as dry fodder. Groundnut haulms were fed as such. Co-4 and sorghum stover were fed two times a day, whereas, subabul was fed once a day. *Ad libitum* drinking water was made available.

The kids were allowed for grazing from 9.00 a.m. to 4.30 p.m. The males were grazed separately and maintained in separate pens. The grazing land of the institution was having *Cenchrus* pasture, naturally growing grasses (*Heteropogon contortus*, *Cynodon dactylon*, *Deschampsia cespitosa*, *Echinochola colona*), Shrubs (*Agerotum houstonianum*, *Bambusa vulgaris*, and *Canna indica*) and tree fodder (*Azadirachta indica*, *Albizia lebbbeck*, *Acacia leucophloea*, *Leucaena leucocephala*, *Gliricidia sepium* and *Ficus religiosa*).

Housing

The kids were housed in open type of housing with an asbestos roofed, earthen floor shed with partition made of chain link material. Pegs made of iron were placed in each partition. Intensive group animals were tethered individually, so that feed intake and left over from each animal could be measured accurately. Semi-intensive group of animals were tied up to the iron pegs in the morning before feeding. After recording the left over feed, they were sent for grazing.

Data collection

The following parameters namely daily feed intake, body weight at fortnightly intervals, monthly body measurements of six male kids were recorded. In females, the reproductive parameters were collected. They are weight at first mating, weight at first kidding, birth weight, weaning weight, kidding interval, litter size, number of service per conception, twinning percentage, kidding percentage and service period. The data thus collected were compiled and analyzed as per Snedecor and Cochran (1996). The data on body weight, body measurement and average daily gain (ADG) were subjected to one way analysis of variance under Completely Randomized Design. For comparisons of body weight, dry matter intake, body weight gain, feed conversion ratio and per cent feed efficiency between groups, the students "t"- test was used.

RESULTS AND DISCUSSION

Productive performance

The body weight of Tellicherry kids showed increased gains, as a result of supplementation with no significant difference between the rearing groups during the 150 days of the growth trial. In both the intensive and semi-intensive groups, the initial body weight has increased linearly as the age advanced. Initial body weight of intensively reared kids was 15.56 ± 0.75 kg for male and 13.13 ± 0.60 kg for females, respectively and in semi-intensive system it was 15.63 ± 0.75 kg and 13.17 ± 0.57 kg for male and females, respectively. The final body weight of Tellicherry kids at 150 days study period of male and female in intensive group was 25.11 ± 1.01 and 19.90 ± 0.72 kg, respectively and in semi-intensive group it was 24.10 ± 0.97 and 19.30 ± 0.49 kg, for male and female, respectively. The study on body weight of Tellicherry goats under intensive and semi-intensive systems of management revealed no significant difference in body weight of Tellicherry goats between the rearing systems. Similar finding was also reported in Barbari and Black Bengal goats of India (Saini *et al.*, 1986; Chowdhury and Faruque, 2001; Sulthana *et al.*, 2012). On the contrary, significant difference in body weight under intensive and semi-intensive systems of management was noticed in earlier studies in different goat breeds of India (Saini *et al.*, 1988; Paramasivam *et al.*, 2002; Abdul Hakim *et al.*, 2005; Elangovan *et al.*, 2008; Patil *et al.*, 2014; Jayanthi, 2015). The study on body weight in Tellicherry goats under two systems of management indicated that the Tellicherry goats were very well adapted

to intensive and semi-intensive systems of management.

The ADG of male kids in intensive and semi-intensive system was 51.54 ± 2.95 and 46.21 ± 3.90 g, respectively. The average daily weight gain observed in the present study was comparable to values reported by Khound *et al.* (1995) in crossbred goats of Assam. However, higher (Chellapandian and Balachandran, 2003; Jayanthi *et al.*, 2014) and lower (Moniruzzaman *et al.*, 2002; Thiruvankadan *et al.*, 2009; Bharanbe and Burte, 2012; Murugan and Meenalochani, 2014) than the present values were also reported by earlier workers on different goat breeds of India.

Growth performance

The birth weight of Tellicherry males (2.33kg) and females (1.96 kg) observed in the present study was comparable with values reported by earlier workers on the same breed (Thiruvankadan *et al.*, 2008; Thiruvankadan *et al.*, 2009; Ramesh Saravana Kumar *et al.*, 2011; Murali *et al.*, 2014). Soundarrajan and Sivakumar (2011) and Thirupathy *et al.* (2015) observed lower than the present values in Tellicherry kids.

The weaning weight of Tellicherry male kids observed in the present study was comparable with earlier reports on the same breed (Thiruvankadan *et al.*, 2009; Meenakshisundaram *et al.*, 2012; Murali *et al.*, 2014). The weaning weights observed in female Tellicherry kids was comparable with reports of Thirupathy *et al.* (2015). On the contrary, the weaning weight observed was higher than the reports of Thiruvankadan

et al. (2009), Meenakshisundaram *et al.* (2012) and Murali *et al.* (2014).

The six(14.10) and nine months(19.16kg) body weight of Tellicherry kids observed in the present study was within the range of values reported by Verma *et al.* (2009). However, lower than the present values were reported by earlier workers in the same breed (Thiruvankadan *et al.*, 2009; Meenakshisundaram *et al.*, 2012; Murali *et al.*, 2014; Thirupathy *et al.*, 2015). The twelve months body weight(20.13) observed was comparable with the report of Murali *et al.* (2014). On the contrary, the values observed were higher than the reports of Verma *et al.* (2009) and Meenakshisundaram *et al.* (2012) and lower than the report of Thiruvankadan *et al.* (2009) on the same breed.

Dry matter intake

The cumulative DMI was 92.72 ± 2.97 kg for males 72.62 ± 1.38 kg for females. The higher DMI in males could be due to faster body growth observed in male kids grows during pre as well as postnatal development (Soundararajan and Sivakumar, 2011). Results of this study indicated that the male kids gained significantly ($P < 0.01$) higher weights than female kids during all the stages which might be due to quantitative difference in the secretion of growth and sex hormones (Gopal Dass, 2007).

