**J. Meat Sci. 2018, 13 (1): 55-59** **Research paper**

# Fatty Acid Composition, Cholesterol and Nutritional Indices of Srinidhi and Vanaraja Chicken Varieties at 16, 20 and 24 Weeks of Age

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## ABSTRACT

The fatty acid profile and cholesterol content were studied in Srinidhi and Vanaraja chicken varieties – slaughtered at the 16, 20 and 24 weeks. All fatty acids studied were significantly (P<0.01) influenced by age and sex. Study recorded significantly (p<0.01) less saturated fatty acid in Srinidhi and Vanaraja chicken at 24 weeks of age followed by 20 weeks and 16 weeks of age. Unsaturated fatty acid recorded significantly (p<0.01) highest in Srinidhi and Vanaraja chicken at 24 weeks of age followed by 20 weeks of age and then 16 weeks of age. MUFA decreased significantly (p<0.01) with age from 16 week to 24 weeks. This corresponded to the significant decrease in C16:1 and C18:1 in the older chickens and might be lower desaturase activity. Significantly (p<0.01)higher PUFA recorded in Srinidhi chicken than Vanaraja chicken at 24 weeks of age than Srinidhi chicken and these might be due to higher Elongase and Thioesterase indices in these birds.Study recorded positive effect of age on atherogenic and thrombogenic index, while h/H and p/s ratio increased significantly. Additionally, n-6/n-3 ratio decreased substantially in the older chickens. Cholesterol content significantly (p<0.01) less in Srinidhi chicken than Vanaraja chicken in all age group and older chicken exhibited significantly (p<0.01) higher cholesterol content as age advanced. Effect of sex dimorphism on cholesterol content also recorded significant. These results opens new prospective for further research on the breeding practices of Srinidhi and Vanaraja varieties in order to produce slow-growing chickens with beneficial fatty acid composition of meat for the consumers.

**Keywords:** *Srinidhi, Vanaraja, Fatty acid profile, Cholesterol*

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## INTRODUCTION

Chicken has the distinction of the most liked meat in Indian subcontinent and is considered as white meat having many unique desirable properties compared to other red meats. Some of these merits are excellent flavor, easy to digest, low fat content, high ratio of polyunsaturated fatty acids to saturated fatty acids, excellent source of protein and fair source of vitamins and minerals, more tender due to less connective tissue and shorter muscle fibers, requires less cooking and retains more nutrients. It is considered nutrient-dense food which is desirable in planning health diets. It contains higher proportion of protein per unit of calories as compared to red meat (Singh *et al.* 2007). Universal acceptability without any taboo is another additional merit (Sharma *et al.* 2012) In addition, according to the report by Umaya Suganthi (2014), meat of native breeds of chicken is known for low fat, high protein and water holding capacitywith desirable taste and flavor and fetches higher price than commercial broilers. Moreover, indigenous chickens contain various endogenous compounds like bioactive amines L-carnitine, Betaine known to be beneficial to humans. Release of Giriraja chicken by University of Agricultural Sciences, Karnataka in the year 1989 can be viewed as the first initiative by poultry breeders to develop varieties suitable for backyard rearing. White Plymouth rock, Red Cornish and New Hampshire breeds were utilized to bring out a bird with color plumage, high egg production and body weight compared to local non-descript fowls and instantly became popular. Taking cue from the success of Giriraja birds, Directorate of Poultry Research, Hyderabad has evolved Vanaraja chicken utilizing Red Cornish as male line and random bred meat control population as dam line which was released in the year 1998 (Viroji Rao 2014). Similarly 'Srinidhi' is a new promising dual purpose variety for rural poultry released in 2013. It has been selected from six test crosses developed at Directorate of Poultry Research, Hyderabad and known for optimum body weight and better egg production. Fatty acid content of chicken is affected by the breed. Chicken genotypes play an important role in the fatty acid composition of meat. This finding assumes great importance because designing of a healthier chicken meat for nutrition conscious consumers. Slow growing strains for egg type lines posses higher efficiency Eicosapentanoeic acid and Docosahexanoeic acid deposition because of a specific gene determinism (FADE gene) involved in elaborating long chain n-3 and n-6 and intake of pasture containing ALA, antioxidants and phytoestrogens. However, fast growing strains, selected for meat traits, had different hormonal profile and deposition of EPA and DHA affected by the estrogen level (Dal Bosco *et al.* 2012).

