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**INDIAN JOURNAL OF VETERINARY AND ANIMAL SCIENCES RESEARCH**
**(Formerly Tamil Nadu Journal of Veterinary and Animal Sciences)**

**Vol. 47** **January - February 2018** **No. 1**

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Review article

# INTEGRATED FARMING SYSTEM – A REVIEW

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The history tells us that since human settlement and civilization both agriculture and animal husbandry have transformed in tune with the growing population and its challenging needs. The transformation was remarkable during the past decades. High yielding varieties in agriculture, fodder crops, cross breeding in livestock hybridization in poultry, farm mechanisation, increased fertiliser and pesticides use, specialised farming practices and government policies that favoured maximising production. In general, modern agriculture begins in research station, where researchers utilise all the required resources or inputs and achieve maximum efficiency. But many rural resource poor households are unable to adopt such package of practices due to non availability of inputs, high cost and not able to get in time. However, in livestock production, the modern technologies are adopted first in private firms mainly due to huge financial support from agencies. Modern, adoptable technologies though have improved production and productivity to meet the growing demand, there have been worry about ecological and social disturbance through environmental pollution and their impact on society. This is happening all over the world. The world is worried about the adverse effects due to high input livestock and agriculture system more in commercial farming. Some of the following impacts are really challenging to reverse them.

- Overuse of natural resources
- Forest cover area is fat declining
- Ground water table is so deep
- Increased soil salinity
- Agriculture land is utilized for other purposes resulting in reduction in cultivable land area
- Population growth and their food demand
- Earth warming due to more green house gases
- Air, water and land contamination
- Disruption of forest animals habitat
- Increasing resistance of pathogens to conventional medicines
- Increase in occupational hazards
- Genetic diversity erosion

To add with the above worrisome facts, population explosion, increasing heads of livestock and more intense poultry farming started imposing great pressure on available natural resources. So, it is big challenge the whole world is facing. Hence, a perfect vision is the need of the hour to address these threatening challenges. The

expected strategy should be holistic and the science and the stakeholders should partner to complement each other to restore the depleting ecosystem and natural resources.

The farming system has revolutionized indigenous farming system in few countries, notably in sub tropical and tropical regions. Low or minimal input system in farming could be achieved through multiple cropping with diversified activities including dairy cows,sheep, goat, piggery, poultry, fodder, mushroom cultivation, bee keeping, agroforestry, fishery, sericulture production. The production must be maximized from limited resources such as land, water, labour and energy. Farming system is viewed as whole farm with the integration of crops, animals, soil, other inputs and environmental influence wherein the farm family attempts to produce outputs within the limitations of its capability and resources and the socio-cultural setting. The combination of livestock and crop activities had helped farmers in the past, almost all over the world, to use the manure as fertilizer for crops, and the crop residues as feed for livestock. So, reusing the waste as input was started long ago. But, there had been losses in the use of farm practices. Sustainable farming system based on science by integrating agricultural systems that would address the aspirations of the farmers and the concerns of the society were developed by researchers. Studies on farming systems in Tamil Nadu Agricultural University, was commenced in 1976. In the mid-eighties, farming system development at Agricultural University was approached in three dimensions viz., education, research and extension. Initially, integrated farming system was conducted as study cum demonstration mode. Research on integrated farming systems was conducted from 1987 onwards at TamilNadu Agricultural University, involving different components (Jayanthi and Balusamy 2017). A few IFS models has already been established in Instructional Livestock Farm Complex, Madhavaram and Post Graduate Research Institute in Animal Sciences, Kattupakkam, TANUVAS.

## FARMING SYSTEM

A farming system is a collection of distinct functional units such as crop, livestock, processing, investments and marketing activities which interact because of the joint use of inputs they receive from the environment which have the common objective of satisfying the farmers' (decision makers) aims. The definition of the borders of the options depends on circumstances; often it includes not only the farm (economic enterprise) but also the household (farm – household system). (Ruthenberg 1971).

Farming system is as the way in which farm resources are allocated subject to the needs and priorities of the farmer in his local circumstances. The farming system is more risky than any other systems and specifically refers to a crop combination or enterprise mix in which the products and byproducts of one enterprise serve as input for the production of other enterprises. (Collinson 1979)

Characterizing farming systems is exceedingly difficult due to the complexity and heterogeneity of the components involved. Farming system methods are compatible with traditional research

approaches and have evolved as a means for involving farmers and farm families in setting research priorities and in identifying appropriate paths to agricultural development. Specifically, farming system views the whole farm as a system and focuses on interdependencies between the system components and their interaction with physical, biological and socioeconomic factors where more commonality would be found within the system than between systems. Therefore, farming system is part of larger systems and that would be divided into many sub-sub systems. (Shaner *et al.* 1982)

Farming is the process of harnessing solar energy in the form of economic plant and animal products, and 'System' implies a set of inter related practices/processes organized into a functional entity, i.e. an arrangement of components or parts that interact according to some process and transforms inputs into outputs. Faming system is a decision making units comprising farm household, cropping and livestock systems that transform land, capital and labour into products for consumption and sale. (Fresco and Westphal 1988)

Farming system is a mix of farm enterprises such as crop, livestock, aquaculture, agro-forestry and fruit crops to which farm family allocates its resources in order to efficiently manage the existing environment for the attainment of family goal in other words. (Pandey *et al*. 1992)

Farming system is an integrated resource management strategy for obtaining economic and sustained crop and livestock production and preserving the resource bases with high environmental quality. (Palaniappan 1992)

These definitions though comprehensive, leave one or the other aspect untouched, call for rephrasing for extensive communicability, usage and applicability and hence the following is a comprehensive definition.

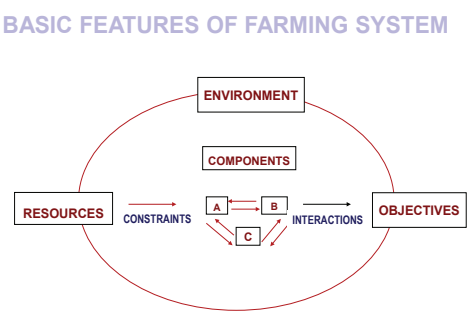
"Farming system represents an appropriate combination of farm enterprises viz.,cropping systems, horticulture, livestock, fishery, forestry, poultry and the means available to the farmer to raise them for profitability. It interacts adequately with environment without dislocating the ecological and socio-economic balance on one hand and attempts to meet the national goals on the other. The farming system in its real sense will help in different ways to lift the economy of agriculture, animal husbandry and standard of living of the farmers of the country as a whole".

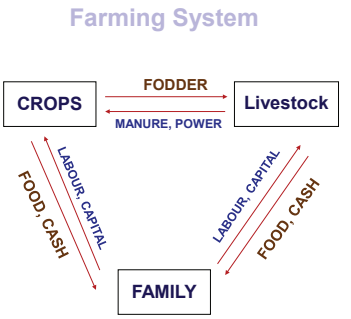
Integrated Farming System (IFS) is an age old concept adopted by our elders, forgotten for a long period, getting encouragement in recent times is a welcoming trend in Agriculture and Livestock farming. In simple definition IFS is a diversification of farming strategy so as to use or reuse the waste of one strategy for another with the objective of additional remuneration and preserving ecosystem. Diversification is an agricultural and or livestock farming strategy to reduce economic risk on the farm. The need of IFS is for household food/ food security at household level, nutritional security for the society, creating rural employment opportunities and sustainability of

Production Systems. IFS can be broadly defined as commodity diversification in to multi enterprise linkage. Generally IFS is practiced as synergy through land-based enterprises like livestock and fishery, poultry, etc. It also includes capturing the new market opportunities through enterprise including post harvest / value addition, from Low value to High value crops, from Water Loving crop to Water Saving crop, from Single crop to Multiple / Mixed crop and in livestock farming it is integrating of livestock with poultry, fish, horticultrure and agroforestry including production to production with processing and value addition.

## FARMING SYSTEM AND ITS BASIC FEATURES

Basic features of farming system is depicted in a diagrammatic representation for quick and easy understanding. It revolves around the environment, resources with objectives with different components with possible constraints and interactions. IFS deals in general with livestock, crops and family.




## CURRENT STATUS

Fragmented holdings and lack of capital investment by livestock farmers, seasonal income and employment, risk of failures, single commodity farming, limited scope in horizontal expansion and deterioration of resource base mainly cost of inputs and high labour cost.

## FARMING ISSUES

Risk in single farming or commodity approach, underemployment in some cases, Lack of quality feed and fodder for livestock, loss in soil fertility, under utilization of farm bio-resources, malnourishment and knowledge and skill gap in stakeholders.

## IFS GOALS

Maximization of productivity, generation of steady and stable income, educed use of inputs / resources. The cumulative income from each farming system will be more when all the farming is integtrated since the byproduct/waste of one is used / recycled for another in IFS.

## CHOICE AND TYPE OF IFS

Depends on demand of the farm produce in the locality, farmers preference,

size of the farm, climatic conditions, knowledge, skill and technology, soil type, resource mobilizing power, credit facility, socio-economic status, storage, transport and marketing and customs, sentiments and beliefs.

## STEPS IN INTEGRATED FARMING SYSTEM RESEARCH (FSR)

- Farm selection: to identify specific farming situation.
- Selection of villages and farmers: Select villages in each farming situation comprising arginal/small and medium/large farmers. Selection of village and farmers should be at random so as to represent all farming community of the target area.
- Diagnosis of constraints in increasing farm productivity: Carry out survey through rapid rural appraisal. Prepare an inventory of farm resources and support services. Identify the production constraints.
- Research design and technology generation and adoption.
- Technology transfer and diffusion of improved farming systems within recommended domain.
- Impact of technology of improved farming system: Productivity, Economic return, Energy input-output, Employment, Equity (gender issue) and Environment.

## INTEGRATED FARMING SYSTEM MONITORING INDICATORS

Monitoring indicators and integrated farming system evaluation methodology developed by Jayanthi (1995).

**1. Productivity**

**A. Crop:** Economic yield, Fodder yield, Residue addition

**B. Livestock and other enterprises :** Productive parameters (short term) & reproductive parameters (long term), Milk, meat, egg yield & manure output.

**C. Manure quantification : C**rop residues and manures

**D. Soil nutrient analysis :** Soil physical properties (Soil type, pH, EC, bulk density, porosity), pre and post harvest analysis for organic carbon and major nutrients & soil microbial population at rhizosphere region (initial and final stages).

**2. Economic analysis for crop, livestock and other enterprises :** Total cost, gross return, Net return, per day return and cost benefit ratio

**3. Employment for family members:** Number of man hours spent for crop, livestock and other enterprises.

**4. Nutrient recyling and its potential:** Nutrient content and nutrient addition

**5. Energy :** Energy output, input and energy efficiency

**6. Water budgeting :** Water requirement for crop production, livestock, for allied activities, otal water requirement and water use efficiency

**7. Nutritive value :** Protein, carbohydrate and fat.

## INTEGRATED FARMING SYSTEM EVALUATION

**Productivity :** To estimate the productivity of a component and compare with the crop component expressed in terms of equivalent crop yield. Further the production estimation itself varies among the interlinked allied component in integrated farming system.

Eg. Rice based farming systems. Productivity of allied components has to be worked out based on their economic products.

**Example:** Fish yield (kg per unit area), poultry layer: total number of eggs per year, mushroom yield: kg per year, milk yield: Litre per year, kids/lambs per year.

Productivity in-terms of grain yield, in livestock and poultry need to be recorded and profit calculated.

## FEASIBLE IFS COMPONENTS

### Dairy unit

The animal shed washing water along with urine can be drained for fodder plots, agriculture, horticulture crop and for agroforestry models. The dung obviously, the best organic fertiliser can be used for agriculture, horticulture crops, vegetable gardens, panchakavya preparation, biogas and many more application. The dairy unit can also be aimed for producing quality heifer calf unit, production and selling fodder and fodder seeds, preparation and marketing of milk products. The campus can also be used as a resource platform for knowledge infusion and skill development.

### Sheep unit

The flock in most cases is nomadic and hence integration scope is very limited. However, lambs fattening may be tried along with flock for additional revenue.

### Goat unit

In rural villages few goat is managed by mostly women with a little or zero resource. Some farmer rear them in raised platform with metal mesh. Desi chicken can be reared underneath the floor, in the ground by providing cheap mesh all sides and by rearing them with little resource and grazing would yield an additional profit from this chicken unit. One such IFS is available at Instructional Livestock Farm Complex, Madhavaram, Tamilnadu Veterinary and Animal Science University, Chennai.

### Piggery unit

The pig sty wash water including dung and urine can be used for raising fodder crop, vegetables, fruits, agroforestry models for additional revenue generation. One such IFS model is created at Post Graduate Research Institute in Animal Sciences, Piggery unit viz.Pig cum Horti-Silvi-Pasture cum Fish culture unit. The present practices of releasing waste water in open lead to lots of environmental issues including health risk due to contamination of soil, plant and animals. The research on use of treated water from piggery farm on Horti cum fodder production, fish farming and recycling of water for cleaning the pig shed has not been studied so far.

| | | |
|---|---|---|
| **Horti component** | **:** | **Guava, Lemon, Goose Berry, Coconut and Tamarind.** |
| | | **Coconut and Tamarind will be used as a border component.** |
| **Silvi Component** | **:** | *Leucaena leucocephala* (Subabul) and *Gliricidia sepium / Sesbania sesban* **as border component** |
| **Pasture Component** | **:** | *Desmanthus virgatus* **and** *Styloxanthus hamata* |
| **Fish Component** | **:** | **Mirgal, Rogu and Katla** |

**In the five acres of land utilized for this IFS model, 200 each of g**uava,lemon and goose berry; 50 each coconut and tamarind; *Desmanthus virgatus and Stylosanthus hamata* each in *2.5 ac.; Leucaena leucocephala* (Subabul) 100, *Gliricidia sepium / Sesbania sesban 100 Nos. and* fresh water fish 500 each of Mirgal,Rogu and Katla. **Harvesting / seed collection from established pastures and arvesting and sale of fishes commences from 2nd year onwards. From fourth year revenue generation in horticulture component. This type of IFS becomes self sustainable in five years period.**

**Poultry**

Desi chicken farmers can diversify their activity by establishing a small chicken incubator to hatch a few dozen eggs to boost their revenue by producing more chicken and eggs. Also in the rural backyard chicken rearing can be diversified in to a few guinea fowl, turkey, pigeons and fancy bird rearing. All these diversified units would yield additional returns. Duck cum fish farming wherever possible.

## ADVANTAGES OF THIS IFS

- Effective water recycling through waste water treatment plant
- Establishment of agroforestry model and fishery unit to compliment income from piggery unit throughout the year
- Agro-ecological equilibrium through natural cropping system management
- A sustainable model for the utilization of waste/barren land – water – labour resource for adoption by the farmers
- Reduction in green house emission
- Augmentation of the system's productivity
- Carbon sequestration through agro-forestry model
- Greater dividends than a single enterprise for the family
- Food security to the farming community even in extreme condition
- Popularization of Organic farming practices
- Soil conservation

## IFS IN WET LAND AGRICULTURE

Farming components such as cropping, fishery, poultry, love birds, duck, goat, pig, fodder and mushroom are possible in wetland.

## IFS IN IRRIGATED LAND AGRICULTURE

Cropping, dairy cows and buffaloes, biogas, fingerlings production, mushroom cultivation, homestead garden, silviculture and sericulture are the potential components for desired integration.

## IFS IN RAINFED LANDS

Farming segments such as cropping, goat, agroforestry, horticulture, silviculture, love birds, rabbit, farm pond and pisciculture may be considered for integration.

**IFS beneficiaries of TNAU**

| Sl.No. | Name and Address of the IFS beneficiaries | Area covered ( acres) | Inputs supplied |
|---|---|---|---|
| 01 | Thiru.G.Gnanasekaran<br>S/o GurusamyChettiar<br>No. 53/54, Middle Street,<br>Pethapuram village<br>Ettayapuram post,<br>Thoothukudi district | 1.05 | **A. Goat and Crop Component**<br>1. Goats (10 female + 1 Male)<br>2. Fodder Seeds<br>3. KKM1 Grass slips<br>**B. Poultry unit**<br>1. Desi chicks (30 Numbers)<br>2. Feeder (2 Nos)<br>3. Drinker (2 Nos)<br>**C. Vermi compost unit**<br>1. Vermi-bag (3 Nos)<br>2. Vermi worms (2000 Nos)<br>3. Basins and Casuarina poles |
| 02 | Thiru R.Radhakrishnan<br>3/80,Jegaveerapandiyapuram<br>Melacheithalai post<br>Kurukkusalai (via)<br>Thoothukudi district | 1.01 | |
| 03 | Thiru P.Periyasamy<br>S/o V.perumal<br>2/11, East street<br>Aandaan Nagar<br>MelaKoottudankaadu post<br>Pudukkottai<br>Thoothukudi district | 1.06 | |

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Full Length Research Articles

# EFFECT OF INCORPORATION OF FINGER MILLET (*ELEUSINE CORACANA*) AS A THICKENING AGENT IN CHICKEN SOUP

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## ABSTRACT

A study was conducted to optimize the level of finger millet (*Eleusine coracana*) powder as a thickening agent in the chicken soup prepared with no added oil. Whole finger millet (FM) was powdered finely and used as thickening agent in chicken soup at 0 (control) 5(FM5), 10(FM10) and 15(FM15) parts levels. The pH significantly decreased with increase in the finger millet level where it was highest in control and lowest in FM15. In the sensory evaluation, appearance, flavour and mouth feel scores significantly decreased with increase in finger millet level. The consistency scores were significantly higher for the treatments with finger millet compared to control. The overall acceptability scores were comparable among the control, FM5 and FM10 treatments and significantly lower for FM15. Hence, from this study, it can be concluded that finger millet might be efficiently utilized as a thickening agent in chicken soup up to 10 parts level, which would fortify the nutritive value.