Feed conversion ratio

The present study male animals showed comparatively better FCR (11.57 ± 1.12) than females (12.74 ± 1.09). In Tellicherry goats, the FCR was numerically better in male animals than females. However, Singh

et al., (2010) observed better ($P < 0.01$) FCR in male Jamunapari goats than females. The differences between sexes would be attributed to the nutritional status and the genetic potential of the animals used in the corresponding studies (Sen *et al.*, 2004).

Weight at first mating

The effect of rearing system on weight at first mating is shown in (Table 1). There was no significant difference in intensive system and semi-intensive system. The present study observed the weight at first mating in intensive and semi-intensive system as 18.51 ± 0.86 kg and 18.13 ± 0.87 kg, respectively. Similarly, Faruque *et al.* (2010) reported no significant difference in weight at first mating between different systems of rearing in Black Bengal goats. On the contrary, Patel *et al.* (2005) reported significant difference between systems of management in Marwari, Parbatsari and local non-discript goats of Rajasthan. The weight at first mating observed in Tellicherry goats was comparable with the earlier report of Kutchi, Jamunapari and Mehsana goats of India (Kumar *et al.*, 2006; Hassan *et al.*, 2010; Patel and Panday, 2013).

Number of services per conception

The overall mean of number of services per conception in intensive and semi-intensive was shown in (Table 1). The present study revealed that number of services per conception in intensive and semi-intensive system was 1.25 ± 0.13 and 1.50 ± 0.23 , respectively. System of management did not significantly influence the services per conception. The present study closely agreed with Chowdhury *et al.* (2002) in Black Bengal goat who reported

services per conception in semi-intensively reared goat was 1.45.

Weight at first kidding

The overall means for weight at first kidding were shown in (Table 1). In the present study, the values were found to be 22.87 ± 0.75 and 23.35 ± 0.98 kg in intensive and semi-intensive system, respectively. The systems of management had no significant effect on weight at first kidding. The non-significant effect of system of management was in accordance with the reports on Jamunapari and Mehsana goats (Hassan *et al.* 2010; Patel and Pandey (2013). However, Patel *et al.* (2005) and Faruque *et al.* (2010) reported significantly higher weight at first kidding in intensively reared goats compared to semi-intensively reared goats.

Litter size

The litter size observed in the present study was 1.08 ± 0.08 and 1.25 ± 0.13 under intensive and semi-intensive system. The above results and the study was concurrent with Hassan *et al.* (2010) in Jamunapari goat (1.93 ± 0.06), Thiruvankadan *et al.* (2000) in Kanni Adu goat (1.70 ± 0.60), Islam *et al.* (2009) in Black Bengal goat of Bangladesh (2.33 ± 0.33) and Gopu *et al.* (2013), in Salem Black goat (1.48 ± 0.13).

Gestational weight gain

The gestational weight gain of goats in intensive and semi-intensive system was 4.36 ± 0.33 and 5.22 ± 0.50 kg, respectively are shown in Table 1. The observed values were comparable with reports of Thiruvankadan *et al.* (2008) in Mecheri sheep in organized farm conditions.

Lactational weight loss

The lactation weight loss in goats of intensive and semi-intensive system was 3.28 ± 0.43 and 2.92 ± 0.72 kg, respectively. The present value was comparable with Islam *et al.* (2009) in Black Bengal goat and the values are lower than the reports of Thiruvankadan *et al.* (2008) in Mecheri sheep of Tamil Nadu under farm conditions.

Service period

The overall means of service period of goats in intensive and in semi-intensive system were 89.00 ± 1.85 and 85.30 ± 2.12 days, respectively as shown in Table 1. The observed service period was comparable with Sangamneri goat (Deokaret *et al.*, 2007) and Berari goat (Kranti kharkar *et al.*, 2014) and shorter than other Indian goat breeds like Jamunapari (Singh and Roy 2003), Sirohi (Pathodiya *et al.*, 2008), Mehsana (Patel and Pandey 2013) and Ganjam (Rao *et al.*, 2009).

Kidding percentage

The kidding percentage of Tellicherry goats under intensive and semi-intensive system was 100 per cent. All the kids given birth were reared under intensive and semi-intensive system of management in the present study. However, the reports of Kumar *et al.* (2006), Singh *et al.* (2009), Patel *et al.* (2005) revealed system of management significantly influenced the kidding percentage.

Twinning percentage

The twinning percentage of Tellicherry goats under intensive and semi-intensive system was 8.33 and 25.00 per cent,

respectively. The present values were higher than the previous reports Verma *et al.* (2009) and Muthuramalingam *et al.* (2014) on the same breed.

Kidding interval

Kidding interval in Tellicherry goat under intensive and semi-intensive system was 245.01 ± 3.84 and 243.39 ± 7.19 days, respectively (Table 1). There was no significant difference observed between two rearing systems in the kidding interval. Acharya (1982) Verma *et al.* (2009) reported similar values in Tellicherry goats reared in its native tract of Kerala.

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Table 1. Mean (\pm S.E) of reproductive performance of Tellicherry goats under intensive and semi- intensive systems

Parameters	Intensive system (T ₁)	Semi-intensive system (T ₂)	T-value	P-value
Weight at first mating (kg)	18.51 \pm 0.86 (12)	18.13 \pm 0.87 (12)	0.306 ^{NS}	0.380
Number of services per conception	1.25 \pm 0.13 (12)	1.50 \pm 0.23 (12)	0.944 ^{NS}	0.179
Weight at first kidding (kg)	22.87 \pm 0.75 (12)	23.35 \pm 0.98(12)	0.390 ^{NS}	0.349
Litter size	1.08 \pm 0.08(12)	1.25 \pm 0.13(12)	1.076 ^{NS}	0.147
Birth weight (kg)				
Male	2.43 \pm 0.18 ^b (7)	2.05 \pm 0.05 ^a (7)	2.003 [*]	0.042
Female	2.23 \pm 0.06 ^b (7)	1.86 \pm 0.09 ^a (7)	3.330 ^{**}	0.003
Overall	2.33 \pm 0.10^b (14)	1.96 \pm 0.05^a (14)	3.247^{**}	0.002
Weaning weight (kg)				
Male	9.86 \pm 0.48 ^b (7)	7.83 \pm 0.17 ^a (7)	4.022 ^{**}	0.001
Female	9.17 \pm 0.43 ^b (7)	7.46 \pm 0.14 ^a (7)	3.709 ^{**}	0.003
Overall	9.51 \pm 0.33^b (14)	7.65 \pm 0.11^a (14)	5.370^{**}	0.000
Gestational weight gain (kg)	4.36 \pm 0.33 (12)	5.22 \pm 0.50 (12)	1.406 ^{NS}	0.088
Lactational weight loss (kg)	3.28 \pm 0.43 (12)	2.92 \pm 0.72 (12)	0.858 ^{NS}	0.126
Service period (days)	89.00 \pm 1.85 (12)	85.30 \pm 2.12 (12)	1.315 ^{NS}	0.103
Kidding percentage	100.00 (12)	100.00 (12)	-	-
Twinning percentage	8.33 (1)	25.00 (3)	-	-
Kidding interval (days)	245.01 \pm 3.84 (12)	243.39 \pm 7.19 (12)	0.198 ^{NS}	0.422