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## MATERIALS AND METHODS

Day old chicks were procured from Directorate on Poultry Research, Hyderabad and raised under identical management practices. Birds were fed ad libitum on layer chick diet (20% CP, 2700 ME) up to 9 weeks and layer grower diet (16% CP, 2700 ME) from 10 to 24 weeks. Each trial comprised of 36 birds of each variety divided into three groups which were slaughtered at 16, 20 and 24 weeks of age with equal distribution of sexes. Total lipid from meat samples were extracted according to the method of Bligh and Dyer (1959). Methyl esters of the total lipids, isolated by preparative thin layer chromatography, were obtained using 0.01% solution of sulfuric acid in dry methanol for 14h, as described by Christie (1973). The fatty acid composition of total lipids was determined by gas-liquid chromatography (GLC) analysis using a chromatograph C SI 200 equipped with a capillary column (DM-2330:30 m×0.25 mm × 0.20μm) and hydrogen as a carrier gas. The oven temperature was first set to 160°C for 0.2 min, then raised until 220°C at a rate of

5˚min-1 and then held for 5 min. The temperatures of the detector and injector were 230˚C. Methyl esters were identified through a comparison to the retention times of the standards. Fatty acids are presented as percentages of the total amount of the methyl esters (FAME) identified (Christie 1973).The amount of each fatty acid was used to calculate the indices of atherogenicity and thrombogenicity, as proposed by Ulbricht and Southgate (1991):

Atherogenicity Index (AI) = (4×C14:0+C16:0 / [MUFA+Σ(n-6)+Σ(n-3)];

Thrombogenicity Index (TI) = (C14:0+C16:0+C18:0) / [0.5 × MUFA +0.5 × (n-6) + 3 × (n-3) + (n-3) / (n-6)]

The h/H ratio was calculated, as suggested by Santos-Silva *et al.* (2002):

h/H=(C18:1+C18:2n-6+C20:4n-6+C18:3n-3+C20:5n-3+C22:5n-3+C22:6n-3)/(C14:0+C16:0)

h =Hypocholesterolemic, H = Hypercholesterolemic Fatty acids (h/H)

Cholesterol measured as per method described by Rajkumar *et al.* (2004).

***Statistical Analysis:*** The data were subjected to ANOVA as per Snedecor and Cochran (1989) to study the influence of sex, variety, age etc. The significant differences between means were obtained by using Duncan's Multiple Range Test.

## RESULTS AND DISCUSSION

**Fatty Acid Composition:** In the present study, variety significantly (p<0.01) (Table 1) influenced the percent palmitoleic acid, linoleic acid, saturated fatty acid (SFA), monounsaturated fatty acid (MUFA), polyunsaturated fatty acid (PUFA). Study recorded significantly (p<0.01) higher MUFA, PUFA in Srinidhi chicken variety than Vanaraja chicken. Variety also significantly (P<0.01) affected other measured different fatty acids. Similar results were reported by Kumar *et al.* (2011) in Japanese quail meat and Karthika *et al.* (2016) in Namakkal quail-1. The overall monounsaturated fatty acid (MUFA) content was more in Srinidhi chicken than in Vanaraja chicken that might be due to Srinidhi chicken parent line egg type as compared to Vanaraja chicken which is meat type line. According to Dal Bosco *et al.* (2012) genotypes plays an important role in fatty acid synthesis and reported significant effect of breed on fatty acid composition of breast meat under organic farming condition. Slow growing egg type lines and laying hen seem to have a higher efficiency in EPA and DHA deposition respecting meat-type chickens, being that elongation is partly affected by the estrogen level. Therefore to design a healthier chicken meat for nutrition-conscious consumer selection of suitable strain is very important. Similarly Jaturasitha *et al.* (2008) reported higher concentration of n-3 fatty acids group i.e. C18:3 and C22:6 in Thai indigenous chicken than other genotypes and ratio of n-6:n-3 fatty acid was more favorable in Thai indigenous chicken than those other chicken.