**Key words:** Finger millet, Chicken soup, Thickening agent

## INTRODUCTION

Change in lifestyle had driven the consumers towards the ready-to-eat foods, of which soup is a major item. Soup is part and parcel of the Indian cuisine, which always finds its place in a complete meal. Apart from that, varieties of soups are also consumed as exclusive snack time food, which palliate hunger, giving a stomach fill feel with low calories. Chicken soup is a famous ready-to-eat food in India, especially Tamilnadu and has long been considered as a healthful food which needs less preparation time and low cost. Chicken soup had been considered as an effective curative for many ailments, of which, its use in the treatment of upper respiratory tract infections is more popular (Saketkhoo et al. 1978) and is being followed as a home

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remedy till now. As it is believed to have healing power, it is mentioned with the nick name "Jewish penicillin" (Ke et al. 2011).

Finger millet (Eleusine coracana) also known as ragi, is an important cereal cultivated in the semi-arid regions of India and Africa. It is a notable staple food for the traditional consumers in the Indian subcontinent, especially for people in rural areas and those of low income groups. It is commonly consumed in the form of porridges and to some extent as pancakes (rotis). Finger millet has remarkably higher crude fiber and mineral content where it is a rich source of calcium, iron and phosphorous with good antioxidant properties and well balanced protein profile containing more lysine, threonine, and valine than other millets (Ravindran, 1991; Barbeau and Hilu, 1993; Sripriya et al. 1997 and Devi et al. 2014). Finger millet is rich in polyphenols, a natural source of antioxidants which could be used to minimize the disease risks that are caused by oxidative deterioration (Banerjee et al. 2012). The whole millet with the seed coat had been proven to possess antimicrobial activity (Viswanath et al. 2009)

Finger millet is a non-acid forming food, easy to digest and is considered to be one of the least allergic and most digestible among available grains (Singh and Raghuvanshi, 2012). Some of the health benefits associated with regular intake of millet foods are hypocholesterolemic, hypoglycemic and antiulcerative characteristics which indicate the scope for its utilization by the non-traditional millet consumer also. The antioxidant potential, antimicrobial activity and the health benefits of finger millet had been discussed vividly (Chethan and Malleshi, 2007).

In the recent past, millet based foods are gaining popularity among the urban population due to the awareness on the health benefits of millets. Since it had not been a usual ingredient in their cuisine, the process of including the millets in the regular meal is still arduous. The apparent way to achieve this is the incorporation of the millets in smaller quantities in the recipes of the common diet consumed day-to-day. Chicken soup is one of the favorite food item consumed by people of all ages. There are various starchy ingredients used as thickeners in soups which have lesser nutritive value. Hence, it would be apt to use finger millet powder as a thickener in chicken soup which will impart the nutritional benefits. The present study was conducted with the objective of optimizing the concentration of finger millet powder to be included in chicken soup as a thickening agent prepared with no added oil based on the physico-chemical and sensory properties.

## MATERIALS AND METHODS

### Broiler meat and bone

Deskinned dressed broiler chicken carcasses were purchased from local market and hot deboning was done manually to separate the meat and frames (bone). The deboned chicken frames were pressure cooked (~15 psi) at 121°C with equal amount of water for 15 minutes, the broth was filtered, and the cooked meat was manually separated from the frames. The filtered broth was cooled and kept separately to be added in the soup.

**Formulation and preparation of chicken soup**

Commercially available food grade ingredients available in the local market were purchased and used. The control soup was formulated with the ingredients as listed in Table 1. All the ingredients from S.No 4 to 12 were mixed well and cooked in a vessel on medium flame for 20 minutes. The ingredients from S.No 1 to 3 were then added and allowed to boil for 10 minutes. Ingredients from S.No 13 to 14 were added immediately after the cooking was completed.

Whole finger millet was powdered finely and used as thickening agent in chicken soup at 5, 10 and 15 parts inclusion levels. The same formulation as that of the control was used for the finger millet treatments and for each treatment, the respective quantity of the finger millet powder was previously mixed well with the filtered broth, added to the soup as described earlier for the control formulation. A total of six trials were carried out.

**pH**

The pH of the chicken soup was recorded by immersing combined glass electrode and temperature probe of the digital pH meter (Model 361, Systronics, India).

**Cooking yield**

Individual weights of each batch of soup before and after cooking were recorded. The cooking yield was calculated as below

$$Cooking\ yield = \frac{Final\ weight\ of\ the\ soup}{Initial\ weight\ of\ the\ soup}\ X\ 100$$

**Cost of Production**

The cost of production for all the chicken soup treatments was calculated based on the market price of the ingredients inclusive of only the cost of raw materials and presented in Indian rupee value.

**Sensory evaluation**

Semi trained sensory panel consisting of students and teaching faculty of the college evaluated the chicken soup. Samples were evaluated for appearance, taste, mouth feel, flavor, aroma, consistency and overall palatability using an 8- point hedonic scales (Keeton, 1983)

## RESULTS AND DISCUSSION

**pH**

The pH values significantly ($p \leq 0.05$) decreased with increase in the concentration of finger millet in the chicken soup (Table 2). The pH was highest in control and lowest in FM15 treatment. In a similar study by Naveena *et al*. (2006) where 5% of finger millet was incorporated in chicken patties, the pH was not significantly altered, but numerically lower than the control patties. finger millet was used as a fat replacer in ice cream at 8%, 9% and 10% to improve the nutritional value by significantly enhancing the iron and fibre content, and corresponding to our results it was observed that the pH value decreased with increase in the finger millet level where 10% treatment had significantly lower pH compared to control and other treatments (Patel *et al*. 2015). It had been explained that water logging in the roots caused variation in pH in the finger millet plants (Kulkarni and

Chavan, 2013). Hence the decrease in pH of the soup with added finger millet might be due to the lower pH of finger millet.

The pH plays an important role in the activity of the polyphenols of the finger millet. It had been stated that the phenolics were heat stable but pH sensitive, which might be precipitated with an increase in pH above neutral to highly alkaline state (Chethan and Malleshi, 2007). In this study the pH was below 6 for all the treatments which proves that the activity of the phenolics of finger millet would be unaffected.

**Cooking yield**

Cooking yield value of FM15 was significantly ($P \leq 0.05$) higher than that of control, FM5 and FM10 (Table 2). It was noticed that the cooking yield improved correspondingly with increase in the level of finger millet. Naveena *et al*. (2006) showed that the finger millet flour inclusion up to 7.5 per cent in chicken patties improved the cooking yield. Similarly, Devendra Kumar *et al*. (2015) had reported that the product yield of finger millet flour added patties was significantly ($P<0.05$) higher compared to the control. Both the researchers had pointed out that the improvement in the product yield might be due to the ability of the finger millet flour to retain the moisture and fat within the product matrix.

**Cost of Production**

The cost of production of the chicken soup was significantly ($P \leq 0.05$) highest for FM15 and lowest for the control (Table 2). Addition of finger millet in the chicken soup marginally increased the cost of production of FM10. The cost of FM5 was comparable with both control and FM10. Almost similar variation in cost of chicken nuggets with comparable sensory quality was reported by Wadpalliwar (2015) with incorporation of finger millet and Kalaikannan *et al*. (2014) with incorporation of wheat flour and oat flour in chicken meat patties.

**Sensory evaluation**

The sensory scores are presented in Table 3

**Appearance**

The appearance score was highest for the control followed by the FM5 treatment and both were comparable. The scores were lower for FM10 and FM15 which might be due to the dark colour of the soup imparted by the finger millet. Patel *et al*. (2015) also reported a narrow range of variation in appearance in ice cream prepared with finger millet where it was lowest in ice cream samples with higher level (10%) of finger millet inclusion. Naveena *et al*. (2006) and Das *et al*. (2015) also observed reduction of appearance scores in chicken patties with more than 7.5 % inclusion of finger millet.

**Mouth feel**

Control soup had significantly highest scores, FM15 had the lowest score whereas FM5 and FM10 were comparable with moderately acceptable scores. It was observed that addition of starchy ingredients such as rice flour in ice cream imparted a powdery mouth feel (Cody *et al*. 2007). In this study FM15 soup had a viscous and sticky mouth feel which was not liked by

the sensory panellists, whereas FM5 and FM10 had above moderately acceptable scores.

**Flavour**

The flavour scores were significantly highest for the control and FM5 which were comparable, followed by FM10 which had a moderately acceptable score. The sensory panellists pointed out that the chicken flavour was masked by the addition of higher levels of finger millet. In concurrent with this result, inclusion of 10% finger millet in ice cream caused significant decrease in the flavour scores (Patel *et al*. 2015).Similarly, Das *et al*. (2015) also observed that 10% finger millet addition in chicken patties caused a marginal decrease in flavour score.

**Consistency**

Consistency was significantly good for FM5 and FM10 which had highest scores. Control had a very thin consistency, FM15 was viscous, and hence both were rated with lower scores. Wendin *et al*. (2010) conducted sensory analyses of different type of foods including soups and observed that high-viscosity soups containing a starch-based thickener, were perceived as more melting, easier to swallow and creamy than unthickened fluids.

**Overall Acceptability**

Control and FM5 had significantly highest scores followed by FM10 and all the three samples had scores above moderately acceptable levels. The score of FM15 was the lowest, which was only slightly acceptable. Inclusion of finger millet in ice cream at 10% level (Patel *et al*., 2015) and in chicken patties above 5% levels (Naveena *et al*. 2006 and Das *et al*. 2015) brought down the overall acceptability scores, compared to the control samples. Rokhsana *et al*. (2007) used rice flour and wheat flour at 13.2% level in soup mix, which had acceptable sensory properties.

## CONCLUSION

The nutritional value of finger millet had been realized by the consumers and its inclusion in the regular diet is gradually increasing. Since chicken soup is a popular food item consumed regularly, it would be apt to incorporate finger millet in the chicken soup. From this study, it can be concluded that finger millet might efficiently be utilized as a thickening agent in chicken soup up to 10% level in the base formulation, which would fortify the nutritive value of soup.

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**Table 1. Ingredients of Chicken Soup**

| S. No. | Ingredients | Parts |
|---|---|---|
| 1 | Cooked chicken frames | 90 |
| 2 | Cooked chicken lean meat | 10 |
| 3 | Filtered chicken broth | 100 |
| 4 | Water | 300 |
| 5 | Common salt | 3 |
| 6 | Mashed tomato | 20 |
| 7 | Onion | 10 |
| 8 | Ginger | 2.5 |
| 9 | Garlic | 2.5 |
| 10 | Spice mix | 5 |
| 11 | Mashed green chilly | 2 |
| 12 | Curry leaves | 5 |
| 13 | Chopped coriander leaves | 5 |
| 14 | Black pepper powder | 5 |

**Table 2 - pH values, cooking yield and cost of production of the chicken soup formulated with finger millet**

| Parameters | Treatments | | | |
|---|---|---|---|---|
| | Control | FM5 | FM10 | FM15 |
| pH | 6.11±0.01$^{a}$ | 5.78±0.07$^{b}$ | 5.65±0.07$^{bc}$ | 5.55±0.07$^{c}$ |
| Cooking yield | 87.88±0.14$^{d}$ | 90.65±0.37$^{c}$ | 93.13±0.29$^{b}$ | 94.45±0.22$^{a}$ |
| Cost of production | 60.31± 0.10$^{c}$ | 60.68± 0.25$^{bc}$ | 61.21± 0.19$^{b}$ | 62.47± 0.15$^{a}$ |

a–d Means in a same row with different superscripts differ significantly (p≤0.05)

**Table 3 - Sensory scores of the chicken soup formulated with finger millet**

| Parameters | Treatments | | | |
|---|---|---|---|---|
| | Control | FM5 | FM10 | FM15 |
| Appearance | 6.54±0.26$^{a}$ | 6.12±0.18$^{ab}$ | 5.92±0.17$^{bc}$ | 5.46±0.14$^{c}$ |
| Mouth feel | 6.62±0.13$^{a}$ | 6.00±0.10$^{b}$ | 6.00±0.14$^{b}$ | 4.77±0.22$^{c}$ |
| Flavour | 6.62±0.13$^{a}$ | 6.38±0.12$^{a}$ | 6.01±0.12$^{b}$ | 4.85±0.15$^{c}$ |
| Consistency | 6.03±0.15$^{b}$ | 6.62±0.13$^{a}$ | 6.84±0.12$^{a}$ | 6.23±0.11$^{b}$ |
| Overall Acceptability | 6.65±0.12$^{a}$ | 6.65±0.14$^{a}$ | 6.23±0.12$^{b}$ | 5.03±0.12$^{c}$ |

a–d Means in a same row with different superscripts differ significantly (p≤0.05)

# PEARL MILLET (*PENNISETUM GLAUCUM*) AS FILLER IN CHICKEN CUTLET

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## ABSTRACT

The present study was undertaken to fortify the nutritive value of chicken cutlet with the addition pearl millet (*Pennisetum glaucum*) as filler and optimize its level of addition. The cutlet was formulated with broiler chicken meat, and the spices and condiments. Four different batches of cutlets were prepared with boiled and mashed pearl millet replacing the meat by 10% (PM10), 20% (PM20) and 30% (PM30) along with a control and subjected to physico-chemical and sensory evaluation. The pH before and after cooking significantly decreased with increase in the concentration of pearl millet. The cooking yield was similar in PM20 and PM30 and significantly higher than PM10 and control. In the sensory evaluation, the texture scores were higher for the control with which PM10 was comparable. Juiciness and tenderness scores increased with the addition of PM. Flavour score and the overall acceptability scores significantly decreased with increase in the concentration of PM. Yet, the scores were above moderately acceptable level. It conclusion**,** pearl millet may be used as effective filler in chicken cutlets up to a level of 10% without much affecting the sensory qualities.

**Key words -** Chicken cutlet, Pearl millet, Filler, Sensory evaluation

## INTRODUCTION

Ready-to-eat foods had gained popularity among the urban and semi-urban population and hence there are commercially increasing demands for these kinds of food products, especially meat based snack foods. In India chicken is consumed widely compared to other types of meat due to its low fat,low cost and absence of any religious or social taboos. Numerous chicken food items had been introduced in to the markets in the last decade and there is continuing desire for new type of foods among the consumers. In a parallel track, the consumers are also in hunt for healthy foods where they expect a combination of nutrition and taste without

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compromising each other. Currently, millets are slowly finding their way in the regular diet of the consumers.However, since the present age people are not used to the taste of the millets as the previous generations, they are not completely contented with their palatability when added in the daily menu in the usual recipe. Hence it is a present need to incorporate the millet varieties in the regular ready-to-eat and ready-to-cook foods without much affecting their usual organoleptic properties. This technique could satisfy the consumer to a greater extent.

Pearl millet (*Pennisetum glaucum*) is an important staple food in semi-arid regions of India and Africa. Pearl millet (PM) costs much less than other conventional cereals and has better nutritional value. It has high dietary fiber (2.6–4.0%) and protein content (8.5–15.1%) and contains several essential minerals like calcium, magnesium, phosphorus, sodium, potassium, zinc, copper and iron (Abdalla *et al*., 1998). Pearl millet has an excellent amino acid profile, except for a lysine deficiency (Burton *et al*., 1972). Pearl millet flour had been incorporated in various meat and egg products (Yashoda *et al*., 2008, Santhi, 2014, Santhi and Kalaikannan, 2015).

Fillers are high carbohydrate ingredients, which are primarily used in comminuted meat products with the objective of reducing the production cost without compromising the eating qualities. Of late, consumers are health conscious, and it is imperative to use nutritive ingredients as fillers in meat foods. Utilizing pearl millet as filler in meat cutlet, which is a common snack in India, will fortify the product making it more nutritious at a lower cost. Hence it would be a mode of value addition to include pearl millet in meat products for developing healthier formulations economically. Utilization of pearl millet in meat products has not been explored thoroughly, and also inclusion of few other millet varieties had been studied by some researchers.The objective of this study is to fortify the nutritive value of chicken cutlet with the addition pearl millet (*Pennisetum glaucum*) as filler and optimize its level of addition based on the physicochemical and sensory parameters.