Means bearing the different superscript within a row differ significantly , * Significant(P< 0.05),

** Highly significant (P< 0.01), ^{NS} Non significant

EFFECT OF DIETARY SUPPLEMENTATION OF GHEE RESIDUE ON SERUM BIOCHEMISTRY AND HAEMATOLOGY OF JAPANESE QUAILS

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Consumer preference towards diversified poultry meat is increasing steadily because of increased health consciousness of consumers. Among the diversified poultry, Japanese quails are the main contributors and its meat is a “gourmet’s delight” due to its good quality animal protein. The ingredients like maize, soyabean meal, fish meal and vegetable oils constitutes a major source of energy, protein and fat in the poultry feed. Poultry farmers are facing deep crisis due to unprecedented increase in the price of these essential feed ingredients. Feed cost is the major expenditure involved in the poultry production and constitutes around 60-70% of the total cost, Hence, a judicious use of ingredients, utilizing industrial by-products/wastes to reduce the cost of production on one side and maximizing the nutrient utilization in poultry on the other side is the need of the hour. Ghee residue, a charred light to dark brown residue is the by-product of ghee industry and, it is a rich source of energy, protein, fat and

minerals. This could be effectively utilized as an unconventional feedstuff in poultry ration (Arumugam *et al.*, 1989). The ether extract content of ghee residue is highly variable (Varma and Narender Raju, 2008), who recorded a wide variation (33.40-80.80 %) in ether extract content of ghee residue obtained from different sources. The effect of higher fat content of ghee residue on Japanese quail serum biochemical profile and haematology is not known. Hence, this study was undertaken to present the effect of inclusion of ghee residue on serum biochemical profile and haematological parameters of Japanese quails.

The experiment was conducted in Japanese quail for the period of 0-5 weeks of age. Five hundred numbers of day old, unsexed Japanese quails belonging to a single hatch were utilized for this experiment. The experimental birds were randomly distributed into four treatment groups with five replicates each containing twenty five Japanese quails.

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Ghee residue was procured from a private dairy plant situated at Erode district of Tamilnadu and analysed for its nutritive value. Experimental rations were formulated based on the nutrient requirements provided for Namakkal Japanese quail by the Department of Poultry Science, Namakkal, Tamil Nadu on iso-caloric and iso-nitrogenous basis by including ghee residue at 0 (T_1), 5(T_2), 10(T_3) and 15(T_4) per cent levels. The experimental ration was fed to brooder for 0-3 and grower for 4-5 weeks of age. The experimental birds were reared in flat decked cages, fed with *ad-libitum* feed and water, providing good ventilation and reared under standard managerial conditions throughout the experiment.

At the end of 35 days of age, slaughter study was conducted as per the procedure described by (Genchev A., and R. Mihaylova, 2008). One hundred and twenty Japanese quails were randomly chosen for this study @ 30 (15 male and 15 female) per treatment. Blood was collected randomly from four birds per replicate in vacutainers. A drop of blood was kept over a slide to prepare a smear for subsequent blood cells count using Leishman-geimsa stain method (Bancroft and Marilyn, 2008). The collected blood was kept in slanting position and left undisturbed for few hours and centrifuged at 2000 rpm for 10 minutes to separate the serum.

Parameters such as total protein, albumen, glucose, calcium, phosphorus, magnesium, total cholesterol, triglycerides, HDL and LDL levels were analysed by using AGAPPE diagnostic kits. The LDL level was calculated by Friedwal equation. The

collected data were statistically analysed using one-way ANOVA under completely randomized design in Software Package for Social Sciences (SPSS) version. 20.0 and significance was tested using Duncan multiple range test (Duncan, 1955).

The study revealed highly significant ($P \leq 0.01$) differences among the treatment groups in serum biochemical parameters (Table 1). There is no published literature available on the effect of ghee residue (GR) on serum biochemical parameters and haematology of Japanese quail for comparison and this study presents the premier report. The total protein level revealed a highly significant ($P < 0.01$) difference in favour of T_1 (3.95 g/dl) followed by T_2 (3.30 g/dl) and T_4 (2.60 g/dl). Albumin level was significant ($P < 0.05$) among the treatment groups, where the highest level was observed in T_1 (1.35 g/dl), lowest level was observed in both T_3 and T_4 (1.05 g/dl). Calcium and phosphorus levels were highly significant ($P < 0.01$) among the treatment groups, where the highest levels of calcium and phosphorus levels were observed in T_1 (14.60 mg/dl and 17.15 mg/dl) and lowest level for calcium was observed in T_3 (10.75 mg/dl) and for phosphorus it was in T_4 (11.15 mg/dl). This might be due to higher free fatty acids in the diet which might react with calcium and phosphorus forming insoluble soaps which prevents its absorption (Gacs and Barltrop, 1977). Triglyceride levels were highly significant ($P \leq 0.01$) among the treatment groups and it was highest in T_1 (168.15 mg/dl) and lowest in T_3 (72.70 mg/dl). LDL levels were highly significant ($P < 0.01$) among the treatment groups and it was highest in T_1 (86.85 mg/

dl) and lowest in T₄ (31.85 mg/dl). Khogare (2012) inferred a decrease in LDL levels after supplementing a high dietary fibre.