Effect of age was significant (p<0.01) (Table 1) on percent palmitic acid, stearic acid, palmitoleic acid, oleic acid, linoleic acid content. As age advanced palmitic acid content decreased significantly (p<0.01) while stearic acid content increased significantly (p<0.01). Study also recorded significant (p<0.01) decrease in palmitoleic acid, oleic acid content, linoleic acid and saturated fatty acid (SFA) content as age advanced in both varieties and corresponded MUFA and PUFA increased significantly (p<0.01). Kumar *et al.* (2011) suggested an increase in oleic acid content with age in two varieties probably to meet the physiological needs of birds (growing cellular mass) as they near maturity. It was obvious an increase in palmitoleic acid content with decrease in palmitic acid with age due to conversion of palmitoleic acid by increased activity of desaturase. According to Popova *et al.* (2016) age was the most significant factor to influence the fatty acid profile than the line of chicken. Spent chicken meat was more in long chain PUFA and lesser in MUFA than young chicken.

The positive effect of later age on the fatty acid composition was associated with a decrease in the atherogenic and thrombogenic index. Tang *et al.* (2009) suggested older birds in general had more fatty acid constituents than younger birds. Study also recorded significant (Fig 1) effect of sex dimorphism on different fatty acid and exhibited significantly (p<0.01) higher percent stearic acid, palmitoleic acid in male than in female. However, polyunsaturated fatty acid (PUFA), monounsaturated fatty acid (MUFA) recorded significantly (p<0.01) more in female than in male.

Similar results were reported in study of Kumar *et al.* (2011) in Japanese quail and Popava *et al.* (2016) in chicken. However, Intarapichet *et al.* (2008) recorded more MUFA in female birds than male birds on the contrary PUFA of breast and thigh of female was significantly (P<0.01) lesser than male. Alessandri *et al.* (2012) study on effect of gender on DHA synthesis in rat indicated estradiol supports the ω-3 index, suggesting that this hormone plays a role on DHA synthesis. Females are more prone than males to increase their index of ω-3 Δ4-desaturation.

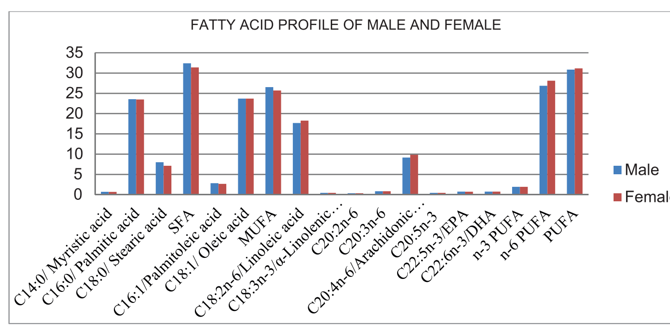

**Fig1.: Fatty acid profile of male and female chicken**

Nutritional Indices: An attempt to take into account the different effects of the various fatty acids, Ulbricht and Southgate (1991) proposed two indices which might better characterize the atherogenic and thrombogenic potential of the diet than the simple approaches such as the p/s ratio.