## MATERIALS AND METHODS

### Broiler chicken meat

De-skinned boneless broiler chicken was procured from the local market. The meat was trimmed of all visible adipose and connective tissues, minced through meat mincer and stored in low-density polyethylene (LDPE) packagingat -18±2$^{o}$C for further use. The meat was used for preparation of cutlet after partial thawing at 4±1$^{o}$C for 12 to 15 h.

### Formulation and preparation of chicken cutlet

The cutlet was formulated with broiler chicken meat, spices and condiments (Table 1). Four different batches were prepared as four treatments with pearl millet replacing the meat by 0% (control), 10% (PM10), 20% (PM20) and 30% (PM30). The pearl millet was boiled with water, mashed well and added to the other ingredients to prepare the batter. The batter was moulded in to circular shapes of about 1 cm thickness and 4 cm diameter. The moulded batter was dipped

in beaten whole egg melange and enrobed with bread crumbs. The cutlet was stored at 4±1°C for 3 to 4 hours for setting. The cutlets were then deep fried in vegetable oil and subjected to physico-chemical and sensory evaluation.

**pH**

For measuring pH of the emulsion and product, 5 gm of sample was homogenized with 45 ml of distilled water by using tissue homogenizer (Polytron PT 3100, Switzerland) for about 1 minute. The pH of the homogenate was recorded by immersing combined glass electrode and temperature probe of the digital pH meter (Model 361, Systronics, India).

**Product yield**

Individual weights of each batch of cutlets before and after cooking were recorded. The product yield was calculated as below

$$Productyield = \frac{Weightofcutletaftercooking}{Rawcutletweight} X\ 100$$

**Sensory evaluation**

Semi trained sensory panel consisting of students and teaching faculty of the college evaluated the chicken cutlet. Samples were evaluated for appearance, flavor, texture, juiciness, and overall palatability using an 8- point hedonic scales (Keeton, 1983).

**Cost of Production**

The cost of production for all the treatments was calculated based on the market price of the ingredients inclusive of only the cost of raw materials and presented in Indian rupee value. The per cent cost reduction of the chicken cutlet on addition of pearl millet had been calculated.

## RESULTS AND DISCUSSION

**pH**

The pH before cooking and after cooking decreased significantly ($p \leq 0.05$) with increase in the concentration of pearl millet and was highest in control and lowest in PM30 treatment (Table 2). A similar decrease in pH was observed by incorporation of finger millet in chicken patties (Naveena *et al*., 2006) and buffalo meat slices (Siddiquia and Khanb, 2011). In concurrent with the present study, Abinayaselvi *et al*. (2016) noticed a decrease in pH when finger millet was added in chicken soup as a thickening agent. In contrast, Para and Subha (2015) found that inclusion of 20% pearl millet flour in chicken nuggets significantly caused an increase in the product pH. This might be due to the form of pearl millet used, since in this study the pearl millet was boiled with water and then added to the cutlet formulation. In view of improving the nutritional value by significantly enhancing the iron and fibre content, Patel *et al*. (2015) used finger millet (FM)as a fat replacer in ice cream at 8%, 9% and 10% levels. Corresponding to our results it was observed that the pH value decreased with increase in the FM level where 10% treatment had significantly lower pH compared to control and other treatments. The pH of raw little millet flour was found to be 5.53 (Deshmukh and Yenag, 2016). Kulkarni and Chavan (2013) explained that water logging in the roots

caused variation in pH in the finger millet plants.Hence the decrease in pH might be due to the lower pH of pearl millet.

**Product yield**

Product yield values of PM20 and PM30 were similar and significantly ($p \leq 0.05$) higher than PM10 and control where the latter two had comparable values. Similarly, addition of pearl millet improved the product yield in chicken nuggets (Para and Subha, 2015) and low fat chicken meat balls (Santhi and Kalaikannan,2015). Likewise, inclusion of oats up to 20% improved the cooking yield of low fat chicken nuggets (Santhi and Kalaikannan 2014). Product yield was improved significantly in chicken patties incorporated with finger millet up to 7.5% replacing lean meat and it was explained that finger millet had the ability to retain moisture in the matrix (Naveena *et al*., 2006). The higher yield observed in the present and previous studies might be due to the good gelation capacity of pearl millet (Oshodi *et al*., 1999).

**Sensory evaluation**

The sensory scores are presented in table 3.

*Appearance score.* In the sensory evaluation, the appearance score was not altered significantly among the control and treatments. A non-significant decrease in the appearance scores was reported in chicken nuggets (Para and Subha, 2015) and chicken meat balls (Santhi and Kalaikannan, 2015) prepared with added pearl millet. It was found that the appearance scores of pasta (Rathi*et al*., 2004a) and biscuits (Rathi*et al*., 2004b) prepared withinclusion of depigmented pearl millet had significantly higher appearance scores compared to the products prepared with the native pearl millet without depigmentation. Pathak *et al*. (2009) noticed a gradual decline in the appearance score of the patties extended with porridge flour which was attributed to the dilution of the meat pigment.In the present study, since cutlet is an enrobed product, the outer colour was not much differentiated among the treatments.

*Flavour score.* Flavour scores were significantly ($p \leq 0.05$) higher for control followed by PM10. PM30 had significantly lowest flavour score whereas PM20 was comparable with both PM10 and PM30. Yet, all the pearl millet treatments had scores above "moderately acceptable level"and the control sample treatments had scores above "very acceptable level". It is evident that the inclusion of pearl millet influences the flavour of the product. Santhi and Kalaikannan (2014) noticed that inclusion of 4% and 7% pearl millet caused a significant decrease in the flavour of low fat chicken meat balls compared to control whereas 10% pearl millet had similar flavour scores as that of control. Similarly 20% level of pearl millet added in chicken nuggets caused a non-significant decrease in the flavour score and this was attributed to the dilution of meaty flavour with increase in pearl millet level (Para and Subha, 2015). In the present study, the sensory panel members pointed out that the meat flavour was overhauled by the pearl millet flavour in PM20 and PM30 treatments.

*Texture score.* Texture scores were significantly ($p \leq 0.05$) higher for the control with which PM10 treatment was comparable.

PM20 and PM30 had significantly lower texture scores. In concurrent with the present study, it was found that chicken meat balls prepared with pearl millet up to 10% level (Santhi and Kalaikannan,2015) and chicken nuggets (Santhi and Kalaikannan, 2014) with oat flour up to 20% level had lower texture score. Para and Subha (2015) reported that the texture scores of chicken nuggets were significantly lowered by addition of pearl millet flour at 20 per cent level ascompared to control while at 10 per cent level it was comparable to control. Similarly, addition of porridge flour at 15% level in chicken patties lowered the texture scorewhich was attributed to the increased moisture retention making the product to be soft and palpable (Pathak *et al*., 2009). This decrease in the texture score might be due to the replacement of structural meat proteins by the extenders/fillers added (Verma *et al*., 1984).

*Juiciness score.* The juiciness scores significantly ($p \leq 0.05$) increased with the addition of pearl millet where all the pearl millet treatments had similar values. The control sample was least juicy with which PM10 was comparable. In previous studies with inclusion of pearl millet flour in chicken nuggets (Para and Subha, 2015) and chicken meat balls (Santhi and Kalaikannan, 2015), a decline in the juiciness scores were observed with increase in the level of pearl millet. This might be due to the form of pearl millet used. Since boiled pearl millet has been used in the present study, the moisture would have improved the juiciness of the product. In a similar study in which porridge flour was added as extender in chicken patties, Pathak *et al*. (2009) observed a decrease in juiciness scores, since the moisture retention due to the addition of porridge flour was not preferred by the sensory panelists. In the present study, since cutlet is an enrobed product with a crispy coating after deep frying, the sensory panelists would have liked the juiciness of the inner stuff brought about by the moisture, which might have imparted a good mouth-feel. *Overall acceptability score.* Overall acceptability scores significantly ($p \leq 0.05$) decreased with increase in the pearl millet level. Control had value of very acceptable level and all the scores of pearl millet incorporated treatments were above "moderately acceptable level". The score of PM10 was 6.75, almost close to the very acceptable level. In similar studies it was found that addition of pearl millet flour in chicken nuggets up to 10% level (Para and Subha, 2015) and in chicken meat balls up to 4% level (Santhi and Kalaikannan, 2015) was organoleptically acceptable, and recommended as the optimum inclusion levels.Yashoda *et al*. (2008) prepared organoleptically acceptable egg chips with incorporation of pearl millet flour. Inclusion of finger millet up to 5% level in chicken patties (Naveena *et al*., 2006), sorghum flour up to 9% level in restructured chicken meat blocks (Malav *et al*., 2013) and oat flour up to 10% in chicken nuggets (Santhi and Kalaikannan, 2014) did not significantly affect the sensory properties.

**Cost of Production**

The cost of raw cutlet and cooked cutlet is presented in table 4. The cost of production of both raw and cooked chicken cutlet decreased and the per cent cost reduction increased with increase in the level of pearl millet. It had been reported

that pearl millet is the cheapest source of energy, protein, Fe and Zn among all cereals and pulses and the cost difference is high when compared with fruits, vegetables, meat, egg, fish and dairy products (Rao *et al*., 2006).

## CONCLUSION

Varieties of fillers are still used in the meat products with the prime objective of reducing the production cost. It is imperative to use nutritional, low-cost and easily available ingredients as extenders/ fillers in the convenience meat foods. Pearl millet, which is one of the important staple food of India is a good choice to be used for this purpose. From the present study it is concluded that replacement of lean meat with pearl millet up to 10% level in chicken cutlet did not cause significant changes in the eating quality of the product and in addition there was a decrease in the production cost. Hence, it is economically beneficial to use pearl millet as effective filler in chicken cutlet up to a level of 10% without much affecting the sensory qualities.

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**Table1- Formulation of chicken cutlet with pearl millet**

| Ingredients | | Weight (g) | | | |
|---|---|---|---|---|---|
| **S. No.** | | **Control** | **PM10** | **PM20** | **PM30** |
| 1 | Deboned chicken mince | 1000 | 900 | 800 | 700 |
| 2 | Boiled pearl millet | 0 | 100 | 200 | 300 |
| 3 | Common Salt | 12 | 12 | 12 | 12 |
| 4 | Ginger | 10 | 10 | 10 | 10 |
| 5 | Garlic | 10 | 10 | 10 | 10 |
| 6 | Spice mix | 30 | 30 | 30 | 30 |
| 7 | Black pepper powder | 10 | 10 | 10 | 10 |
| | **For enrobing** | | | | |
| 8 | Beaten egg melange | 250 | 250 | 250 | 250 |
| 9 | Bread crumbs | 70 | 70 | 70 | 70 |

**Table 2- pH and Cooking yield of chicken cutlet with pearl millet**

| Parameters | Treatments | | | |
|---|---|---|---|---|
| | **Control** | **PM10** | **PM20** | **PM30** |
| pH before cooking | $6.03\pm0.05^{a}$ | $5.90\pm0.02^{b}$ | $5.80\pm0.03^{bc}$ | $5.76\pm0.01^{c}$ |
| pH after cooking | $6.16\pm0.02^{a}$ | $6.11\pm0.01^{b}$ | $6.06\pm0.01^{c}$ | $6.01\pm0.01^{d}$ |
| Cooking yield | $80.10\pm1.08^{b}$ | $80.57\pm1.09^{b}$ | $84.95\pm0.67^{a}$ | $84.71\pm1.03^{a}$ |

a–d Means in a same row with different letters are significantly different ($p\leq0.05$)

**Table 3 - Sensory qualities of chicken cutlet with pearl millet**

| **Parameters** | Control | **PM10** | **PM20** | **PM30** |
|---|---|---|---|---|
| Appearance | 7.24±0.13 | 7.25±0.13 | 7.15±0.17 | 7.18±0.10 |
| Flavour | 7.21±0.10$^{a}$ | 6.79±0.15$^{b}$ | 6.54±0.12$^{bc}$ | 6.39±0.13$^{c}$ |
| Texture | 7.04±0.11$^{a}$ | 6.86±0.16$^{ab}$ | 6.50±0.12$^{b}$ | 6.43±0.18$^{b}$ |
| Juiciness | 6.04±0.18$^{b}$ | 6.50±0.14$^{ab}$ | 6.61±0.16$^{a}$ | 6.64±0.22$^{a}$ |
| Overall Acceptability | 7.07±0.05$^{a}$ | 6.75±0.10$^{b}$ | 6.43±0.10$^{c}$ | 6.14±0.10$^{d}$ |

a–d Means in a same row with different letters are significantly different ($p \leq 0.05$)

**Table 4 – Cost of production (Rs) of chicken cutlet with pearl millet**

| Product type | **Control** | **PM10** | | **PM20** | | **PM30** | |
|---|---|---|---|---|---|---|---|
| | **Cost (Rs)** | **Cost (Rs)** | **PCR** | **Cost (Rs)** | **PCR** | **Cost (Rs)** | PCR |
| Raw cutlet | 258.28 | 236.12 | 8.58 | 213.96 | 17.16 | 191.8 | 25.74 |
| Cooked cutlet | 312.45 | 280.71 | 10.16 | 236.72 | 24.24 | 211.21 | 32.40 |

PCR- Per cent cost reduction

# EFFECT OF INCORPORATION OF FERMENTED BAMBOO SHOOT, BEET ROOT AND CABBAGE ON THE QUALITIES OF CHICKEN NUGGETS UNDER FROZEN STORAGE

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## ABSTRACT

Chicken nuggets prepared from spent hens' meat by incorporating fermented bamboo shoots at 10 per cent, beet root at 10per cent and cabbage at 15per cent levels were evaluated for different physicochemical, microbial and sensory qualities under frozen (-18±1°C) storage condition. The $p^H$of all nuggets increased significantly ($P<0.05$) during the storage period. The hardness, redness (a*), yellowness (b*) and chromavalues of all the nuggets decreased significantly ($P<0.05$) during storage period. The ΔE values of all the nuggets increased during storage period. There was no growth of microorganisms in all the nuggets during the period. The beet root incorporated nuggets recorded better sensory qualities compared to other nuggets in the study under frozen (-18±1°C) storage up to 90 days.

**Key Words:** Nugget; physicochemical; sensory; microbial quality.

## INTRODUCTION

The consumption of poultry meat and meat products is increasing all over the world (Mielnik *et al.* 2002). Chicken nuggets, which areusually acceptable and can be prepared suitably and economically by using the tough and fibrous meat of spent chickens (Das *et al.*2013). However, adequate amount of dietary fibers are not commonly available in meat products. Therefore, incorporation of vegetables containing good amount of dietary fibers will help in better digestibility and improvement of health status of the consumers. Moreover, the value addition of these meat products with some low cost vegetables can help in better utilization of spent hens and also improves its functionality. Besides health benefit effects, dietary fiber incorporation alsoincreases the bulk and prevent cooking loss in meat products by enhancing water binding capabilities and great economic advantages for both the consumers and processors (Grigelmo- Miguel *et al.*1999). Bamboo shoots are potent antioxidant (Singhal*et al.* 2013), low in calories, high in dietary fiber (Nirmala *et al.* 2008). Beet roots are very good source of dietary fiber and contain natural antioxidants like polyphenols and betalains. *Brassica* foods are very nutritive, providing nutrients and health promoting phytochemicals such as vitamins, carotenoids, fiber (Vasanthi *et al.* 2009) and help to reduce fat and controls cholesterol level. Therefore, the

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present study was undertaken to study the effect of incorporation of selected levels of fermented bamboo shoot, beet root and cabbage on the physicochemical, microbial and sensory qualities of chicken nuggets kept under frozen (-18±1°C) storage.

## MATERIALS AND METHODS

### Source of raw materials

Spent hens for the experiment were procured from the poultry farm of ICAR Research Complex for NEH Region and slaughtered as per standard procedures, deboned manually, removed the connective tissues and stored at (-18±1°C) till further processing. Binders, fillers, vegetables, refined oil, condiments and spices used were purchased from the local market. Chemicals were purchased from standard firms.

### Preparation of vegetable paste

Fermented bamboo shoots were chopped into small pieces and washed in clean water to remove excessive sourness and then grinded to fine paste in a domestic grinder. The skin of raw beet roots were peeled off and then washed and cut into small cubes and grinded to fine paste in a domestic grinder. Raw cabbages were washed and cut into small pieces and then grinded to fine paste in the same manner.

### Preparation of condiments and spice mix

Condiments were prepared by making a fine paste of onion, garlic and ginger in the ratio of 3:2:1. Spices were purchased from local market, removed the extraneous materials and dried in an oven at 60°C overnight and then ground to fine powder and were mixed in required proportion to obtain the spice mix. The spice mix formula used was red chilli powder- 12.5%, white peppercorn-50%, cardamom-12.5%, cinnamon-12.5% and clove-12.5%.