The decreasing trend of parameters like total protein, albumin, calcium, phosphorus, triglycerides and LDL levels might be due to increased level of crude fibre in the respective ration as the level of inclusion of De-oiled Rice Bran (DORB) in experimental rations become inevitable as the inclusion levels of GR increased. Dietary fiber has an abrasive effect on the intestinal wall and may result in increase in endogenous cell losses and nutrients may enter in to the lumen, so the availability of nutrients is reduced and this is supported by Mateos *et al.* (2012). Similar finding was reported by Loganathan *et al.* (2014) who noticed decreased serum LDL, total protein and triglyceride levels with increase in the level of inclusion of GR in broilers. The levels of total cholesterol and HDL were not influenced by feeding ghee residue at graded levels in Japanese quail ration. Anitha *et al.* (2008) reported that there was no effect on serum triglyceride, HDL, LDL and total cholesterol levels after supplementing a diet containing crude rice bran oil in broilers. The reason for this difference might be due to differences in the fatty acid composition of oil and GR. The gradual increase in the crude fibre content of experimental ration might also influence the triglycerides and LDL levels of serum in Japanese quails. The result on serum glucose level was highly significant (P<0.01) between the treatment groups, where the highest level was observed in T₄ (275.95 mg/dl) and lowest level in T₁ (172.45 mg/dl). The increasing trend of glucose might be due to lactose content of ghee residue in the

respective rations and this is supported by Gentao *et al.* (2003) who reported that the presence of higher lactose level in the diet will reduce the insulin level by increasing the insulin to glucose ratio in serum. The results on magnesium level was highly significant (P<0.01) between the treatment groups, where highest level of magnesium was observed in T₃ (8.70 mg/dl) and lowest level was observed in T₁ (7.25 mg/dl). The reason for gradual increase in the levels of magnesium might be due to calcium and magnesium antagonistic effect and this is supported by Fawcett *et al.* (1999). The results on serum biochemical parameters clearly evidenced that increasing the level of ghee residue would decrease the serum parameters like total protein, albumen, calcium, phosphorus, triglycerides and LDL levels except glucose and magnesium. The results on haematological parameters like RBC, WBC and Differential count (DC) was not significant among the treatment groups, which indicated that increasing the level of ghee residue even up to 15 per cent have not influenced the haematological parameters in Japanese quails and this was supported by Selvamani (2015) who reported a similar finding in swine fed with graded levels of ghee residue.

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TABLE 1. Serum biochemical parameters of Japanese quail fed with graded levels of ghee residue (Mean \pm SE)

Serological parameters	Inclusion of ghee residue at graded levels in feed				P value
	T ₁ (0%GR)	T ₂ (5%GR)	T ₃ (10%GR)	T ₄ (15% GR)	
Total protein** (g/dl)	3.95 ^a \pm 0.21	3.30 ^b \pm 0.19	3.05 ^{bc} \pm 0.15	2.60 ^c \pm 0.15	0.000
Albumin* (g/dl)	1.35 ^a \pm 0.11	1.15 ^{ab} \pm 0.08	1.05 ^b \pm 0.05	1.05 ^b \pm 0.05	0.023
Glucose** (mg/dl)	172.45 ^a \pm 6.41	219.00 ^b \pm 9.69	240.45 ^b \pm 10.08	275.95 ^a \pm 11.23	0.000
Calcium** (mg/dl)	14.60 ^a \pm 0.76	11.85 ^b \pm 0.86	10.75 ^b \pm 0.39	12.40 ^b \pm 0.39	0.001
Phosphorus** (mg/dl)	17.15 ^a \pm 0.86	11.40 ^b \pm 0.61	11.35 ^b \pm 0.67	11.15 ^b \pm 0.70	0.000
Magnesium** (mg/dl)	7.25 ^b \pm 0.26	8.35 ^a \pm 0.13	8.70 ^a \pm 0.11	8.50 ^a \pm 0.11	0.000
Triglycerides** (mg/dl)	168.15 ^a \pm 36.44	96.11 ^b \pm 11.92	72.70 ^b \pm 5.52	78.60 ^b \pm 13.32	0.005
Total cholesterol ^{NS} (mg/dl)	248.70 \pm 10.83	267.20 \pm 8.85	245.60 \pm 10.59	230.80 \pm 8.77	0.081
HDL ^{NS} (mg/dl)	104.70 \pm 6.21	109.50 \pm 6.44	94.05 \pm 6.44	90.80 \pm 5.19	0.110
LDL** (mg/dl)	86.85 ^a \pm 9.05	35.85 ^b \pm 3.58	36.50 ^b \pm 3.97	31.85 ^b \pm 2.66	0.000

Mean of twenty samples.

Mean values bearing same superscript within rows did not differ significantly.

^{NS}-Non significant; **-Highly significant ($P \leq 0.01$); *-Significant ($P < 0.05$).

TABLE 2. Haematological parameters of Japanese quail fed with graded levels of ghee residue (Mean \pm SE)

Haematological parameters	Inclusion of ghee residue at graded levels in feed				P value
	T ₁ (0%GR)	T ₂ (5%GR)	T ₃ (10%GR)	T ₄ (15% GR)	
RBC ^{NS} ($\times 10^6$)	2.31 \pm 0.10	2.37 \pm 0.22	2.24 \pm 0.19	2.32 \pm 0.08	0.954
WBC ^{NS} ($\times 10^3$)	23.63 \pm 1.68	22.75 \pm 2.26	24.50 \pm 2.47	22.75 \pm 2.26	0.930
Differential Leukocyte Count ^{NS} (%)					
Lymphocyte	44.50 \pm 0.65	46.25 \pm 0.85	43.00 \pm 0.82	45.00 \pm 1.22	0.143
Monocyte	1.50 \pm 0.29	1.25 \pm 0.25	1.50 \pm 0.29	1.50 \pm 0.29	0.894
Basophils	7.75 \pm 0.85	8.25 \pm 1.11	9.00 \pm 0.71	8.25 \pm 0.63	0.775
Eosinophils	8.25 \pm 0.48	8.25 \pm 0.63	8.75 \pm 0.75	9.00 \pm 0.91	0.840
Heterophils	38.00 \pm 1.35	36.00 \pm 1.68	37.75 \pm 1.44	36.25 \pm 1.25	0.688

Mean of four samples.

^{NS}-Non significant.