The atherogenic and thrombogenic index take into account the different effects that single fatty acid might have on human health and in particular on the probability of increasing the incidence of pathogenic phenomenon, such as atheroma and/or thrombus

**Table 1: Fatty acid composition (% of total FAME) of Srinidhi and Vanaraja Chiken**

| **Male** | **Srinidhi** | | | **Vanaraja** | | | | **Significance Factor** | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 16 W | 20W | 24 W | 16 W | 20 W | 24 W | Pooled | Variety | Age | Variety |
| Fatty Acid | | | | | | | SE | | | × Age |
| C14:0/ Myristic acid | 0.85 | 0.83 | 0.67 | 0.61 | 0.58 | 0.54 | ±0.08 | * | * | * |
| C16:0/ Palmitic acid | 29.47 | 27.90 | 27.01 | 28.94 | 26.03 | 25.83 | ±1.24 | NS | * | NS |
| C18:0/ Stearic acid | 9.57 | 10.11 | 11.97 | 11.61 | 12.12 | 13.47 | ±0.8 | * | * | * |
| C16:1/Palmitoleic acid | 4.24 | 3.00 | 1.96 | 2.62 | 2.24 | 2.12 | ±0.68 | * | * | NS |
| C18:1/ Oleic acid | 25.65 | 24.47 | 20.87 | 23.86 | 22.34 | 21.89 | ±1.34 | NS | * | NS |
| C18:2n-6/Linoleic acid | 19.76 | 19.14 | 18.58 | 21.12 | 19.04 | 17.98 | ±0.65 | * | * | NS |
| C18:3n-3/α-Linolenic acid | 0.42 | 0.45 | 0.47 | 0.47 | 0.45 | 0.40 | ±0.16 | NS | NS | NS |
| C20:2n-6 | 0.39 | 0.38 | 0.37 | 0.48 | 0.47 | 0.40 | ±0.17 | NS | NS | NS |
| C20:3n-6 | 0.87 | 0.85 | 0.77 | 0.95 | 0.99 | 1.02 | ±0.18 | NS | NS | NS |
| C20:4n-6/Arachidonic acid | 7.55 | 8.89 | 15.11 | 7.79 | 8.91 | 13.92 | ±0.77 | * | * | * |
| C20:5n-3 | 0.47 | 0.43 | 0.36 | 0.25 | 0.24 | 0.21 | ±0.20 | NS | NS | NS |
| C22:5n-3/EPA | 0.74 | 0.89 | 1.75 | 0.73 | 0.89 | 1.87 | ±0.21 | NS | NS | NS |
| C22:6n-3/DHA | 0.68 | 0.99 | 1.34 | 0.69 | 0.98 | 1.65 | ±0.22 | NS | NS | NS |
| n-3 PUFA | 1.88 | 1.89 | 1.90 | 1.84 | 1.88 | 1.92 | ±0.56 | * | * | * |
| n-6 PUFA | 27.31 | 28.00 | 33.78 | 28.91 | 27.95 | 31.80 | ±0.58 | * | * | * |
| | 39.73 | 39.35 | 39.05 | 41.95 | 40.06 | 39.65 | ±1.78 | * | * | * |
| MUFA | 29.39 | 26.00 | 22.83 | 26.48 | 25.04 | 23.91 | ±1.04 | * | * | * |
| | 30.88 | 34.78 | 38.82 | 32.47 | 34.07 | 36.83 | ±1.23 | * | * | * |
| **Female** | | | | | | | | | | |
| C14:0/ Myristic acid | 0.677 | 0.64 | 0.61 | 0.69 | 0.70 | 0.71 | ±0.69 | * | * | * |
| C16:0/ Palmitic acid | 23.83 | 23.01 | 22.60 | 23.16 | 23.76 | 24.84 | ±1.02 | NS | * | NS |
| C18:0/ Stearic acid | 10.47 | 11.67 | 14.72 | 11.81 | 12.00 | 13.90 | ±0.99 | * | * | NS |
| C16:1/Palmitoleic acid | 5.29 | 3.15 | 2.69 | 3.73 | 3.67 | 3.84 | ±0.96 | * | * | NS |
| C18:1/ Oleic acid | 31.89 | 28.15 | 22.31 | 27.92 | 25.87 | 23.12 | ±1.01 | NS | * | NS |
| C18:2n-6/Linoleic acid | 21.34 | 21.96 | 23.92 | 21.30 | 23.43 | 24.23 | ±0.79 | * | * | NS |
| C18:3n-3/α-Linolenic acid | 0.56 | 0.61 | 0.63 | 0.61 | 0.65 | 0.67 | ±0.05 | NS | NS | NS |
| C20:2n-6 | 0.29 | 0.34 | 0.39 | 0.32 | 0.37 | 0.41 | ±0.05 | NS | NS | NS |
| C20:3n-6 | 0.42 | 0.41 | 0.40 | 0.48 | 0.45 | 0.43 | ±0.88 | NS | NS | NS |
| C20:4n-6/Arachidonic acid | 5.04 | 8.02 | 10.45 | 5.90 | 7.08 | 8.96 | ±0.89 | * | * | * |
| C20:5n-3 | 0.06 | 0.15 | 0.22 | 0.03 | 0.15 | 0.27 | ±0.09 | NS | NS | NS |
| C22:5n-3/EPA | 0.42 | 0.68 | 1.08 | 0.51 | 0.98 | 1.04 | ±0.10 | NS | NS | NS |
| C22:6n-3/DHA | 0.35 | 0.47 | 0.79 | 0.46 | 0.51 | 0.80 | ±0.11 | NS | NS | NS |
| n-3 PUFA | 1.95 | 1.90 | 1.91 | 1.85 | 1.88 | 1.92 | ±0.90 | * | * | * |
| n-6 PUFA | 26.38 | 29.98 | 34.07 | 30.20 | 30.51 | 30.19 | ±0.95 | * | * | NS |
| SFA | 34.65 | 36.03 | 37.74 | 35.76 | 37.07 | 39.49 | ±1.29 | * | * | * |
| MUFA | 37.02 | 30.91 | 25.00 | 31.55 | 29.58 | 26.99 | ±1.03 | * | * | * |
| PUFA | 28.33 | 30.90 | 37.26 | 32.69 | 33.01 | 33.52 | ±1.45 | * | * | * |