### Preparation of experimental chicken nuggets

The frozen meat was thawed and cut into small cubes and then minced in a meat mincer of 6mm plate. The formulation of meat emulsions for preparationof chicken nuggets are presented in Table 1. The meat emulsions were filled in aluminum moulds and then pressure cooked at 121°C at 20 psi for 20 minutes. The cooked nuggets were cooled, chilled and then cut into uniform size of 4 x 1.5 x 1.5 cm each, packed in LDPE bags and stored at (-18±1°C) for evaluating the physicochemical, microbial and sensory qualities on different days of storage viz. $15^{th}$, $30^{th}$, $45^{th}$, $60^{th}$, $75^{th}$ and $90^{th}$ day. Three batches of such chicken nuggets were prepared and evaluated for the study.

### Parameters evaluated

The $p^H$ of the samples were determined as per the method described by Trout *et al.*(1992) using a digital pH meter (pH/ Ion 510, Eutech Instruments). Texture profile analysis (TPA) was conducted using a Stable Micro System TA-XT2 texture analyzer (Texture Technologies Corp., UK) as per Sirisomboon*et al.* (2000) with a slight modification i.e., instead of 30 mm distance, it was set at 10 mm. The texture qualities of chicken nuggets in terms of hardness were measured using TA-XT2 texture analyzer fitted with a 75 mm flat cutting blade probe. Hardness values were considered as mean peak cutting force and expressed in kg and conducted at a pretest speed of 1.0 mm/s,

test speed of 0.5 mm/s, distance of 10 mm, and load cell of 50.0 kg. The color of chicken nuggets during initial and storage period was measured using Hunter L, a, b color measuring system (Color Quest XE model) and estimated as Hunter value L, a and b where 'a' ('+' value indicated redness and '–' value indicated greenness), 'b' ('+' value indicated yellowness and '–' value indicated blueness) and 'L' (varies from 0 to 100 where '100' indicated white and '0' indicated black), hue angle, chroma value and total color difference (ΔE) were calculated to study color evolution. Samples from three different places of nuggets were taken in the sample holder and secured against the viewing aperture. Hunter color difference (ΔE) was calculated from the equation, $\Delta E = (\Delta L2 + \Delta a2 + \Delta b2)^{1/2}$ using initial color values of chicken nuggets as reference, hue angle = tan-1 (b/a) and chroma value = (a2+b2)1/2.

The samples were analyzed microbiologically as per APHA (1990) for standard plate count (SPC), psychrotropic count (PTC), total coliform count (TCC), *Staphylococcus aureus* count and yeast and mould counts. Readymade media from Hi-media laboratories (P) Ltd., Mumbai, were used for the enumeration of different microbes. Duplicate plates were prepared and the counts were expressed as colony forming units (CFU) per gram.

Sensory evaluation was conducted by nine member semi trained panelists using a 7 point descriptive scale, where, 7=extremely desirable and 1=extremely undesirable (Keeton 1983).

Data were interpreted by analysis of variance (ANOVA) with Duncan's Multiple Test Range on SPSS 16.0 software packages as per standard methods (Snedecor and Cochran 1994).

## RESULTS AND DISCUSSION

The $p^H$ of all nuggets increased significantly ($P<0.01$) during frozen storage period (Table 2). On 15$^{th}$day, the highest pH was recorded in beet root incorporated nuggets (6.14±0.03) while the lowest pH was recorded in fermented bamboo shoot incorporated nuggets (5.94±0.03) which increased to 6.28±0.01 and 6.08±0.02 respectively on 90$^{th}$ day. The lower pH in fermented bamboo shoot incorporated nuggets might be due to the acidic property of fermented bamboo shoot and also due to the accumulation of nitrogenous substances consequence to the protein breakdown (Das *et al.*2013). Kumar and Tanwar (2011) also reported an increase in pH of meat products with increasing storage time.

Texture profiling in terms of hardness, significantly ($P<0.01$) differed between the treatment groups but no significant ($P>0.05$) variation was observed on different storage days (Table 2). The hardness value of all nuggets decreased with the advancing storage period with maximum overall hardness value in control nuggets (0.52±0.01) and minimum value in cabbage incorporated nuggets (0.27±0.01). Saleh and Ahmed (1998) reported that the hardness of beef patties extended with carrot and sweet potato decreased due to reduction in friction and binding among the meat particles. Devatkal*et al.*(2004) and Yi *et al.*(2012) also reported lower hardness

values in vegetable and flour incorporated meat products compared to control products.

Beet root incorporated nuggets recorded higher redness (a*) value than the other nuggets (Table 3). Higher a* value of beet root incorporated nuggets could be attributed to betalain pigment present in beet root which gave a characteristic red color to the beet root incorporated nuggets. Devatkal*et al.*(2008) reported that carrots incorporated in nuggets and buffalo meat loaves had significantly ($P<0.05$) higher a* value than control nuggets. Our findings for beet root incorporated nuggets were also similar to the above studies. However, the cabbage and fermented bamboo shoot incorporated nuggets showed lower a* values which could be due to dilution of the myofibrilar protein that reduced a* value. In agreement with the present findings, Kumar *et al.*(2010) also reported that control nuggets were darker (higher a* value) than nuggets treated with green banana and soybean hulls flour. Significant ($P<0.05$) decrease in a* value of fermented bamboo shoot and beet root incorporated nuggets was observed during storage which might be due to bleaching of the nuggets. Mean yellowness (b* value) was higher for beet root treated nuggets and lower for fermented bamboo shoot and cabbage incorporated nuggets. Our results were in agreement with findings of Kumar *et al.*(2010) who reported that nuggets treated with green banana and soyabean hulls flour were comparable with control in terms of yellowness (b* value). Reitmer and Prusa (1991) also investigated the addition of corn germ protein to raw pork and found that the degree of redness increased but lightness and yellowness of the product decreased. Significant ($P<0.05$) increase in $\Delta E$ value with advancing storage period was observed in control nuggets (Table 3.). The highest mean $\Delta E$ value (3.08±0.35) was recorded on 90$^{th}$day and lowest (2.54±0.42) on 60$^{th}$day of frozen storage.The highest hue angle value was recorded in fermented bamboo shoot incorporated nuggets (80.48±0.12) while the lowest value was recorded in beet root incorporated nuggets (63.44±0.25). Hue angle value increased from 15$^{th}$day till 90$^{th}$day of frozen storage, except in beet root incorporated nuggets, where the hue angle value decreased from 65.48 to 63.44 from 15$^{th}$ to 90$^{th}$day. The highest chroma value was recorded in beet root incorporated nuggets (16.94±0.12) while least chroma value was recorded for fermented bamboo shoot incorporated nuggets (14.19±0.07). There was a significant ($P<0.05$) decrease in the chroma value on storage.

No growth of microorganisms were observed in all the nuggets which could be attributed to proper care and handling during processing and heat treatment, as it was pressure cooked at 20 psi for 20 minutes at 121°C and subsequent frozen (-18±1°C) storage. The absence of coliforms and *Staphylococcus aureus* might be indicative of good hygiene practices which were in conformity with the findings of Nath *et al.* (1995) in chicken patties and Sudheer*et al.* (2011) in restructured chicken blocks.

The results of different sensory parameters evaluated have been presented in Table 4.The highest mean color score was recorded in beet root and the least in fermented bamboo shoot incorporated nuggets. The higher color scores in beet root incorporated nuggets might be due

to the red betalain pigment (Pravel 2012) present in the beet root which gave a characteristic red color, thereby giving beet root incorporated nuggets higher color scores. Lower color scores in fermented bamboo shoot incorporated nuggets might be attributed to the whitish color of bamboo shoots.Highest flavor scores were recorded in beet root incorporated nuggets (5.65±0.07) followed by control nuggets (5.48±0.07), fermented bamboo shoot incorporated nuggets (5.19±0.09) while cabbage incorporated nuggets recorded the least scores (5.06±0.08). Our results showed that fermented bamboo shoot incorporated and cabbage incorporated nuggets had lower flavor scores than control and beet root incorporated nuggets. However, the flavor scores improved with advancement of frozen storage period, more significantly ($P \leq 0.05$) in fermented bamboo shoot incorporated nuggets. Sudheer*et al.*(2011) found that the flavor scores of low fat restructured chicken block incorporated with gizzard were significantly higher than control samples on frozen storage (-18±1°C).The highest mean juiciness score was recorded in beet root incorporated nuggets, followed by fermented bamboo shoot, control and cabbage incorporated nuggets. Das *et al.*(2013) reported that the juiciness score of fermented bamboo shoot incorporated nuggetsand control nuggets decreased on advancement of storage. Eyas (2001) indicated that decrease juiciness might be due to loss of moisture from the product during storage, as LDPE packages were permeable to water vapour. However, in contrast to the findings of Das *et al.* (2013), there was an improvement in the juiciness scores of fermented bamboo shoot incorporatednuggets and control nuggets on frozen storage till 90 days which could be due to difference in the storage temperature and packaging materials. Sink and Hsu (1979) also reported that storage time had little effect on the sensory attributes of frankfurters.Overall, beet root incorporated nuggets recorded significantly ($P<0.05$) higher texture scores while cabbage incorporated nuggets recorded the least texture scores (Table 4). Das *et al.*(2013) observed that the texture scores were significantly ($P<0.01$) higher in fermented bamboo shoot incorporated nuggets than control nuggets which might be due to the dietary fiber content of fermented bamboo shoot (Nirmala *et al.*2011) and also contributed in better emulsion formation (Talukdar and Sharma 2010) resulting improvement in texture. However, our findings were in contrast with Das *et al.*(2013) as the texture scores in fermented bamboo shoot and cabbage incorporated nuggets were lower than control nuggets. The mean overall acceptability score was highest for beet root incorporated nuggets (5.90±0.06) while fermented bamboo shoot and cabbage incorporated nuggets were lower than control although within the acceptable range of scores. It was observed that beet root incorporated nuggets recorded better sensory attributescores than control and other nuggets.

The findings of the present study revealed that functional chicken nuggets could be prepared by incorporating 10 per cent beet root, 10 per cent fermented bamboo shoots and 15 per cent cabbage and stored safely up to 90 days under frozen (-18±1°C) temperature. Moreover, based on the different physicochemical, microbial

and sensory quality parameters, 10 per cent beet root incorporated nugget was found to be the most suitable in the development of functional chicken nuggets.

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**Table 1: Formulation of meat emulsions for preparation of chicken nuggets**

| Ingredients | T1 | T2 | T3 | T4 |
|---|---|---|---|---|
| Lean meat | 77.50 | 67.50 | 67.50 | 62.50 |
| Refined wheat flour | 5.00 | 5.00 | 5.00 | 5.00 |
| Refined oil | 5.00 | 5.00 | 5.00 | 5.00 |
| Added fat | 2.00 | 2.00 | 2.00 | 2.00 |
| Ice cubes | 5.00 | 5.00 | 5.00 | 5.00 |
| Condiments mix | 3.50 | 3.50 | 3.50 | 3.50 |
| Spice mix | 0.45 | 0.45 | 0.45 | 0.45 |
| Salt | 1.50 | 1.50 | 1.50 | 1.50 |
| Sodium benzoate | 0.05 | 0.05 | 0.05 | 0.05 |
| FBS | - | 10.00 | - | - |
| BR | - | - | 10.00 | - |
| CB | - | - | - | 15.00 |
| **Total** | **100.00** | **100.00** | **100.00** | **100.00** |

T1 – Control, T2 – Fermented Bamboo Shoot (FBS), T3 – Beet root (BR), T4 – Cabbage (CB)

**Table 2: $p^H$ and hardness of chicken nuggets kept under frozen storage period (-18±1°C)**

| Treatment/ Parameters | Storage Period(Days) | | | | | | Treatment mean ±SE |
|---|---|---|---|---|---|---|---|
| | 15 | 30 | 45 | 60 | 75 | 90 | |
| **$p^H$** | | | | | | | |
| T1(Control) | $6.13\pm0.04^{Da}$ | $6.16\pm0.03^{CDa}$ | $6.21\pm0.02^{BCa}$ | $6.24\pm0.01^{ABa}$ | $6.28\pm0.01^{ABa}$ | $6.30\pm0.01^{Aa}$ | **$6.22\pm0.01^{p}$** |
| T2(FBS) | $5.94\pm0.03^{Bb}$ | $5.97\pm0.05^{Bb}$ | $5.99\pm0.03^{ABb}$ | $6.00\pm0.01^{ABc}$ | $6.03\pm0.01^{ABc}$ | $6.08\pm0.02^{Ac}$ | **$6.00\pm0.01^{q}$** |
| T3(BR) | $6.14\pm0.03^{Da}$ | $6.16\pm0.04^{CDa}$ | $6.20\pm0.02^{BCDa}$ | $6.23\pm0.01^{ABCa}$ | $6.26\pm0.01^{ABa}$ | $6.28\pm0.01^{Aab}$ | **$6.21\pm0.01^{p}$** |
| T4(CB) | $6.12\pm0.03^{Ba}$ | $6.13\pm0.03^{Ba}$ | $6.18\pm0.03^{ABa}$ | $6.19\pm0.01^{ABb}$ | $6.21\pm0.01^{Ab}$ | $6.24\pm0.01^{Ab}$ | **$6.18\pm0.01^{pq}$** |
| **Day mean ±SE** | **$6.08\pm0.02^{S}$** | **$6.11\pm0.02^{RS}$** | **$6.15\pm0.02^{QR}$** | **$6.16\pm0.02^{QR}$** | **$6.19\pm0.02^{PQ}$** | **$6.22\pm0.02^{P}$** | |
| **Hardness (kgf)** | | | | | | | |
| T1(Control) | $0.56\pm0.03^{a}$ | $0.55\pm0.01^{a}$ | $0.53\pm0.01^{a}$ | $0.51\pm0.02^{a}$ | $0.50\pm0.05^{a}$ | $0.49\pm0.01^{a}$ | **$0.52\pm0.01^{p}$** |
| T2(FBS) | $0.42\pm0.03^{Ab}$ | $0.38\pm0.02^{ABbc}$ | $0.37\pm0.04^{ABbc}$ | $0.35\pm0.01^{ABc}$ | $0.34\pm0.01^{Bb}$ | $0.33\pm0.01^{Bc}$ | **$0.36\pm0.01^{q}$** |
| T3(BR) | $0.42\pm0.02^{b}$ | $0.41\pm0.04^{b}$ | $0.41\pm0.02^{b}$ | $0.39\pm0.01^{b}$ | $0.36\pm0.01^{b}$ | $0.36\pm0.01^{b}$ | **$0.39\pm0.01^{q}$** |
| T4(CB) | $0.30\pm0.03^{c}$ | $0.30\pm0.04^{c}$ | $0.29\pm0.03^{c}$ | $0.26\pm0.01^{d}$ | $0.25\pm0.01^{c}$ | $0.23\pm0.01^{d}$ | **$0.27\pm0.01^{r}$** |
| **Day mean±SE** | **0.42±0.02** | **0.42±0.02** | **0.40±0.02** | **0.38±0.02** | **0.36±0.02** | **0.35±0.02** | |

Means with different superscripts in small letter in each column and capital letters in each row differ significantly ($P<0.05$)