EXTENSION SERVICE REQUIREMENTS FOR THE EFFECTIVE TRANSFER OF FISHERIES TECHNOLOGIES

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Fisheries are one of the important types of renewable resources which play a vital role in the economic development of a nation. In order to increase fish production continuously and sustainably, a major change in the attitude, knowledge and skills of the fishermen are required. In order to achieve this, the extension system could efficiently transfer the new innovations in fisheries through various extension methods like individual, groups and mass contact approaches. The Fisheries developments organisations like Central Fisheries Institutes, State Department of Fisheries, State Agricultural Universities, Non-Governmental Organisations, etc., should have strong research bases for the development of innovations in fisheries and also have sound extension services for the transfer of technologies successfully for the speedy adoption by the fishermen. Keeping the above aspects in view, the study of extension service requirements for the effective transfer of fisheries technologies was undertaken.

Out of 21 fishing villages in Thoothukudi district, four fishing villages namely, Thoothukudi South, Punnakayal, Alanthalai and Periyathalai were selected

for this study. A total of 120 respondents were randomly selected for this study from these villages. Since Thoothukudi district does not have much aquaculture activity, the technologies selected were only from fishing and fish processing fields. Thus, the respondents were fishermen those who were actively engaged in fishing and fish processing activities.

Among the various technologies available in fisheries, only 13 fisheries technologies such as., use of selective gear , use of ice on board, use of synthetic materials ,use of marine anticorrosive paints, use of marine antifouling paints, use of cathodic protection of fishing boats, use of aluminium alloy sheathing, use of copper sheathing, use of electronic equipments, preparation of value added products(fish/prawn pickle, dry fish / masala dry fish, masmin and wafers), dry fish packaging, use of low cost smoking chamber and hygienic handling of fish and fishery products were selected for the study. The extension services selected for the effective transfer of these technologies were training, demonstration, on-the-spot guidance, mass media, advisory services, exhibition and mid-term and short-term courses.

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The selected fisheries technologies and extension services were administered to 120 fishermen in order to find out the effectiveness of fisheries extension services. The data were collected from the respondents by using an extension service list constructed for the 13 fisheries technologies. The responses used to indicate the type of extension service requirements were highly required, required and not required.

The collected data were tabulated and computed in order to find out the effectiveness of extension service requirements with regard to the selected fishing and fish processing technologies which are given in the Table. 01.

It could be inferred from the Table. 01. that about 56.88 per cent of the fishermen indicated that training was highly required for the early adoption of selected fisheries technologies while about 23.80 per cent of them indicated that the training was required. Only 19.32 per cent of the fishermen specified that no was training needed. The findings of Vasanthakumar *et al.* (1990) supported this finding who reported that the effective diffusion of scientific technologies could be done through training programmes. Most of the fishermen (45.56%) point out that demonstration was highly required extension service for the fast adoption of technologies. About 30.82 per cent of the fishermen indicated that the demonstration was required for adoption while only 23.62 per cent of the fishermen stated that the demonstration was not required for the transfer of fisheries technologies. This finding is in accordance with the findings of Veeraputhiran (1998) who concluded

that the demonstration was a suitable extension method for dissemination of fisheries innovations. Only 35.73 per cent of the fishermen indicated that on-the-spot guidance was required for transfer of fisheries technologies while 30.47 per cent of them stated that on-the-spot guidance was highly required.

It could be also observed from the Table.01. that about 37.18 per cent of the fishermen required mass media services for the dissemination of fisheries technologies. About 26.24 per cent of the fishermen indicated that mass media services were highly required for transfer of fisheries technologies. This finding is supported by Seema *et al.* (1992) who reported that mass media services were required for the transfer of agricultural innovations to the farm women. Nearly 50.78 per cent of the fishermen required no advisory services while only 28.08 per cent of the fishermen required advisory services for effective diffusion of fisheries technologies. About 61.77 per cent of the respondents indicated that the exhibition was not required while 20.57 per cent of them indicated that the exhibition was required for transfer of fisheries technologies. This result is supported by the findings of Labh Singh *et al.* (1999). Nearly 63 per cent of the fishermen not required mid-term and short-term courses for the adoption of fisheries technologies.

The study revealed that training, demonstration, on-the-spot guidance and mass media services are mostly required for the speedy dissemination of fisheries technologies when compared to other extension services like advisory services,

exhibition and mid-term and short-term courses. It gives the impression that lack of extension teaching aids is a major constraint in the extension services. Therefore, adequate teaching aids with suitable extension services could be implemented by the fisheries development organisations and extension workers in order to create an effective learning situation to improve the skills of fishermen and also to speed up the transfer of technologies in the present day context.

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Table. 01. Extension services required for transfer of selected fisheries technologies

Sl.No	Extension Services	Responses		
		HR	R	NR
01	Training	56.88	23.80	19.32
02	Demonstration	45.56	30.82	23.62
03	On-the-spot guidance	30.47	35.73	33.80
04	Mass media	26.24	37.18	36.58
05	Advisory services	21.14	28.08	50.78
06	Exhibition	17.66	20.57	61.77
07	Mid-term and short-term courses	14.79	18.59	66.62

HR – Highly Required

R- Required

NR – Not required

PATHOLOGICAL EVIDENCE OF INFECTIOUS LARYNGOTRACHEITIS AMONG LAYER BIRDS IN KERALA

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Infectious laryngotracheitis (ILT) is an important acute and highly contagious respiratory disease of chicken causing significant economic loss in the poultry industry, world-wide. Though reports of ILT among layer flocks in India are available, confirmed cases of infectious laryngotracheitis (ILT) among layers of Kerala is lacking. The disease is characterized by severe dyspnea, coughing and rales resulting in severe production losses. Losses occur due to excessive mortality, decreased growth rates and decreased egg production. ILT virus (ILTV) belongs to the genus *Ilto virus*, family herpesviridae, subfamily alpha herpesvirinae and the *Gallid herpes virus 1* species 1. In a very severe form of disease, there will be bloody mucus in the trachea with high mortality. A milder form which causes nasal discharge, conjunctivitis, reduced weight gain and egg production has also been noticed.