[1]SE: Standard error. *P<0.01. NS: Non significant

formation. The recommended values of the AI are below 0.5 (Ulbricht and Southgate, 1991) and it was decreased in the older birds (p<0.01). The thrombogenic index was also significantly decreased (p<0.01), while the h/H ratio increased (P<0.01) in the older chicken. In addition Srinidhi chicken n-6:n-3 ratio, h/H ratio more favorable than Vanaraja chicken meat.

***Cholesterol content:*** The mean of cholesterol content (Table 3) at 16, 20, 24 weeks of age for Srinidhi male was 32.03, 59.33, 56.78 mg/100 g and for Srinidhi female was 50.61, 44.98, 58.32 mg/100 g, respectively. Similarly, corresponding mean for Vanaraja male was 49.18, 60.87, 66.60 mg/100g and Vanaraja female was 65.55, 57.85, 75.44 mg/100g, respectively. Vanaraja chicken recorded significantly (p≤0.05) higher cholesterol content than Srinidhi chicken. Female chicken was significantly (p≤0.05) higher in cholesterol content than male chicken. Exhibited increase in cholesterol content as age advanced.

**Table 2: Fatty acid nutritional indices of Srinidhi and Vanaraja chicken at 16, 20 and 24 weeks of age**

| | Srinidhi | | | Vanaraja | | | Significance Factor | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Male | 16 W | 20W | 24 W | 16 W | 20 W | 24 W | Pooled SE | Variety | Age | Variety × Age |
| p/s | 0.77 | 0.82 | 0.98 | 0.79 | 0.82 | 0.94 | ±0.08 | * | * | * |
| n-6/n-3 | 14.84 | 12.06 | 9.56 | 15.29 | 11.99 | 8.15 | ±1.42 | * | * | NS |
| AI | 0.49 | 0.48 | 0.47 | 0.50 | 0.48 | 0.46 | ±0.03 | * | * | NS |
| TI | 1.10 | 1.00 | 0.98 | 1.18 | 0.97 | 0.99 | ±0.10 | * | * | NS |
| h/H | 2.00 | 2.03 | 2.19 | 1.86 | 1.99 | 2.18 | ±0.20 | NS | * | NS |
| Female | | | | | | | | | | |
| p/s | 0.82 | 0.92 | 0.99 | 0.84 | 0.91 | 0.99 | ±0.09 | * | * | NS |
| n-6/n-3 | 19.83 | 17.03 | 13.63 | 19.11 | 14.25 | 12.02 | ±1.43 | * | * | NS |
| AI | 0.41 | 0.40 | 0.40 | 0.40 | 0.43 | 0.46 | ±0.04 | * | * | NS |
| TI | 0.96 | 0.97 | 0.99 | 0.98 | 0.99 | 1.08 | ±0.09 | * | * | NS |
| h/H | 1.98 | 1.89 | 1.80 | 1.85 | 1.98 | 2.11 | ±0.29 | NS | * | NS |