**Table 3: Color of chicken nuggets kept under frozen storage (-18±1°C)**

| Treatment/ Parameters | Storage Period(Days) | | | | | | Treatment mean ±SE |
|---|---|---|---|---|---|---|---|
| | 15 | 30 | 45 | 60 | 75 | 90 | |
| **Redness(a*)** | | | | | | | |
| T1 | 2.72±0.23$^{b}$ | 2.55±0.08$^{b}$ | 2.48±0.12$^{b}$ | 2.67±0.13$^{b}$ | 2.45±0.08$^{b}$ | 2.31±0.09$^{bc}$ | **2.53±0.06$^{q}$** |
| T2 | 2.55±0.11$^{Ab}$ | 2.38±0.07$^{ABCb}$ | 2.43±0.07$^{ABb}$ | 2.31±0.05$^{BCc}$ | 2.24±0.04$^{BCb}$ | 2.17±0.05$^{Cc}$ | **2.35±0.03$^{r}$** |
| T3 | 7.60±0.16$^{ABa}$ | 7.85±0.09$^{Aa}$ | 7.62±0.12$^{ABa}$ | 7.52±0.12$^{ABa}$ | 7.38±0.09$^{Ba}$ | 7.35±0.07$^{Ba}$ | **7.55±0.05$^{p}$** |
| T4 | 2.62±0.10$^{b}$ | 2.59±0.16$^{b}$ | 2.52±0.13$^{b}$ | 2.48±0.13$^{bc}$ | 2.44±0.05$^{b}$ | 2.41±0.04$^{b}$ | **2.51±0.04$^{q}$** |
| **Day mean±SE** | **3.87±0.37$^{P}$** | **3.84±0.39$^{PQ}$** | **3.76±0.38$^{Q}$** | **3.75±0.37$^{Q}$** | **3.63±0.37$^{QR}$** | **3.56±0.37$^{R}$** | |
| **Yellowness(b*)** | | | | | | | |
| T1 | 13.95±0.13$^{b}$ | 14.49±0.14$^{a}$ | 14.29±0.34$^{b}$ | 14.30±0.25$^{b}$ | 14.14±0.15$^{b}$ | 13.98±0.06$^{b}$ | **14.19±0.08$^{q}$** |
| T2 | 14.13±0.13$^{ABb}$ | 13.76±0.30$^{Bb}$ | 14.33±0.08$^{Ab}$ | 14.04±0.13$^{ABb}$ | 13.96±0.10$^{ABb}$ | 13.73±0.10$^{Bb}$ | **13.99±0.07$^{r}$** |
| T3 | 16.65±0.18$^{Aa}$ | 14.51±0.21$^{Ba}$ | 15.18±0.26$^{Ba}$ | 15.02±0.34$^{Ba}$ | 14.97±0.06$^{Ba}$ | 14.58±0.16$^{Ba}$ | **15.15±0.13$^{p}$** |
| T4 | 14.04±0.13$^{b}$ | 14.00±0.15$^{ab}$ | 14.13±0.14$^{b}$ | 13.96±0.19$^{b}$ | 13.90±0.14$^{b}$ | 13.82±0.10$^{b}$ | **13.98±0.06$^{r}$** |
| **Day mean±SE** | **14.69±0.20$^{P}$** | **14.19±0.11$^{QR}$** | **14.48±0.13$^{PQ}$** | **14.33±0.14$^{Q}$** | **14.24±0.09$^{QR}$** | **14.03±0.08$^{R}$** | |
| **ΔE** | | | | | | | |
| T1 | 0.00±0.00 | 1.71±0.25$^{Bb}$ | 2.26±0.56$^{AB}$ | 2.03±0.30$^{AB}$ | 2.25±0.17$^{ABb}$ | 2.87±0.30$^{Aab}$ | **1.85±0.17$^{r}$** |
| T2 | 0.00±0.00 | 1.93±0.35$^{b}$ | 2.70±0.81 | 2.43±0.32 | 2.76±0.29$^{b}$ | 3.06±0.17$^{ab}$ | **2.15±0.21$^{q}$** |
| T3 | 0.00±0.00 | 3.24±0.39$^{ab}$ | 2.39±0.51 | 2.79±0.44 | 2.18±0.24$^{b}$ | 2.43±0.32$^{b}$ | **2.17±0.20$^{r}$** |
| T4 | 0.00±0.00 | 3.80±0.88$^{a}$ | 3.60±1.04 | 2.92±0.64 | 3.93±0.55$^{a}$ | 3.98±0.60$^{a}$ | **3.04±0.33$^{p}$** |
| **Day mean±SE** | 0.00±0.00 | **2.67±0.47$^{PQ}$** | **2.74±0.61$^{R}$** | **2.54±0.42$^{PQ}$** | **2.78±0.31$^{PQ}$** | **3.08±0.35$^{P}$** | |
| **Hue angle** | | | | | | | |
| T1 | 79.06±0.82$^{a}$ | 80.00±0.32$^{a}$ | 80.07±0.61$^{a}$ | 79.44±0.47$^{a}$ | 80.18±0.31$^{ab}$ | 80.61±0.37$^{a}$ | **79.89±0.21$^{pq}$** |
| T2 | 79.77±0.39$^{Ba}$ | 80.17±0.31$^{ABa}$ | 80.38±0.25$^{ABa}$ | 80.66±0.21$^{Aa}$ | 80.87±0.17$^{Aa}$ | 81.00±0.20$^{Aa}$ | **80.48±0.12$^{p}$** |
| T3 | 65.48±0.40$^{Ab}$ | 61.56±0.53$^{Cb}$ | 63.31±0.61$^{Bb}$ | 63.32±0.67$^{Bb}$ | 63.75±0.24$^{Bc}$ | 63.25±0.35$^{Bb}$ | **63.44±0.25$^{r}$** |
| T4 | 79.45±0.34$^{a}$ | 79.57±0.58$^{a}$ | 79.89±0.54$^{a}$ | 79.93±0.46$^{a}$ | 80.05±0.23$^{b}$ | 80.10±0.24$^{a}$ | **79.83±0.17$^{pq}$** |
| **Day mean±SE** | **75.94±1.05$^{Q}$** | **75.33±1.36$^{R}$** | **75.91±1.26$^{Q}$** | **75.83±1.25$^{QR}$** | **76.21±1.22$^{P}$** | **76.24±1.28$^{P}$** | |
| **Chroma value** | | | | | | | |
| T1 | 14.22±0.17$^{b}$ | 14.71±0.15$^{b}$ | 14.51±0.32$^{b}$ | 14.55±0.26$^{b}$ | 14.35±0.15$^{b}$ | 14.17±0.06$^{b}$ | **14.42±0.08$^{q}$** |
| T2 | 14.36±0.14$^{ABb}$ | 13.97±0.29$^{Bc}$ | 14.53±0.08$^{Ab}$ | 14.23±0.13$^{ABb}$ | 14.14±0.10$^{ABb}$ | 13.91±0.10$^{Bb}$ | **14.19±0.07$^{r}$** |
| T3 | 18.30±0.21$^{Aa}$ | 16.51±0.17$^{BCa}$ | 16.99±0.22$^{Ba}$ | 16.81±0.31$^{BCa}$ | 16.69±0.09$^{BCa}$ | 16.33±0.15$^{Ca}$ | **16.94±0.12$^{p}$** |
| T4 | 14.29±0.14$^{b}$ | 14.25±0.17$^{bc}$ | 14.36±0.13$^{b}$ | 14.18±0.20$^{b}$ | 14.11±0.14$^{b}$ | 14.03±0.10$^{b}$ | **14.20±0.06$^{r}$** |
| **Day mean±SE** | **15.29±0.30$^{P}$** | **14.86±0.19$^{Q}$** | **15.10±0.21$^{PQ}$** | **14.94±0.21$^{Q}$** | **14.82±0.19$^{Q}$** | **14.61±0.18$^{R}$** | |

Means with different superscripts in small letter in each column and capital letters in each row differ significantly (P<0.05)

**Table 4: Sensory qualities of chicken nuggets kept under frozen storage period (-18±1°C)**

| Treatment/ Parameters | Storage period(days) | | | | | | Treatment mean ± SE |
|---|---|---|---|---|---|---|---|
| | 15 | 30 | 45 | 60 | 75 | 90 | |
| **Colour** | | | | | | | |
| T1 | 5.07±0.18$^{Cb}$ | 4.93±0.18$^{Cb}$ | 5.07±0.17$^{Cb}$ | 5.15±0.13$^{BCb}$ | 5.67±0.17$^{Aa}$ | 5.59±0.13$^{ABab}$ | **5.25±0.07$^{q}$** |
| T2 | 4.93±0.16$^{ABb}$ | 4.74±0.20$^{Bb}$ | 4.93±0.17$^{ABb}$ | 5.15±0.17$^{ABb}$ | 5.07±0.20$^{ABb}$ | 5.33±0.13$^{Ab}$ | **5.02±0.07$^{r}$** |
| T3 | 6.19±0.14$^{ABa}$ | 6.22±0.16$^{ABa}$ | 6.00±0.12$^{ABa}$ | 6.37±0.13$^{Aa}$ | 5.96±0.17$^{ABa}$ | 5.78±0.13$^{Ba}$ | **6.09±0.06$^{p}$** |
| T4 | 5.22±0.19$^{b}$ | 4.96±0.20$^{b}$ | 4.85±0.17$^{b}$ | 5.26±0.19$^{b}$ | 5.11±0.16$^{b}$ | 5.26±0.14$^{b}$ | **5.11±0.07$^{r}$** |
| **Day mean ± SE** | **5.35±0.10$^{Q}$** | **5.21±0.11$^{R}$** | **5.21±0.09$^{R}$** | **5.48±0.09$^{P}$** | **5.45±0.09$^{PQ}$** | **5.49±0.07$^{P}$** | |
| **Flavor** | | | | | | | |
| T1 | 5.48±0.19$^{ABC}$ | 5.19±0.19$^{Cab}$ | 5.15±0.20$^{Ca}$ | 5.30±0.16$^{BCb}$ | 5.78±0.15$^{ABa}$ | 5.96±0.10$^{Aa}$ | **5.48±0.07$^{pq}$** |
| T2 | 5.04±0.25$^{BC}$ | 5.04±0.21$^{BCab}$ | 4.56±0.23$^{Cb}$ | 5.30±0.18$^{ABb}$ | 5.48±0.20$^{ABab}$ | 5.70±0.18$^{Aa}$ | **5.19±0.09$^{qr}$** |
| T3 | 5.56±0.22 | 5.63±0.15$^{a}$ | 5.52±0.14$^{a}$ | 5.89±0.14$^{a}$ | 5.78±0.18$^{a}$ | 5.56±0.19$^{ab}$ | **5.65±0.07$^{p}$** |
| T4 | 4.96±0.24 | 4.85±0.24$^{b}$ | 5.07±0.20$^{ab}$ | 5.22±0.15$^{b}$ | 5.07±0.21$^{b}$ | 5.19±0.14$^{b}$ | **5.06±0.08$^{r}$** |
| **Day mean ± SE** | **5.26±0.11$^{QR}$** | **5.18±0.10$^{R}$** | **5.07±0.10$^{R}$** | **5.43±0.08$^{Q}$** | **5.53±0.10$^{PQ}$** | **5.60±0.08$^{P}$** | |
| **Juiciness** | | | | | | | |
| T1 | 5.48±0.17$^{AB}$ | 4.59±0.19$^{Db}$ | 4.85±0.19$^{CD}$ | 5.19±0.15$^{BCb}$ | 5.44±0.17$^{AB}$ | 5.89±0.13$^{Aa}$ | **5.24±0.08$^{r}$** |
| T2 | 5.07±0.24 | 5.07±0.18$^{b}$ | 5.15±0.16 | 5.52±0.15$^{ab}$ | 5.44±0.17 | 5.63±0.15$^{ab}$ | **5.31±0.07$^{q}$** |
| T3 | 5.63±0.17 | 5.67±0.17$^{a}$ | 5.00±0.18 | 5.85±0.18$^{a}$ | 5.81±0.13 | 5.96±0.19$^{a}$ | **5.65±0.07$^{p}$** |
| T4 | 5.30±0.23 | 4.96±0.20$^{b}$ | 5.04±0.18 | 5.26±0.17$^{b}$ | 5.41±0.18 | 5.26±0.14$^{b}$ | **5.20±0.07$^{r}$** |
| **Day mean± SE** | **5.37±0.10$^{R}$** | **5.07±0.10$^{S}$** | **5.01±0.09$^{S}$** | **5.45±0.08$^{QR}$** | **5.53±0.08$^{Q}$** | **5.69±0.08$^{P}$** | |
| **Texture** | | | | | | | |
| T1 | 5.30±0.19$^{BCb}$ | 5.19±0.20$^{Cb}$ | 5.52±0.18$^{ABCab}$ | 5.26±0.13$^{Cb}$ | 5.78±0.13$^{ABa}$ | 5.89±0.13$^{Aa}$ | **5.49±0.07$^{q}$** |
| T2 | 5.41±0.19$^{ABab}$ | 4.70±0.17$^{Cb}$ | 5.19±0.16$^{Bb}$ | 5.33±0.14$^{ABb}$ | 5.33±0.13$^{ABb}$ | 5.74±0.11$^{Aa}$ | **5.28±0.07$^{qr}$** |
| T3 | 5.89±0.16$^{a}$ | 5.74±0.15$^{a}$ | 5.70±0.13$^{a}$ | 6.07±0.18$^{a}$ | 5.81±0.13$^{a}$ | 6.00±0.11$^{a}$ | **5.87±0.06$^{p}$** |
| T4 | 4.96±0.22$^{ABb}$ | 4.81±0.23$^{Bb}$ | 5.22±0.18$^{ABab}$ | 5.41±0.13$^{Ab}$ | 5.30±0.18$^{ABb}$ | 5.00±0.11$^{ABb}$ | **5.12±0.07$^{r}$** |
| **Day mean ± SE** | **5.39±0.10$^{QR}$** | **5.11±0.10$^{R}$** | **5.41±0.08$^{QR}$** | **5.52±0.08$^{PQ}$** | **5.56±0.08$^{PQ}$** | **5.66±0.07$^{P}$** | |
| **Overall acceptability** | | | | | | | |
| T1 | 5.41±0.16$^{ABCb}$ | 5.00±0.16$^{Cb}$ | 5.33±0.15$^{BCab}$ | 5.15±0.13$^{Cb}$ | 5.81±0.15$^{Aa}$ | 5.74±0.11$^{ABab}$ | **5.41±0.06$^{q}$** |
| T2 | 5.11±0.19$^{BCb}$ | 4.81±0.18$^{Cb}$ | 5.00±0.21$^{BCb}$ | 5.41±0.19$^{ABb}$ | 5.52±0.15$^{ABab}$ | 5.70±0.16$^{Aab}$ | **5.26±0.08$^{r}$** |
| T3 | 5.89±0.17$^{a}$ | 5.93±0.12$^{a}$ | 5.67±0.13$^{a}$ | 6.07±0.13$^{a}$ | 5.96±0.14$^{a}$ | 5.89±0.16$^{a}$ | **5.90±0.06$^{p}$** |
| T4 | 5.26±0.15$^{b}$ | 4.93±0.18$^{b}$ | 5.22±0.17$^{ab}$ | 5.37±0.16$^{b}$ | 5.26±0.19$^{b}$ | 5.33±0.12= | **5.23±0.07$^{r}$** |
| **Day mean± SE** | **5.42±0.09$^{Q}$** | **5.17±0.09$^{R}$** | **5.31±0.09$^{QR}$** | **5.50±0.08$^{Q}$** | **5.64±0.08$^{P}$** | **5.67±0.07$^{P}$** | |

Means with different superscripts in small letter in each column and capital letters in each row differ significantly (P<0.05)

# EFFECT OF AGE ON CARCASS, MEAT QUALITY CHARACTERISTICS AND NUTRITIONAL COMPOSITION OF NANDANAM TURKEY-II MEAT

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## ABSTRACT

The study was conducted to find out the effect of age on carcass, meat quality characteristics and nutritional composition of Nandanam Turkey-II. Totally twelve birds were separated into two different age groups *viz.,* young (20 weeks) and adult (40 weeks). The birds were slaughtered and breast muscle was obtained. The carcass, meat quality characters, proximate composition, amino acid, fatty acid and cholesterol content of meat of two age groups were analysed. The carcass characteristics *viz.,* edible offal weight, in-edible offal, blood weight, feather weight and head weight had significant difference ($P<0.01$) between two age groups. Meat quality characteristics *viz.,* pH ($P<0.05$), muscle fibre diameter ($P<0.01$) and myofibrillar fragmentation index ($P<0.01$) of young turkey meat were significantly lower than adult turkey meat. The young turkey meat had significantly higher moisture content ($P<0.01$), while it showed significantly lower protein, fat and total ash content than adult turkey meat. The significant difference ($P<0.05$) was observed in lysine and phenylalanine and highly significant difference ($P<0.01$) was observed in arginine, isoleucine, threonine, valine, alanine, aspartic acid, glutamic acid and glycine contents of meat from young and adult age groups of turkey. The meat of young turkey had significantly lower total saturated fatty acids ($P<0.01$), mono unsaturated fatty acids ($P<0.05$) and higher poly unsaturated fatty acids ($P<0.01$), P/S ratio when compared to adult turkey meat. The cholesterol content of young turkey meat was significantly ($P<0.01$) lower than adult turkey meat. Based on the results it was concluded that the meat of young Nandanam Turkey-II had the superior meat quality characters and nutritional composition than the meat of adult birds.

**Key words:** Meat quality characteristics, Nandanam Turkey-II meat, amino acid, fatty acids, cholesterol.

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This manuscript is part of M.V.Sc., thesis submitted to TANUVAS.

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## INTRODUCTION

Meat is an excellent source of good quality animal protein which provides all the essential amino acids and various micronutrients in proper proportion to human being (National Health and Medical Research council, 2006).

Consumption of poultry meat and poultry meat products is growing all over the world (Mielnik, 2002). Turkey (*Meleagris gallopavo*) meat has been perceived and marketed as a healthy alternative to red meat due to its leanness, low cholesterol content and favorable fatty acid profile (Brunel *et al.,* 2006).

Studies have been done to assess turkey meat quality in western countries. To popularize production and processing of turkey meat under Indian conditions it is necessary to study meat quality characteristics and nutritional composition of turkey strain available in India. To the best of our knowledge, there are no available reports which focused on nutritional value of meat of native turkey variety. The objective of the investigation was to compare the meat quality characteristics and nutritional composition of meat of two different age groups of Nandanam Turkey-II.

## MATERIALS AND METHODS

### Experimental Design

### Turkey meat sample

The young and adult Nandanam Turkey-II (Beltsville Small White birds evolved as Nandanam Turkey-II by the individual selection for 20 generations) with the age of 20 weeks and 40 weeks old respectively were used for this study. The birds were given with adequate rest and were slaughtered by neck severing method. The samples were taken from the breast (*Pectoralis major*) muscle (Sarica *et al.,* 2011) immediately after slaughter and used for the analysis. The dried meat samples were used for the estimation of proximate composition.