A gramasree layer of four months of age was presented to the Department of Veterinary Pathology, College of Veterinary and Animal Sciences, Mannuthy, Thrissur for necropsy examination with a clinical history of expectoration of blood mixed mucus. Ten birds of the same age group were reported to have died with symptoms of respiratory distress and expectoration

of blood mixed mucus. Another layer bird of nine months old was also brought from Thrissur district. The birds were subjected to detailed postmortem examination. Gross lesions were recorded and representative tissue samples of trachea and lungs were taken in 10 percent neutral buffered formalin for histo pathological studies. Paraffin blocks were made out of the fixed tissues and sections of 4 micron thickness were prepared. The sections were subjected to routine Hematoxylin and Eosin staining. Special staining techniques for demonstration of intra nuclear inclusion bodies, as described by Luna using Lendrum and Page Green were also carried out.

On gross examination of the carcasses, the tracheal mucosa was found to be highly hyperemic and hemorrhagic with presence of blood clots mixed with mucus in the lumen. Though the crop mucosa was intact, feed contents were mixed with blood and mucus, thus indicating that it was the swallowed mucus and blood which got mixed with the feed. The lungs were edematous and showed areas of moderate congestion and hemorrhage. Microscopic examination of the H&E stained tracheal sections revealed moderate infiltration of lymphocytes in the mucosa and submucosa associated with formation of syncytia by

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mucosal epithelial cells⁴. The epithelial cells showed vacuolar degeneration with desquamation. The sloughed mucosal epithelial cells were seen within the tracheal lumen and high magnification of the epithelial cells revealed intranuclear inclusion bodies⁵. The tracheal sections were also subjected to special staining procedures using Lendrum and Page Green as described by Luna.

By employing Page Green stain, bright red intranuclear inclusion bodies were demonstrated within the tracheal epithelial cells whereas connective tissue and muscles took green and red colours respectively. In Lendrum technique, the inclusion bodies appeared as deep magenta coloured bodies against a faint yellow stained background. The observations have shown that laryngotracheitis exist among the layers of Kerala, especially in Palakkad and Thrissur districts, though official reports are lacking. The findings also necessitate the isolation of virus and its strain identification⁶. Page Green has been identified as an effective histopathological stain for demonstration of viral inclusions

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ESTIMATION OF TOTAL SAPONIN CONTENT OF COMMONLY AVAILABLE FODDER CROPS FOR DAIRY CATTLE

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Saponin is one of the important plant secondary metabolite which has been shown to selectively modulate the rumen microbial populations resulting in an improvement of rumen fermentation and decreases the methane production. Chemically saponins are high molecular weight glycosides in which a triterpene saponins or steroidal aglycone moiety is linked to one or more sugar chains. The saponins may be considered a part of plant defense system because they are known to inhibit mould, to be antimicrobial and to protect plants from insect attacks (Francis *et al.*, 2002). Saponin in higher level causes bloat and lower level beneficial for ruminants. The majority of research on saponin has been employed to exploit it for inhibition of rumen ciliate protozoa and selectively inhibiting some bacteria, which might reduces the production of hydrogen ions for the methane emission (Bharathidhasan *et al.*, 2013). Currently numerous studies had been attempted to exploit these saponin as a natural feed additive to modulate the efficiency of rumen fermentation by enhancing protein metabolism, reducing nutritional stress or bloat, decreasing methane emission and improve the animal health and productivity (Patra *et al.*, 2006). Early study has been reported that plants rich in saponins decreased the methane

production in the rumen (Agarwal *et al.*, 2006). Similarly Goel *et al.* (2008) observed that the methane emission was decreased by the way of decreasing the methanogen populations through *Sesbania saponins* by 78 %, *Fenugreek saponins* by 22 % and *Knautia saponins* by 21% by *in vitro* fermentation technique. Saponin extracts from *Yucca schidigera* and *Quillaja saponaria* had been demonstrated to reduce methanogenesis by *in vitro* (Holtshausen *et al.*, 2009). Sterol binding capability of saponins has been implicated to the destruction of protozoal cell membranes (Hostettmann and Marston, 1995). The saponin appears to reduce methane emission by inhibiting protozoa and interfering hydrogen transfer between the protozoa and associated methanogens. The decrease in methane emission will reflect on increasing the production performance of dairy cattle. Hence the present study was carried out with an objective to find out the total saponin content of the commonly available fodder crops for dairy cattle.

Six samples each of sixteen commonly available forages in Tamil Nadu used for feeding dairy cattle were collected (approximately 2 kg on each sample) as per the standard procedure. The collected forage samples were dried in a hot air oven at a

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temperature of 55 - 65°C to constant weight and ground to pass through 1 mm sieve and stored in airtight containers for saponin analysis. The plant extracts were prepared (Sirohi *et al.*, 2009) by weighing of one gram sample into 250 ml conical flask and to it 10 ml of 50 % aqueous methanol was added and the flasks were tightly sealed and kept in a orbital shaker at 120 rpm for 24 hrs. After which the contents of the flask was filtered through four layers of muslin cloth. The filtrate obtained was further filtered through Whatman no.1 filter paper and the resultant filtrate was used for total saponin estimation. Saponin in plant extracts were determined using colorimetric method described by Baccou *et al.* (1977). In a test tube containing 0.25 ml of plant extract, 1.75 ml ethyl acetate and 1.0 ml of reagent A (0.5 ml anisaldehyde + 99.5 ml ethyl acetate) and 1.0 ml of reagent B (50 ml concentrated sulphuric acid + 50 ml ethyl acetate) were added and mixed thoroughly and incubated in a water bath maintained at 60° C for 20 minutes. After cooling to room temperature the optical density was measured at 430 nm in a UV spectrophotometer (Perkin Elmer model Lambda 25). A reagent blank was also simultaneously measured for its optical density. The concentration of saponin in the plant extract was calculated by fitting the optical density values in saponin standard curve. Saponin standard curve was drawn by determining the optical densities of standard saponin solutions of varying strength (0.1 mg to 1.0 mg) adopting the same procedure as that for plant extracts. The data were statistically analysed through the procedure of statistical analysis system (IBM SPSS® Version 20.0 for Windows®) as per the Snedecor and Cochran (1989).