SE: Standard Error; * p<0.01; NS: Non Significant

**Table 3: Effect of age and sex on cholesterol percentage of Srinidhi and Vanaraja chicken**

| Variety | Sex | Age | | | |
|---|---|---|---|---|---|
| | | 16 weeks | 20 weeks | 24 weeks | Overall |
| Srinidhi | Male | 32.03±1.13 | 44.98±2.34 | 56.78±1.98 | 44.60±1.98 |
| | Female | 51.30±1.78 | 58.32±1.78 | 59.33±2.13 | 56.32±1.68 |
| | Overall | 41.66±1.09 | 51.65±2.09 | 58.05±1.97 | 50.45b±1.97 |
| Vanaraja | Male | 49.18±2.00 | 60.87±1.98 | 66.60±1.59 | 58.88±2.03 |
| | Female | 65.55±1.23 | 57.85±1.98 | 75.44±1.58 | 66.28±1.98 |
| | Overall | 57.36±1.87 | 59.36±1.68 | 71.02±1.87 | 62.58a±1.78 |
| Sex | Male | 40.61±1.90 | 52.92±2.01 | 61.69±2.00 | 51.74p±1.25 |
| | | 58.42±1.87 | 58.08±2.01 | 67.38±1.98 | 61.29q±1.43 |
| | Overall | 49.51z±1.67 | 55.50y±1.98 | 64.53x±1.67 | 56.51±1.65 |

Means with different superscripts in each class differ significantly (p≤0.05)

In the present study, cholesterol values differed significantly in two varieties irrespective of age and sex. Significant difference in cholesterol content can be attributed by the difference in fat content in both the varieties and difference in genetic expression of both varieties. Vanaraja meat showed more cholesterol content than Srinidhi meat irrespective of age. Intarapichet *et al.* (2008) also observed significant effect of genotype on cholesterol content of native chicken and Jaturasitha *et al.* (2008), Ni Wayan Suriani *et al.*(2014) also observed significant effect of breed and species on cholesterol content of breast meat of chicken. The overall values for cholesterol content increased with age from 16 weeks to 24 weeks in varieties, sex and this can be attributed tothe age which increased fat content and therefore the cholesterol content also increased proportionately. The result can be corroborate with study of Anita (2015) recorded higher cholesterol content in female than male and increase in cholesterol content as age advanced from 16 to 24 weeks of age in Rajasri chicken.

## CONCLUSION

Based on the result of the present study it was revealed that, age and sex significantly influence the fatty acid composition of chicken meat. Further study recorded Srinidhi chicken meat rich in MUFA, PUFA as compared to Vanaraja chicken. While the effect of the variety was limited to differences in some individual fatty acids and related nutritional indices of lipid metabolism but age induced significant changes in fatty acid composition in both sex. Decrease of MUFA correspondingly increases the PUFA. Also, study recorded positive effect of age on atherogenic and thrombogenic index, while h/H and p/s ratio increased significantly. Additionally, n-6/n-3 ratio decreased substantially in the older chickens. These results opens new prospective for further research on the breeding practices of Srinidhi and Vanaraja varieties in order to produce slow-growing chickens with beneficial fatty acid composition of meat for the consumers.

**CONFLICT OF INTEREST:** The authors declare that they have no competing interests.

**ETHICS STATEMENT:** Not Applicable

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