### Analytical procedures

The pH was measured using a digital pH meter (Digisun electronic system, model: 2001) as per the method outlined by Troutt *et al.* (1992). Water holding capacity was assessed by adopting the filter paper press method recommended by Grau and Hamm (1957) with certain modifications. Muscle fibre diameter was measured according to the method outlined by Jeremiah and Martin (1982). Myofibrillar fragmentation index (MFI) was determined as per the method outlined by Davis *et al.* (1980) using ‘‘Virtis homogeniser 45” (Virtis Company, Gardinar, New York, USA) with slight modifications. Proximate composition *viz.,* moisture, protein, fat and total ash content of meat samples were analyzed by following the standard procedure (AOAC, 1995). Fat estimation was done in SOCS plus (Model SCS 4, Pelican Equipment Pvt. Ltd., Chennai) and protein estimation in KEL plus (Model Classic DX, Pelican Equipment Pvt. Ltd., Chennai). Fatty acid profile was estimated by the method of Palmquist and Jenkins (2003) with slight modification. Cholesterol content was determined using cholesterol test kit (Recombigen Pvt ltd., India). The lipid extract was used as per the method described by Wybenga *et al.*

(1970). Lipid extract was prepared by the method described by (Folch *et al.,* 1957). The procedure as described by Bruckner *et al.* (1991) was followed to estimate amino acid content. The meat sample was hydrolysed by standard hydrolysis procedure (Fountoulakis and Lahm, 1998).

**Statistical analysis**

The data was analyzed with unpaired t- test using IBM® SPSS® 20.0 for MS-Windows®.

## RESULTS AND DISCUSSION

**Carcass characteristics**

The carcass characteristics of young and adult age groups of Nandanam Turkey-II were presented in table 1, along with test of significance and found that there was highly significant difference ($P<0.01$) in edible offal, in-edible offal, blood, feather and head weight and non-significant difference ($P>0.05$) in dressing per cent between two age groups. Breed, sex and slaughtering age influence carcass characteristics of turkeys (Roberson *et al.,* 2003).

**Meat quality characteristics**

The meat quality characteristics of breast meat of young and adult of Nandanam Turkey-II were presented in table 1, along with test of significance and revealed that there was a highly significant difference ($P<0.01$) in muscle fibre diameter, myofibrillar fragmentation index and significant difference ($P<0.05$) in pH. The pH of adult turkey meat was significantly ($P<0.05$) higher than young turkey meat. The similar results were obtained by Boni *et al.* (2010b) in quails ($P<0.05$). However, contrary to the findings of this study a highly significant ($P<0.01$) decrease in pH with increase age has been reported (Sarica, *et al.,* 2011) in turkey. pH plays an important role during emulsification and is strictly related to the physicochemical and functional properties of an emulsion (Zobra and Kurt, 2006).

The water holding capacity of meat samples decreased non significantly ($P>0.05$) as age of the bird increased suggesting that birds slaughtered at young age have better juiciness compared to adult birds since water holding capacity of meat is closely related to tenderness and juiciness (Lawrie, 1985). Similarly a decrease in water holding capacity with increase in age has been reported in thigh meat of turkey (Sarica, *et al.,* 2011).

The meat of adult turkey had significantly ($P<0.01$) higher fibre diameter than young. The higher the fibre diameter was observed in adult turkey than young and it could be due to increased age and maturity. The fibre size is an important factor in determining meat tenderness (Seideman and Crouse, 1986) and it was negatively correlated to tenderness of the muscle. The increased fibre diameter with increasing age was observed by Singh *et al*. (1985) in both breast and thigh muscles of layer chicken.

Myofibrillar fragmentation index (MFI) is an accurate index for tenderness and is a useful indicator of the extent of proteolysis (Olson *et al.,* 1976). The meat of young turkey had significantly ($P<0.01$) lower myofibrillar fragmentation index than adult turkey which indicates more

tenderness. The significantly similar results were obtained by Ilavarasan *et al.* (2015) in Kodi adu goat meat. Animal age has been shown to have more influence on tenderness attributes than sex of the animal (Huff and Parrish, 1993).

**Proximate composition**

The proximate composition of meat of young and adult age groups of Nandanam Turkey-II (Table 1) revealed that the meat of young turkey had significantly higher moisture ($P<0.01$) and lower protein ($P<0.05$), fat ($P<0.01$) and total ash ($P<0.05$) content than adult turkey meat. The higher moisture content was observed in young turkey meat than adult and it could be due to less fat content in young. As animal age increases, the fat content increased and moisture content decreased (Lawrie, 1998) and fat is the last tissue to mature and older animals tending to be fatter (Warriss, 2000). Similar results were obtained by Boni *et al.* (2010b) in quail ($P<0.05$). But contrary to this, Sarica *et al.* (2011) found low fat in adult turkey. The fat content of meat was highly variable and was influenced by factors such as age, sex, nutrition, body weight, growth rate, physiological condition and physical activity of animal. There was not much difference noticed in the composition of meat between the age groups of emu except the lipid content (Berge *et al.,* 1997).

**Amino acid content**

The amino acid content of young and adult age groups of Nandanam Turkey-II meat was summarized in table 2 and it revealed highly significant difference ($P<0.01$) in arginine, isoleucine, threonine, valine, alanine, aspartic acid, glutamic acid and glycine contents. Glutamic acid was found to be higher quantity among the amino acids. Similar results were obtained by Wattanachant *et al.* (2004) in indigenous chicken and Boni *et al.* (2010a) in quail. Contrary to this, glysine was found as the major amino acid in chicken meat (Jorfi *et al.,* 2012). Glutamic acid was found to have a detectable effect on the taste of chicken meat, which may contribute to the differences in flavour among meat (Farmer, 1999). The amino acid composition of meat protein remains fairly constant for most species regardless of the type of cut (Schwiegert, 1987). The methionine was found to be very less ($P>0.05$) when compared to other amino acids. The results were congruent with findings made in chicken (Jorfi *et al.,* 2012). The results of this study revealed that Nandanam Turkey-II meat is a rich source of all essential and non-essential amino acids.

**Fatty acid content**

The fatty acid contentof young and adult age groups of Nandanam Turkey-II meat (Table 3) revealed highly significant difference ($P<0.01$) in myristic, linoleic and docosohexanoic acid and significant difference ($P<0.05$) in stearic, arachidic and ecosapentaenoic acid content between them. The fatty acid profile of turkey meat was significantly affected by age at slaughter. Palmitic acid was the predominant saturated fatty acid which was higher in adult age groups. Oleic acid was the predominant mono unsaturated fatty acid. The poly unsaturated fatty acids such as the linoleic, linolenic, ecosapentaenoic and docosohexanoic acid were all higher in younger age groups. The mean total

saturated (P<0.01) and total mono unsaturated fatty acids (P<0.05) content were significantly increased where as the total poly unsaturated fatty acids and P/S ratio content were significantly (P<0.05) decreased as age at slaughter increased. The similar results were observed in Ostrich (Girolami *et al.,* 2003), desi chicken (Ilavarasan *et al.,* 2015) and quail (Boni, *et al.,* 2010b). The recommended poly unsaturated to saturated (P/S) ratio in the human food is 0.45-0.65 and lower ratios in the diets may increase the occurrence of cardiovascular disease. The meat of young Nandanam Turkey-II had P/S ratio within this range. The meat of adult turkey had significantly (P<0.01) higher cholesterol content than the meat of young. The increased cholesterol content with increased age was observed by Girolami *et al.* (2003) in ostrich (P>0.05). The cholesterol content increased with advance in slaughter age (Madruga *et al.,* 2001). The climate, soil content, water composition and breeding policies of the various regions will affect the nutrient content of the animal feed and thus the nutrient content of the animal's meat (Okeudo and Moss, 2005).

Based on the meat quality characters and nutritional composition it was observed that Nandanam Turkey-II slaughtered at 20 weeks of age had better meat quality as well as balanced nutritional composition as compared to birds slaughtered at 40 weeks of age.

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**Table 1. Carcass, meat quality characteristics and proximate composition (Per cent) of young and adult age groups of Nandanam Turkey-II meat (Mean ± S.E.)**

| Parameter | Young | Adult | t - value |
|---|---|---|---|
| **Carcass characteristics** | | | |
| Dressing percent | 68.27 ± 1.27 | 71.68 ± 1.06 | 2.05$^{NS}$ |
| Edible offal weight (kg) | 0.11 ± 0.01 | 0.23 ± 0.02 | 5.62** |
| In-edible offal (kg) | 0.19 ± 0.01 | 0.53 ± 0.06 | 5.46** |
| Blood weight (kg) | 0.06 ± 0.01 | 0.24 ± 0.02 | 6.98** |
| Feather weight (kg) | 0.12 ± 0.01 | 0.36 ± 0.03 | 8.05** |
| Head weight (kg) | 0.06 ± 0.01 | 0.14 ± 0.01 | 10.38** |
| **Meat quality characteristics** | | | |
| pH | 5.96 ± 0.03 | 6.07 ± 0.04 | 2.29* |
| Water holding capacity ($cm^2$) | 2.10 ± 0.06 | 2.18 ± 0.06 | 1.00$^{NS}$ |
| Fibre diameter (µm) | 77.92 ± 0.85 | 96.00 ± 1.34 | 11.42** |
| Myofibrillar fragmentation index | 967.83 ± 1.14 | 1045.83 ± 1.35 | 44.14** |
| **Proximate composition (Per cent)** | | | |
| Moisture | 74.46 ± 0.15 | 73.24 ± 0.13 | 5.18** |
| Protein | 23.62 ± 0.11 | 24.10 ± 0.13 | 2.79* |
| Fat | 0.68 ± 0.03 | 1.36 ± 0.05 | 11.71** |
| Total Ash | 1.10 ± 0.03 | 1.23 ± 0.03 | 3.10* |

No. of samples - 6, means bearing different superscripts differ significantly.

* = significant (P<0.05), ** = highly significant (P<0.01), $^{NS}$ = Non - significant (P>0.05).

**Table 2. Amino acid content (g/100 g of meat) of two age groups of Nandanam Turkey-II meat (Wet basis) (Mean ± S.E.)**

| Amino acid (g/100 g of meat) | Young | Adult | t-value |
|---|---|---|---|
| **Essential amino acids** | | | |
| Arginine | 0.72 ± 0.01 | 0.81 ± 0.01 | 5.64** |
| Histidine | 0.37 ± 0.02 | 0.39 ± 0.01 | $0.65^{NS}$ |
| Isoleucine | 0.53 ± 0.02 | 0.63 ± 0.02 | 3.20** |
| Leucine | 0.90 ± 0.02 | 0.96 ± 0.02 | $1.93^{NS}$ |
| Lysine | 0.90 ± 0.02 | 0.84 ± 0.02 | 2.35* |
| Methionine | 0.13 ± 0.01 | 0.15 ± 0.01 | $2.06^{NS}$ |
| Phenylalanine | 0.46 ± 0.02 | 0.51 ± 0.01 | 2.73* |
| Threonine | 0.33 ± 0.01 | 0.16 ± 0.01 | 10.52** |
| Valine | 0.53 ± 0.01 | 0.64 ± 0.01 | 5.50** |
| **Non-essential amino acids** | | | |
| Alanine | 0.70 ± 0.01 | 0.89 ± 0.01 | 13.77** |
| Aspartic acid | 1.07 ± 0.02 | 1.25 ± 0.02 | 6.21** |
| Glutamic acid | 1.50 ± 0.01 | 0.75 ± 0.02 | 29.55** |
| Glycine | 0.54 ± 0.02 | 0.83 ± 0.02 | 11.81** |
| Serine | 0.51 ± 0.01 | 0.52 ± 0.01 | $0.54^{NS}$ |
| Tyrosine | 0.42 ± 0.01 | 0.44 ± 0.01 | $0.10^{NS}$ |

No. of samples - 6, means bearing different superscripts differ significantly.

* = significant (P<0.05), ** = highly significant (P<0.01), $^{NS}$ = Non - significant (P>0.05).

**Table 3. Fatty acid analysis (%) and cholesterol content (mg/100 g) of young and adult age groups of Nandanam Turkey-II meat (Mean ± S.E.)**

| Fatty acid type | Fatty acid (Per cent) | Young | Adult | t - value |
|---|---|---|---|---|
| (SFA) | Myristic Acid (C14:0) | 1.12 ± 0.09 | 2.79 ± 0.14 | 9.86** |
| | Palmitic Acid (C16:0) | 23.75 ± 0.24 | 24.83 ± 0.54 | 1.82 $^{NS}$ |
| | Stearic Acid (C18:0) | 17.89 ± 0.24 | 18.53 ± 0.12 | 2.26* |
| | Arachidic Acid (C20:0) | 0.91 ± 0.04 | 1.34 ± 0.14 | 3.02* |
| | Behenic Acid (C22:0) | 1.19 ± 0.07 | 1.31 ± 0.15 | 0.74 $^{NS}$ |
| (MUFA) | Palmitoleic Acid (C16:1) | 1.84 ± 0.17 | 2.20 ± 0.13 | 1.68 $^{NS}$ |
| | Oleic Acid (C18:1) | 28.13 ± 0.46 | 29.22 ± 0.28 | 2.02 $^{NS}$ |
| (PUFA) | Linoleic Acid (C18:2) | 19.84 ± 0.34 | 17.49 ± 0.39 | 4.52** |
| | Linolenic Acid (C18:3) | 0.87 ± 0.15 | 0.81 ± 0.06 | 0.39 $^{NS}$ |
| | Ecosapentaenoic Acid (C20:5) | 0.84 ± 0.04 | 0.58 ± 0.07 | 3.10* |
| | Docosohexanoic Acid (C22:6) | 0.81 ± 0.05 | 0.49 ± 0.07 | 3.70** |
| Total saturated fatty acids (SFA) | | 44.86 ± 0.21 | 48.79 ± 0.67 | 5.55** |
| Total mono unsaturated fatty acids (MUFA) | | 29.97 ± 0.43 | 31.42 ± 0.29 | 2.79* |
| Total poly unsaturated fatty acids (PUFA) | | 22.36 ± 0.30 | 19.37 ± 0.27 | 7.36** |
| Total unsaturated fatty acids (UFA) | | 52.33 ± 0.68 | 50.80 ± 0.43 | 1.90$^{NS}$ |
| P/S ratio | | 0.50 ± 0.01 | 0.40 ± 0.01 | 10.19** |
| Cholesterol (mg/100 g) | | 35.09 ± 0.30 | 37.45 ± 0.25 | 6.03** |

No. of samples - 6, means bearing different superscripts differ significantly.

* = significant (P<0.05), ** = highly significant (P<0.01), $^{NS}$ = Non - significant (P>0.05).

Short Communications

# IMPROVING SHELF LIFE AND NUTRITIVE VALUE OF WET DISTILLER'S GRAIN

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The Indian livestock industry is continuously growing. The high livestock population, around 512.05 million numbers in 2012 (Press Information Bureau, Ministry of Agriculture, Government of India, 2014) has lead to rise in the price and scarcity of feed ingredients. Feed accounts to 70% of the total cost of livestock production. Reducing feed cost will economically benefit livestock farmers. Use of locally available agro industrial by-products will help meet the feed requirements and reduce feeding cost. Wet distiller's grain is one of the important agro industrial by-product used for feeding dairy cattle. When grain is fermented to produce ethanol, primarily the starch is utilized, leaving behind a protein rich residue called distillers grains. India ranks fifth in the world in ethanol production and produces ethanol using agricultural crops as feedstock. There is a distinct trend and interest amongst Indian distilleries to evaluate grain distillery option; hence there is an increase in the upcoming of grain based distilleries which has led to increased production of distiller's grain. In spite of its abundant availability, the important factors which limits the utility of wet distillers grains as animal feed is its short (3-7 days) shelf life. The nutritional quality of distiller's grains declines rapidly due to spoilage from mould and yeast growth. Enhancing the shelf life of distiller's grains and augmenting its nutritive value would increase its value as a feed ingredient and further reduce feed cost. It is in this context that a study was conducted to improve shelf life of wet distiller's grain and identify and quantify the deficit nutrients in it so that a supplemental strategy could be evolved to enhance its nutritive value.

**Evaluation of chemical composition :** Twelve samples of wet distiller's grains were collected from grain based distilleries in Southern India and subjected to proximate analysis (AOAC, 2000), fibre fractionation (Goering and Van Soest, 1970) and were also analysed for calcium, phosphorus, magnesium, manganese, iron, copper and zinc using atomic absorption spectrophotometer (Perkin Elmer, Model No.3310, 1994).