A highly significant ($p < 0.01$) difference was observed between grass/shrubs and tree fodders in total saponin levels (Table 1). Among the grass/shrubs *Vigna unguiculata* had maximum level (3.80 %) of total saponin and the minimum saponin level (0.82 %) was observed in the *Brachiaria mutica*. The total saponin content of the other forages like *Stylosanthus scabra*, *Sorghum vulgare*, *Saccharum officinarum*, *Medicago sativa*, *Panicum maximum*, *Cyanodon dactylon* and *Pennisetum typhoides x Pennisetum purpureum* were 3.70 %, 2.87 %, 1.72 %, 1.53 %, 1.49 %, 1.22 % and 0.84 % respectively. The present findings on total saponin of the forages were almost consistent with that reported earlier. The *Medicago sativa* contained similar saponin level (1.72 %) as that reported (0.78 - 1.78 %) by Vieira and Borba (2011). The range of saponin in other grasses was little higher than the observed values recorded in this experiment. In the tree fodders, *Acacia nilotica* (6.18 %) had highest total saponin content and *Gliricidia sepium* (3.48 %) had lowest total saponin content. The total saponin content of other tree fodders like *Albezia lebback*, *Moringa oleifera*, *Sesbania grandiflora*, *Leucaena leucocephala* and *Azadirachta indica* was 3.68 %, 3.86 %, 3.98 %, 4.13 % and 4.16 % respectively. It was concluded that the highest total saponin was presented in *Acacia nilotica* (6.18 %) and *Vigna unguiculata* (3.8 %) among tree fodders and grass/shrubs groups respectively.

The total saponin content of *Acacia nilotica* (7.36 %) and *Leucaena leucocephala* (5 %) reported by Almahy and Nasir (2011) and Belewu *et al.* (2008) respectively were higher than the present

findings. The total saponin in *Azadirachta indica* (4.16 %) was higher in the present study than the earlier reported values of 3.21 % by Sirohi *et al.* (2009). A minimum saponin content of 1.6 % was reported by Ogbe *et al.* (2011/12) and maximum content of 4.09 % was reported by Alexander *et al.* (2008) in *Moringa oleifera*. There are some factors, such as physiological age, environmental and agronomic factors, which may affect the saponin content of plants (Yoshiki *et al.*, 1998).

The present study revealed that the tree fodders had higher level of saponin than grasses. *Acacia nilotica* contained highest level of saponin. The variations in the concentration of total saponin between the present study and reported values might be due to the maturation of plants because of the physiological changes occurring during the plant growing cycle, soil type, fertility, water supply are known to affect the concentration in plants. Moreover species vary in their response to climatic and physiological changes that induces the changes in chemical composition and in particular, in the concentration of secondary compounds (Dann and Low, 1988). Saponin supplementation through forages has been employed to exploit it for inhibition of rumen ciliate protozoa which might improve the efficiency of microbial protein synthesis by reducing microbial protein turn over and enhance protein flow to the duodenum and ruminant production (Patra and Saxena, 2009). Currently numerous studies had been attempted to exploit these saponin as a natural feed additive to modulate the efficiency of rumen fermentation by enhancing protein metabolism, reducing nutritional stress or

bloat, decreasing methane emission and improve the animal health and productivity (Patra *et al.*, 2006). Agarwal *et al.* (2006) observed that methane production was reduced by *in vitro* with water, ethanol and methanol extracts of soap nut (*Sapindus mukorossi*). Addition of Tea saponin at 2, 4, 6 and 8 mg against 200 mg mixture *in vitro* decreased methane concentration by 13, 22, 25 and 26%, respectively (Hu *et al.*, 2005). Hence, the present study might be helpful for the inclusion of Saponin rich forages in ruminant diet to improve the rumen fermentation and reduce the methane emission to environment.

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Table 1.Total saponin content of commonly available fodder crops for dairy cattle on DM basis (Mean[#] ± S.E)

S.No.	Forages	Total Saponin
Grasses/Shrubs		
1	<i>Panicum maximum</i>	1.49 ± 0.18
2	<i>Cyanodon dactylon</i>	1.22 ± 0.07
3	<i>Pennisetum typhoides x Pennisetum purpureum</i>	0.84 ± 0.16
4	<i>Brachiaria mutica</i>	0.82 ± 0.03
5	<i>Sorghum vulgare</i>	2.87 ± 0.35
6	<i>Medicago sativa</i>	1.72 ± 0.39
7	<i>Vigna unguiculata</i>	3.80 ± 0.48
8	<i>Stylosanthus scabra</i>	3.70 ± 0.32
9	<i>Saccharum officinarum</i>	1.53 ± 0.17
Tree fodders		
10	<i>Gliricidia sepium</i>	3.48 ± 0.25
11	<i>Leucaena leucocephala</i>	4.13 ± 0.55
12	<i>Sesbania grandiflora</i>	3.98 ± 0.57
13	<i>Acacia nilotica</i>	6.18 ± 0.25
14	<i>Albezia lebback</i>	3.68 ± 0.32
15	<i>Azadirachta indica</i>	4.16 ± 0.38
16	<i>Moringa oleifera</i>	3.86 ± 0.11
Statistical significance between Grasses/shrubs and Tree fodders		
	Grasses/Shrubs* (Mean ± S.E)	2.66 ± 0.23 ^a
	Tree fodders* (Mean ± S.E)	4.03 ± 0.18 ^b
	Test of significance	p<0.01

Mean of six observations

* Means bearing different superscripts in the same column differ significantly

EFFECT OF GUAVA POWDER ON PROXIMATE AND SENSORY CHARACTERISTICS OF FUNCTIONAL CHICKEN MEAT NUGGETS

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Poultry meat products are desirable component in our diet. They are important sources of protein, essential vitamins and minerals. However, in recent years the concerns are towards meat products having high levels of saturated fatty acids, cholesterol, salt and deficiency of dietary fibre. In order to alleviate these concerns, healthier meat products and/or functional meat products are gaining popularity. These products either possess functional ingredients that improve health or contain lesser quantity of undesirable compounds like cholesterol, fat etc. Reformulation of chicken products by incorporating health enhancing ingredients like green vegetables, fibre, vegetables proteins, PUFA, antioxidants etc. is one of the best methods to produce healthier chicken products (Devatkal *et al.*, 2008). Meat and meat products are very low in dietary fibre content and hence the intake of dietary fibres along with them has a great role in the nutrition/digestive system. These dietary fibres are concentrated in cereals, pulses, fruits and vegetables and their daily intake helps in prevention of many nutritional disorders, gut related problems,

cardiovascular diseases, type 2 diabetes, certain types of cancer and obesity (Verma 2010).