***In vitro* degradability studies:** The *in vitro* dry matter and nitrogen degradability of the samples were determined using rumen simulation technique (RUSITEC) described by Czerkawski and Breckenridge (1977). The rumen liquor (cattle) used in

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the study was collected from a slaughter house immediately on slaughter and the contents were transported to the laboratory maintaining a temperature of 39°C and anaerobic conditions. During the *in vitro* study, the dilution rate maintained was 0.55 ml/minute. A ten day adaptation period was followed by the degradability study. Wet distiller's grain samples were incubated for 3, 6, 9, 12, 24, 36, 48 and 72 hours. Three runs were made and thus six measurements were made for each parameter studied. The per cent *in vitro* degradability of samples were calculated by the following formula:

$$\text{In vitro degradability} = \frac{\text{Weight of nylon bag with sample before incubation} - \text{weight of nylon bag with sample after incubation}}{\text{Weight of sample}}$$

The results of dry matter degraded at various time intervals were fitted to the exponential equation of McDonald (1981) using Neway software (1992).

$$P = a + b\,(1 - e^{-ct})$$

Where,

P is the effective degradability after t hours of incubation

a, b, c are constant in exponential equation

a + b = potential degradability

c = rate of degradability

The effective rumen degradable nitrogen (ERDN) was calculated as follows,

$$\text{ERDN} = 0.8\,[\text{soluble N}] + \frac{\text{Insoluble N} \times \text{rate of degradation}}{\text{Rate of degradation} + \text{outflow rate of degradation}}$$

The per cent potential microbial nitrogen production was derived by dividing the per cent organic matter apparently digested by 33.3 (AFRC, 1992). The per cent difference in nitrogen between potential microbial nitrogen and ERDN was calculated by subtracting the former from later, while this difference was considered as the nitrogen supplementation required, the NPN supplementation was calculated by multiplying with 0.80 to allowance for digestibility (AFRC, 1992) whereas no allowance was given for nitrogen supplementation through diet (AFRC, 1992). The per cent organic matter apparently digested was calculated by subtracting total ash content of feed ingredients from its dry matter and multiplying with the per cent effective degradability. The per cent digestible RDN was derived by multiplying per cent RDN with 0.75 followed by 0.85 to account for microbial true protein and its digestibility. The per cent UDN values were obtained by subtracting per cent RDN from total per cent nitrogen and per cent UDN by subtracting per cent ADIN. The RDP and UDP were calculated by multiplying RDN and UDN by 6.25.

**Enhancing shelf life of distillers grains :**A study was conducted to enhance the shelf life of wet distiller's grain by addition of de oiled rice bran (DORB) and salt at different levels.

**The treatments adopted were as follows**

| | |
|---|---|
| T1 | 100% Wet distillers grain |
| T2 | 100% Wet distillers grain +0.5% salt |
| T3 | 100% Wet distillers grain +1.0% salt |
| T4 | 90% Wet distillers grain +10% DORB |
| T5 | 90% Wet distillers grain +10% DORB+0.5% salt |
| T6 | 90% Wet distillers grain +10% DORB+1.0% salt |
| T7 | 80% Wet distillers grain +20% DORB |
| T8 | 80% Wet distillers grain +20% DORB+0.5% salt |
| T9 | 80% Wet distillers grain +20% DORB+1.0% salt |
| T10 | 70% Wet distillers grain +30% DORB |
| T11 | 70% Wet distillers grain +30% DORB+0.5% salt |
| T12 | 70% Wet distillers grain +30% DORB+1.0% salt |

Each treatment had three replicates. Two Kg of wet distiller's grain per replicate was used. The above treatments were kept in plastic trays at room temperature for 15 days. Samples were collected on $2^{nd}$ , $4^{th}$ , $6^{th}$, $8^{th}$ and $10^{th}$ days for estimation of pH (Wilson and Wilkins, 1972), mould count and yeast count (Jenkins, 1992) and expressed as colony forming units per milliliter. Data were analysed with analysis of variance (ANOVA) and linear regression as per the procedure of statistical analysis system (SPSS, version 17.0 for windows). When significant difference ($P<0.05$) were detected, the multiple range test was used to separate the mean value.

**Chemical composition :** The mean moisture of wet distiller's grains was 72.91±0.28 per cent. Crude protein, ether extract, crude fibre and total ash of wet distiller's grains on dry matter basis were found to be, 26.09±0.62. 8.19±0.24, 18.07±0.39 and 3.42±0.09 per cent, respectively. The high crude protein content in distiller's grain makes it an ideal protein source for ruminants. Presence of distillers' solubles could be the reason for high crude protein (Mustafa *et al*., 2000).

The mean NDF, ADF, cellulose, hemicellulose and lignin content in wet distiller's grain were respectively 70.86±1.67, 23.55±0.61, 18.24±0.21, 46.85±1.51 and 3.5±0.10 per cent. The high NDF reported in this study could be attributed to the presence of hulls, further the heat applied during alcohol distillation, renders some of the protein in the distiller's grain insoluble in neutral detergent solution giving the appearance of higher NDF (Rasco*et al*., 1989).

The mean calcium, phosphorus, magnesium as per cent and copper, zinc, iron and manganese in ppm in wet distiller's grains respectively were 0.19±0.01, 0.79±0.06, 0.142±0.004, 15.74±0.70, 54±1.62, 251±4.644 and 24.96±0.27. The calcium to phosphorus ratio was 0.19:0.79 indicating higher phosphorus than calcium. Phosphorus is a mineral of particular interest in dairy rations because it is one of the most

expensive nutrient in the ration. However, in wet distiller's grains the phosphorus content is high and also due to fermentation a portion of the phytate-phosphorus is hydrolyzed by microbial phytase which increases the bioavailability of it leading to significant cost-savings benefit to the producer. If calcium supplementation is taken care through supplementing calcium carbonate the calcium to phosphorus imbalance could be corrected.

***In vitro* degradability studies:** The degradation rate/hour, degradable soluble, degradable insoluble, undegradable and effective degradability of dry matter respectively were 0.16±0.02, 53.8±1.32, 31±1.41, 15.2±1.07 and 76.87±0.43 per cent and the same for nitrogen respectively were 0.12±0.01, 31.2±1.16, 53.8±1.28, 15±0.95 and 62.39±1.59 per cent in wet distillers grains. Variations in degradability of dry matter and nitrogen in distiller's grain have been attributed to type of grain used, temperature and time of drying during ethanol extraction. Low effective degradability of nitrogen might be due to the protein becoming undegradable in distiller's grain due to extensive heating of grains during alcohol distillation process (Kalscheur, 2006). The partitioning of total nitrogen in wet distiller's grain revealed effective rumen degradable nitrogen (ERDN) of 2.35±0.06% and digestible RDN of 1.49±0.04%. The potential microbial nitrogen production on fermenting wet distiller's grains' was 2.48±0.01. The RDP and UDP as per cent crude protein in wet distiller's grains were respectively 62.39±1.59 and 14.26±1.02. Consequent to lower ERDN in distiller's grain, lower potential microbial nitrogen production was observed. Kaiser, (2005) observed that high level of distiller's grain in the ration decreases rumen degradable protein, depresses ammonia levels and increases rumen undegradable protein causing microorganisms to starve and thus reducing microbial protein production. The ERDN, digestible RDN and potential microbial nitrogen production of distiller's grain is lower than that reported for oil cakes. Denaturation of protein during alcohol extraction process renders it undegradable and during alcohol extraction process some of the readily degradable protein could have undergone degradation. As a consequence of low ERDN microbial protein production is in deficit compared to the availability of organic matter hence necessitating need for additional nitrogen supplementation to enhance microbial protein production.

Further interpretation of degradability data revealed that for effective utilization of nutrients in wet distiller's grains, nitrogen supplementation to the tune of 0.14% was required. Additional supplementation of carbohydrate was not required as organic matter apparent/ digested on fermenting wet distillers grains was 74.47±0.42 per cent.

**Enhancing shelf life of wet distillers grains :** The effect of various treatments (T 1 to T 12) on mould count at various time intervals is depicted in Figure 1. The results indicate that mould count was significantly ($p<0.05$) lower in wet distiller's grain and deoiled rice bran (DORB) combination of 70:30 irrespective of the number of days of preservation. Distiller's grain without the addition of deoiled rice bran had highest mould count at all the time intervals.

Addition of salt, within the distiller's grain and de oiled rice bran combinations decreased the mould count. In all the combinations at all intervals of time 1% salt addition significantly ($p<0.05$) reduced the mould count. The effect of various treatments on yeast count at various time intervals is depicted in Figure 2. Similar to mould count the yeast count was also significantly lowest when distiller's grain was combined with deoiled rice bran at 70:30 ratio during all intervals. Further adding salt in all combinations of distiller's grain and de oiled rice bran caused decrease in yeast count. In all time intervals yeast count was highest in distiller's grain alone without addition of salt. The effect of the various treatments on pH, yeast count ($10^6$ CFU ml $^{-1}$) and mould count ($10^6$ CFU ml $^{-1}$) at $10^{th}$ day of preservation is presented in table 1. From the table it can be inferred that adding de oiled rice bran reduces the growth of yeast / mould in wet distiller's grain and adding salt further inhibits the growth. Addition of de oiled rice bran to distiller's grain caused significant ($p<0.05$) increase in the pH. Addition, of salt also lead to significant ($p<0.05$) elevation of pH. Rice bran has a very good water absorption capacity (182.2-213.1%), more over defatting or oil removal from bran increases its water absorption capacity. Adding salt as a preservative is an age old but practical method. Salt is toxic to most microbes because of the effect of osmolarity, or water pressure. Hence, inclusion of de oiled rice bran to wet distiller's grains reduced the water activity and further adding salt changed the osmolarity of the medium, thus causing a decreased growth of yeast or mould. This method of enhancing shelf life of wet distiller's grains is a low cost strategy applicable at the farmers' level. Hence, the chances for its adoption by small and marginal farmers are high.

The nutritive value of wet distiller's grain can be augmented by supplementing calcium to overcome the wide calcium to phosphorus ratio. Further for effective utilisation of nutrients in wet distiller's grain supplementation of nitrogen to the tune of 0.14% is required. A practical approach to improve shelf life of wet distiller's grain would be to mix it with de oiled rice bran in 70:30 ratios and sprinkle 1% salt. This keeps the wet distillers grain in good condition without spoilage for 10 days.

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**Table 1. The effect of the various treatments on pH, yeast count ($10^6$ CFU ml $^{-1}$) and mould count ($10^6$ CFU ml $^{-1}$) at $10^{th}$ day**

| Treatments | pH | Mould | Yeast |
|---|---|---|---|
| 100% Wet distillers grain | $7.14^{c}\pm0.02$ | $74.00^{f}\pm2.65$ | $189.67^{g}\pm0.88$ |
| 100% Wet distillers grain +0.5% salt | $6.91^{b}\pm0.02$ | $72.00^{ef}\pm1.15$ | $181.67^{g}\pm1.45$ |
| 100% Wet distillers grain +1.0% salt | $6.78^{a}\pm0.02$ | $70.00^{e}\pm0.58$ | $170.67^{ef}\pm1.76$ |
| 90% Wet distillers grain +10% DORB | $7.43^{de}\pm0.04$ | $62.00^{d}\pm1.15$ | $172.67^{f}\pm2.73$ |
| 90% Wet distillers grain +10% DORB+0.5% salt | $7.33^{d}\pm0.02$ | $61.00^{d}\pm0.58$ | $162.67^{de}\pm2.91$ |
| 90% Wet distillers grain +10% DORB+1.0% salt | $7.25^{c}\pm0.04$ | $59.67^{d}\pm0.88$ | $154.00^{c}\pm1.15$ |
| 80% Wet distillers grain +20% DORB | $7.74^{i}\pm0.03$ | $50.00^{c}\pm0.58$ | $154.00^{cd}\pm1.15$ |
| 80% Wet distillers grain +20% DORB+0.5% salt | $7.60^{gh}\pm0.02$ | $46.33^{b}\pm1.20$ | $150.67^{c}\pm1.76$ |
| 80% Wet distillers grain +20% DORB+1.0% salt | $7.48^{ef}\pm0.04$ | $46.00^{b}\pm1.53$ | $142.33^{b}\pm2.60$ |
| 70% Wet distillers grain +30% DORB | $7.85^{j}\pm0.04$ | $41.67^{b}\pm0.88$ | $151.00^{c}\pm4.51$ |
| 70% Wet distillers grain +30% DORB+0.5% salt | $7.67^{hi}\pm0.06$ | $40.00^{a}\pm0.58$ | $133.67^{a}\pm3.18$ |
| 70% Wet distillers grain +30% DORB+1.0% salt | $7.54^{fg}\pm0.03$ | $37.00^{a}\pm0.58$ | $129.00^{a}\pm1.53$ |

Mean of three observations.

Mean bearing different superscripts differ significantly ($p<0.05$).

**Fig. 1.Mould count ($10^6$ CFU ml$^{-1}$) at various time intervals**

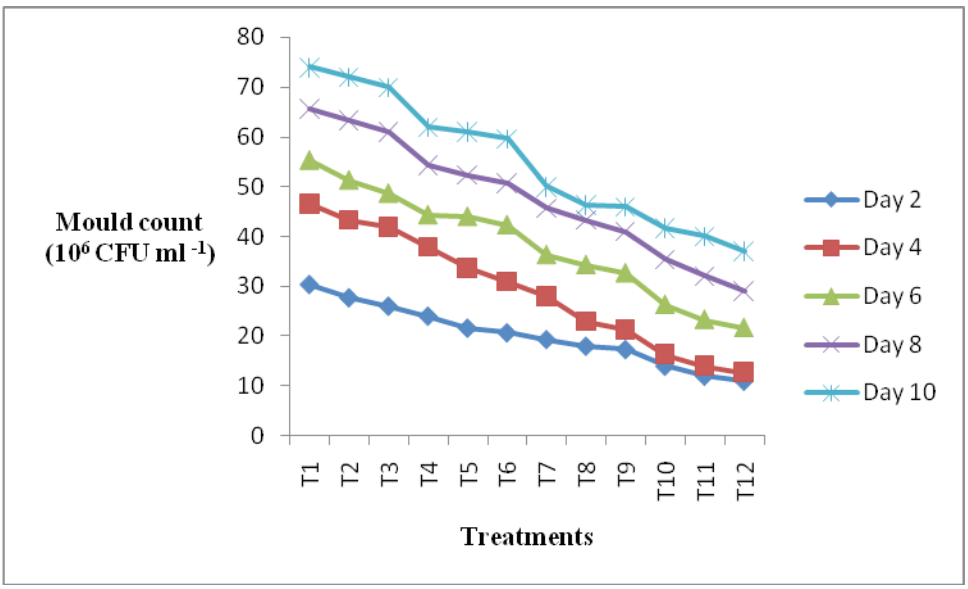
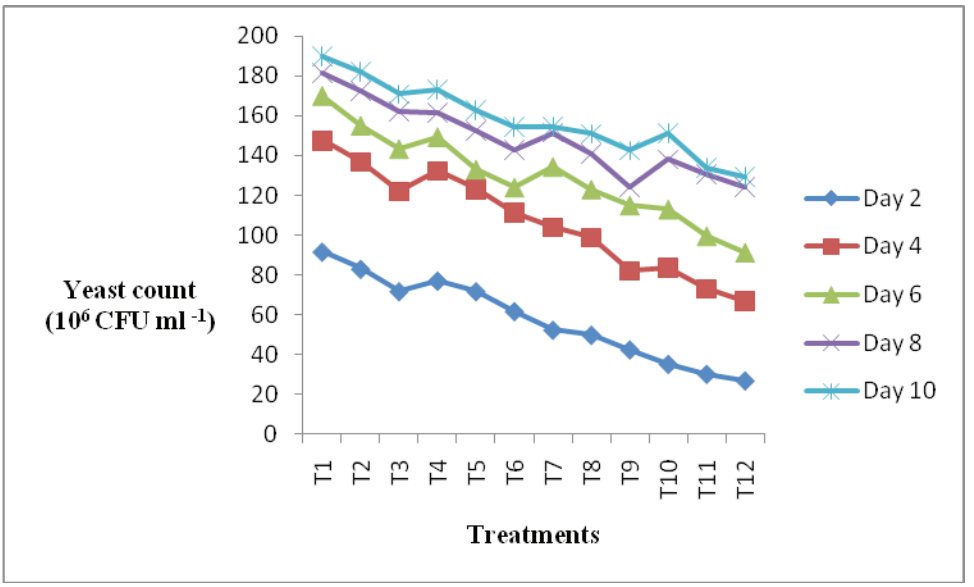


**Fig. 2. Yeast count ($10^6$ CFU $ml^{-1}$) at various time intervals**



# VIRTUAL EVALUATION OF ANAEMIA – SIMPLE TECHNIQUE

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Anaemia is one of the important clinical manifestations seen in various disease conditions. In the modern era, a battery of tests is done to ascertain the degree of anaemia. Among them reticulocyte counting plays an important role in evaluating the anaemic status and bone marrow response to anaemia. Reticulocytes are the stage in maturation of erythroid cells between the metarubricyte and matured erythrocytes. This ripening of reticulocyte to erythrocyte takes place by haemoglobination, membrane remodelling and cytoskeleton stabilization. They contain reticulum network of RNA, mitochondria and other organelles. Two types of reticulocytes are identified by supravital staining method which are, aggregate and punctate reticulocytes. In canines normally aggregate reticulocytes are more common (1, 2). In 1940s manual counting of reticulocytes with supravital stains was developed which remains the gold standard test for reticulocyte counting. With this background a simple technique was developed to enumerate the RBC and reticulocytes simultaneously and two different diluting fluids to score the merit of the method for adoption.