Guava (*Psidium guajava*. L) fruit is considered as highly nutritious because the peel and pulp of guava (*Psidium guajava*. L) fruit has high levels of dietary fibres, indigestible fraction, and phenolic compound (Mercadante *et al.*, 1999). Hence, the study was conducted to prepare functional chicken meat nuggets with the addition of guava powder to enhance the dietary fibre content in the product.

Chicken meat nuggets were prepared by using lean chicken meat along with particular levels of other ingredients. Chicken meat was minced and added with the pre weighed quantities of salt (2%), sodium nitrite (0.012%) and sodium tri polyphosphate (0.3%) one by one and mixed by hand. Ice flakes (10%) and refined vegetable oil (10%) were added slowly in between until the complete dispersal. Then Condiment paste (4%), pepper (1%), spice mix (2%) and refined flour (10%) were added one by one. The final emulsion was taken as control. For treatments, the guava

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powder was added at three different levels viz. 0.5, 1.0 and 1.5 per cent to the final emulsion and mixed by hand. The emulsion was then filled uniformly into aluminium moulds and cooked in steam for 30 minutes until it reaches the internal temperature of 72° C.

The proximate composition of functional chicken meat nuggets were analyzed by following the standard procedure of AOAC (1995). The sensory qualities of chicken meat nuggets was assessed by subjecting the nuggets samples to the sensory scores of appearance, flavour, texture, juiciness and overall acceptability by a trained and semi-trained taste panel drawn from the Department of Livestock Products Technology (Meat Science), Madras Veterinary College, Chennai- 600 007 on a nine point hedonic scale as given in the score card. The data was subjected to statistical analysis in SPSS (version 20.0) software as per the standard procedure outlined by Snedecor and Cochran (1994).

The proximate analysis revealed that there was no significant difference ($P>0.05$) in protein, fat and ash content (%) of control and three levels of guava powder incorporated chicken nuggets. There was highly significant ($P<0.01$) difference in moisture and dietary fibre content (%) between control and treatments (Table 1). The increasing levels of guava powder showed decreasing trend in the moisture content and increasing trend in the dietary fibre content. This is due to the higher dietary fibre content of guava powder (Verma *et al.* 2013).

There was no significant difference ($P>0.05$) in values of appearance, flavour, texture, juiciness and overall acceptability scores of control, 0.5, 1 and 1.5 per cent levels of guava powder incorporated chicken nuggets (Table 2). Apparently there was a higher score for 1.5 per cent guava powder incorporated chicken nuggets in all the sensory values. These similar results were observed by Verma *et al.* (2013) also in sheep meat nuggets with the incorporation of guava powder.

Based on the above findings it has been concluded that the fiber enriched functional chicken meat nuggets can be prepared with incorporation of 1.5 per cent guava powder without affecting the physico-chemical and sensory characteristics of the product and it can be recommended to the people/patients with hypertension, bowel disorders, Ischemic Heart Diseases, etc.,

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Table 1. Proximate composition of chicken nuggets incorporated with different levels of guava powder

Parameters	Control	Different levels of guava powder (%)			F value
		0.5	1.0	1.5	
Moisture (%)	64.23 ^b ± 0.40	64.20 ^b ± 0.55	61.90 ^a ± 0.63	61.05 ^a ± 0.38	10.418 ^{**}
Protein (%)	17.23 ± 0.37	17.45 ± 0.58	17.93 ± 0.40	17.77 ± 0.31	0.540 ^{NS}
Fat (%)	23.52 ± 1.46	22.32 ± 1.36	22.58 ± 1.37	20.90 ± 0.87	0.709 ^{NS}
Ash (%)	5.37 ± 0.28	5.33 ± 0.21	4.82 ± 0.25	4.73 ± 0.22	1.921 ^{NS}
Dietary fibre (%)	1.19 ^a ± 0.03	2.36 ^b ± 0.01	4.43 ^c ± 0.02	5.93 ^d ± 0.01	13706.42 ^{**}

Means bearing different superscripts (a, b, c and d) within rows differ significantly (P<0.01)

n=6

NS - Not Significant

** - Highly Significant (P<0.01) difference

Table 2. Sensory evaluation of chicken nuggets incorporated with different levels of guava powder

Parameters	Control	Different levels of guava powder (%)			F value
		0.5	1.0	1.5	
Appearance	7.33 ± 0.22	7.43 ± 0.19	7.78 ± 0.21	7.92 ± 0.16	1.996 ^{NS}
Flavour	7.22 ± 0.32	7.45 ± 0.18	7.83 ± 0.22	7.78 ± 0.14	1.698 ^{NS}
Texture	7.32 ± 0.28	7.30 ± 0.20	7.57 ± 0.17	7.75 ± 0.19	1.007 ^{NS}
Juiciness	7.07 ± 0.30	7.38 ± 0.20	7.62 ± 0.17	7.62 ± 0.08	1.662 ^{NS}
Overall acceptability	7.15 ± 0.30	7.22 ± 0.23	7.67 ± 0.20	7.90 ± 0.12	2.660 ^{NS}

n=6

NS - Not Significant

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Journal articles and abstracts

Bardbury, J.M., Mc Carthy, J.D and Metwali, A.Z. (1990). Micro immunofluorescence for the serological diagnosis of avian Mycoplasma infection. *Avian Pathology*, **19**:213-222.

Raja, S., Rani, A., Ravi, M and Kumar. K. (2007). Histopathology of CPV infection. Page no. 120-122....Venue....Date...Place...

Books and articles within edited books

Rundall, C.J. (1991). A colour Atlas of Diseases of the Domestic Fowl and Turkey. 2nd ed. London. Wolf Publishing Ltd. 175 p.

Handbooks, Technical bulletins, Thesis and Dissertations

Callow, L.L and Dalgliesh, R.J. (1982). Immunity and Immunopathology in Babesiosis. In: S. Choen and K.S. Warren (Ed) Immunology of Parasitic Infections. Blackwell, Oxford. pp 475-526.

Electronic publications

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