Blood samples for the study were collected from the dogs presented to Madras Veterinary College Teaching hospital. Based on the clinical evaluation the dogs are classified into apparently healthy and anaemic group with each of 30 dogs. From each animal 2ml of whole blood was collected in potassium dichromate EDTA coated collection tubes and immediately subjected to the analysis. Diluting fluids namely, Methylene Blue diluting fluid (Methylene Blue – 0.5 gm, Potassium Oxalate – 1.6 gm and Distilled Water –100 ml) and Brilliant Cresyl Blue diluting fluid (Brilliant Cresyl Blue – 1.0 gm, Mercuric Chloride – 0.5 gm, Sodium Sulphate – 5.0 gm, Sodium Chloride – 1.0 gm and Distilled Water –100 ml) were prepared freshly for counting the reticulocyte and erythrocyte simultaneously. The counting procedure was carried out using the RBC diluting pipette using central primary square of neubauer chamber. Blood was taken upto 0.5 mark in the RBC diluting pipette and the diluting fluid was drawn upto 101 mark, then mixed well and incubated at room temperature for 30 minutes. After discarding first few drops of diluted blood

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from the RBC diluting pipette the Neubauer chamber was charged and sufficient time was allowed for the blood cells to settle. The Neubauer chamber was examined under 40X power by using binocular laboratory microscope. The reticulocytes were identified by the presence of blue reticulum inside the cells. The number of RBC present in the central primary square of neubauer chamber was counted to arrive the total erythrocyte count. The reticulocytes were counted simultaneously while counting the RBC, minimum of 1000 erythrocytes were counted to arrive the reticulocyte percentage. Formulae used for calculating the total erythrocyte count, corrected reticulocyte percentage (CRP) and reticulocyte production index (RPI) are tabulated in table- 1. All these parameters were estimated and grouped accordingly. The staining clarity between the two different diluting fluids was analysed by visualizing the shape of reticulocytes and erythrocytes, degree of staining and presence of artefacts in the counting chamber.

The data obtained were statistically analysed by using independent sample student T- test in SPSS software (IBM®SPSS®Ver20.0 for Windows®).

In the present study, the total erythrocyte count was significantly low in the anaemic group compared to the healthy group ($p<0.01$) and the corrected reticulocyte percentage was higher in the anaemic group than in healthy population. The anaemic group had higher reticulocyte production index than the healthy group. The results of TEC, CRP and RPI obtained by using two different staining methods were tabulated in table -2. The methylene blue diluting fluid has the better staining quality when compared to the staining fluid prepared by using the brilliant cresyl blue stain, which is depicted in Figure – 1.

Most of the laboratory techniques use the reticulin (RNA content) in the cytoplasm of reticulocytes for its identification. Brecher (1949) described the Supravital staining technique for identification of reticulocytes with the help of light microscope remains a gold standard method for reticulocyte enumeration (3). Reticulocytes have diffuse basophilic hue (polychromasia), which can be used to differentiate from RBC. Normally reticulocyte count is expressed in percentage (i.e., reticulocytes per total number of erythrocytes counted). When the bone marrow performs well, the reticulocyte count should be greater if packed cell volume (PCV) drops. So it is necessary to correct the reticulocyte percentage towards the PCV by using the formula given in table-1. The corrected value is called as corrected reticulocyte percentage (CRP). CRP is calculated taking into account the normal PCV of the breed if available or in general the species (4). When the dog is undergoing the intense erythropoietic stimulation due to underlying pathology it causes the release of more young basophilic macro reticulocytes (shift cells) into the peripheral circulation which reduces the reticulocyte maturation time in the bone marrow. Most of the times it will be less than one day due to intensively active bone marrow and increases the peripheral maturation time (3,5,6,7,8). So the correction for the reticulocyte maturation time is made by using the formula given in table -1. This correction is called as 'Shift Correction' and the value obtained is called as "reticulocyte

production index (RPI)".The supravital stains namely methylene blue and brilliant cresyl blue present in the diluting fluids stains the reticulin present in the reticulocyte and also the components present in the diluting fluid preserves the RBC structure and integrity, which aids in its counting. Potential interference in the reticulocyte counting are Howell-Jolly bodies, basophilic stippling, Heniz bodies, platelet clumps and parasites. The reticulocyte counting was done immediately after blood collection to avoid the temperature and time dependent variations as reported by earlier studies (9). In this study, the increased corrected reticulocyte count in the anaemic group indicates the active erythropoiesis and active response of bone marrow for the underling pathology for anaemia. The increase in the reticulocyte production index indicates the activation of erythropoiesis by proliferation of erythroid series of committed stem cells in the bone marrow and regenerative anaemia. In this technique, we can able to count the erythrocyte and reticulocyte simultaneously, which are the good indicators of the anaemic status and bone marrow function. This method is simple and cost effective when compare to other techniques as it does not involve any high end instruments and also this technique can be used as an in-clinic diagnostic tool to assess the anaemic status of an animal and to evaluate the treatment response in the animal.

Anaemia being the major clinical outcome in most of diseases in canines, there must be a simple and cost effective technique to virtually evaluate the anaemic status of an animal. Reticulocytes and erythrocyte counting are the hallmark for evaluating the anaemic condition of the animals. In this study, a unique methodology was developed and followed to count both reticulocyte and erythrocyte simultaneously with the help of Neubauer counting chamber using the diluting fluids prepared from two different supravital stains. Hence, this can be utilised as an ideal laboratory tool in identification of the health status of the animal and to evaluate the treatment regimen.

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**Table: 1 – Formulae for calculating total erythrocyte count, corrected reticulocyte percentage**

(CRP) and reticulocyte production index (RPI) (1, 2)

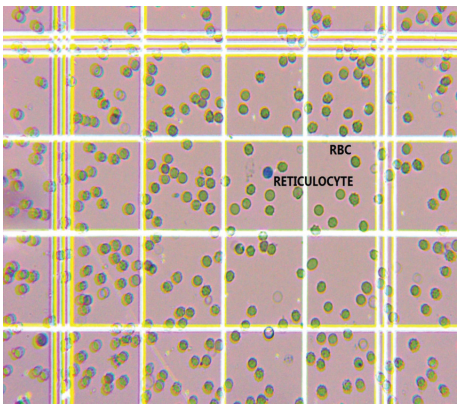
| | |
|---|---|
| Total Erythrocyte count (X $10^6$/cu.mm) | = Total No. of RBCs in 25 Squares X Depth factor X Dilution Factor |
| Corrected reticulocyte percentage(CRP) | = Observed % reticulocyte X Observed PCV Normal PCV |
| Reticulocyte Production Index (RPI) | = CRP / Reticulocyte Maturation Time |
| Reticulocyte Maturation Time | 1 day for PCV of 45<br>1.5 days for PCV of 35<br>2 days for PCV of 25<br>2.5 days for PCV of 15 |
| Normal PCV for dogs | 45 |

**Table: 2- Evaluation of total erythrocyte count, corrected reticulocyte percentage (CRP) and reticulocyte production index (RPI) in control group and anaemic group**

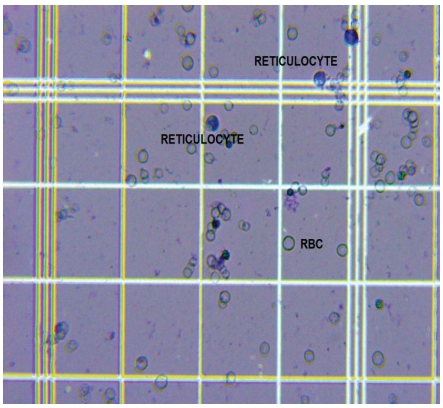
| PARAMETERS | CONTROL GROUP(n=30) | | ANAEMIC GROUP (n=30) | | REFERENCE RANGE |
|---|---|---|---|---|---|
| | Methylene Blue diluting fluid | Brilliant Cresyl Blue diluting fluid | Methylene Blue diluting fluid | Brilliant Cresyl Blue diluting fluid | |
| Total Erythrocyte count (X$10^6$/ cu.mm) | 8.1±0.68 | 7.9±0.57 | 5.3±0.88** | 4.32±0.61$^{aa}$ | 5.5- 8.5 (3) |
| Corrected Reticulocyte Percentage(CRP) | 0.86±0.01 | 0.81±0.12 | 1.35±0.13* | 1.25±0.08$^{a}$ | ≤ 1 (1) |
| Reticulocyte Production Index(RPI) | 0.81±0.67 | 0.91±0.43 | 1.64±0.87* | 1.54±0.23$^{a}$ | < 1(1) |

**, $^{aa}$ Significantly differ at 1% level ($p<0.01$)

**Figure -1: Reticulocytes stained with methylene blue diluting fluid and brilliant cresyl blue diluting fluid**




Reticulocytes stained with methylene blue diluting fluid




Reticulocytes stained with brilliant cresyl blue diluting fluid

# TUBE CYSTOSTOMY FOR SURGICAL MANAGEMENT OF OBSTRUCTIVE UROLITHIASIS IN SHEEP AND GOATS

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Obstructive urolithiasis is a serious and potentially fatal condition in male small ruminants. Obstructive urolithiasis commonly results from obstruction of the urethral lumen at the distal portion of the sigmoid flexure and at the urethral process. One or multiple uroliths may cause obstruction and results in blockage of urine outflow. (Radostits *et al.* 2007)

Urinary calculi formation usually results from various physiological, nutritional and managemental factors. High concentrate and low roughage diet results in disproportionate calcium- phosphorus ratios and are mainly incriminated in formation of uroliths and crystals in the urine. The anatomy of the male ruminant urinary tract due to the narrowness of the passage at the level of sigmoid flexure potentiates uroliths to lodge and thereby causing obstruction to urine outflow. (Makhdhoomi and Ghazi, 2013). Management of obstructive urolithiasis generally involves establishing a patent urethra through medical and surgical treatment. Medical treatment of obstructive urolithiasis involves supplementation of calculolytic agents for dissolution of calculi and dietary modifications. Medical management of obstructive urolithiasis in ruminants has generally been unsuccessful. Surgical intervention is necessary to relieve the obstruction, either by direct removal of the urolith or bypassing the obstruction (Ewoldt *et al*. 2008).

Currently, surgical tube cystostomy appears to be the most appropriate approach and successful treatment for obstructive urolithiasis in small ruminants (Van Metre and Fubini, 2006). Tube cystostomy diverts urine through a catheter placed in the urinary bladder exiting through the body wall. The advantage of tube cystostomy includes a fairly simple procedure, a relatively short duration of anaesthesia and restoration of full urethral patency.

The study was conducted in male sheep and goat that were referred to Large animal clinics – Out Patient- Surgery Unit of Madras Veterinary College Teaching Hospital with a history of anuria, dysuria, stranguria and distended bladder. A total of 6 animals were studied (sheep-2 and goat-4). A detailed history of the animals were collected. A thorough physical and clinical examination was performed.

Pre-operatively, the animals were administered normal saline at the dose rate of 10 ml / kg body weight intravenously. Antibiotics and anti-inflammatory drugs were also administered. Anaesthesia was achieved through lumbosacral epidural spinal analgesia using 2 per cent lignocaine at the dose rate of 5 mg / kg body weight. Sedation was done using xylazine at the dose rate of 0.01 mg /kg body weight intravenously. In one case that warranted general anaesthesia, ketamine

was administered intravenously at the dose rate of 2.2 mg / kg body weight.

In Tube cystostomy, the animals were positioned in right lateral recumbency. The bladder was approached in left paramedian region cranial to the last pair of rudimentary teats. The bladder was exteriorised. A stab incisison was made in the apex of urinary bladder. The urine was drained and calculi in the bladder was removed with the forceps. The bladder was flushed with normal saline to remove remaining calculi. A 24 size Foley catheter was inserted into the stab incision made in the bladder and the balloon was inflated with normal saline or distilled water (Plate – 1). The catheter was fixed in the urinary bladder by means of purse string suture pattern using 3/0 or 4/0 polyglecaprone .Then the abdominal muscles and skin were apposed. The free end of the Foley catheter was fixed to the skin using silk.

Post operatively ammonium chloride salt was administered orally at the dose rate of 0.5 g /kg body weight for acidification of urine and dissolution of urinary calculi. Walpole's solution was flushed into the urinary bladder through Foley catheter in tube cystostomy (Janke *et al.* 2009). Antimicrobial agent ceftriaxone was administered at the dose rate of 20 mg/kg body weight intravenously and analgesic meloxicam at the dose rate of 0.2 mg/ kg body weight intravenously**.** The Foley catheter was intermittently occluded using a clamp to encourage urination through urethra.

Haematological analysis revealed increase in PCV values due to dehydration of the animal. Neutrophil count was significantly increased due to pain and inflammation as a result of obstructive urolithiasis which was in concurrence with findings of Rakestraw *et al.* (1995). Biochemical analysis revealed significant increase in BUN & Creatinine pre-operatively and decreases post operatively and reaches to normal in all the cases. Dubey *et al*.(2005) also found similar increase of BUN & Creatinine pre-operatively in obstructive urolithiasis cases. This significant increase in BUN and serum creatinine is due to the accumulation of urine and other metabolites in the urinary bladder and in the peritoneal cavity. Significant increase in phosphorus was also noticed due to heavy concentrate diet which acts as a main predisposing factor in formation of uroliths. ( Makhdhoomi and Ghazi, 2013)

Pre-operatively radiographic evaluation revealed presence of radio-opaque calculi in one case and radiolucent calculi in five cases. In tube cystostomy, post-operatively normograde contrast cystourethrography on day 1 revealed filling defect of contrast agent in urethra showing obstruction at the level of sigmoid flexure. After dissolution of calculi and normal urination, the contrast agent visaulised the whole length of urethra indicated no obstruction in urethral passage. (Palmer *et al.* 1998).

Ultrasonographic examination pre-operatively revealed presence of calculi in bladder and urethra and also the site of obstruction in the urethra. Both radio-lucent and radio-opaque calculi were visible under ultrasound. Post-operatively

on ultrasonography after normal urination, calculi were not visible in the urethra which indicated the calculi dissolution by acidification of urine.

Urine analysis revealed significant decrease in urine pH post operatively due to acidification of urine by oral ammonium chloride supplementation (Dubey *et al.*2006). The type of calculi found on calculi analysis were calcium phosphate (2 cases ), struvite (2 cases) , calcium carbonate (1 case ) and calcium oxalate (1 case). The time period taken to return for normal urination in tube cystostomy was (10.66 ± 0.06 days)

Post-operatively the wound healing was better in tube cystostomy. The Foley catheter was removed on 12±0.93 days after normal urination. In tube cystostomy there was free flow of urine and no straining while urination after recovery.

Tube cystostomy was a better surgical technique for management of obstructive urolithiasis in sheep and goat. In tube cystostomy, there was early resumption to normal urination, better wound healing of the surgical site, less post-operative complications, retaining of breeding potential and aesthetic value of the animal.

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**Tube cystostomy**

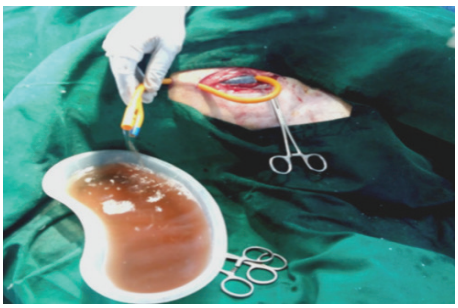

**Plate.1: Tube cystotomy Foley catheter fixed in bladder**

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**Results and Discussion** may contain subheading if appropriate. This part should be brief and to the point, without repetition of results.

An **Acknowledgement** section, if required, may be given.

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| 1. | Place of Publication | : University Publication Division (Printing Press)<br>Tamil Nadu Veterinary and<br>Animal Sciences University,<br>Madhavaram Milk Colony, Mathur Road,<br>Chennai – 51. Ambattur Taluk<br>Thiruvallur District |
| 2. | Periodicity of Publication | : Bi-Monthly |
| 3. | Printer's Name<br>Whether citizen of India<br>Address | : **Dr. M.K.Sudeep Kumar**<br>Yes<br>Director of Distance Education<br>Tamil Nadu Veterinary and<br>Animal Sciences University,<br>Madhavaram Milk Colony<br>Chennai – 51. Ambattur Taluk<br>Thiruvallur District |
| 4. | Publisher's Name<br>Whether citizen of India<br>Address | : **Dr. T.J. Harikrishnan**<br>Yes<br>Director of Research<br>Tamil Nadu Veterinary and<br>Animal Sciences University,<br>Madhavaram Milk Colony<br>Chennai – 51. Ambattur Taluk<br>Thiruvallur District |
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| 6. | Name and address of individuals who own the newspaper and parents or share holders holding more than one per cent of the total capital | : **The Registrar**<br>Tamil Nadu Veterinary and<br>Animal Sciences University,<br>Madhavaram Milk Colony, Chennai – 600 051. |

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