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The Relationship Between Meat Quality Characteristics and Nutritional Composition of Nandanam Quail-III Slaughtered at Different Ages

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ABSTRACT

In recent years, Japanese quail meat has gained much popularity among consumers. The aim of this study was to evaluate the meat quality characteristics and nutritional composition of Nandanam Quail-III (*Coturnix coturnix japonica*) meat as influenced by age at slaughter. Totally twelve birds were divided into two different age groups. The birds were slaughtered and breast muscle was obtained. The meat quality characters, proximate composition, amino acid and fatty acid content of meat of two age groups were analysed. The significant difference ($P<0.01$) was observed in muscle fibre diameter, myofibrillar fragmentation index, moisture, protein, fat, major amino acids, total saturated fatty acids, total P/S, cholesterol content between two age groups. Based on the results it was concluded that the meat of young Nandanam Quail-III had the superior meat quality characters in terms of less fibre diameter, lesser myofibrillar fragmentation index and nutritional composition like less fat, saturated fatty acids, higher poly unsaturated fatty acids and amino acids.

Keywords: Meat quality characteristics, nutritional composition, Nandanam Quail-III, amino acids and fatty acids

Meat is a nutrient-dense food and meat and meat products are important sources of wide range of nutrients. However, meat is not a homogeneous food group and the composition of meat varies by meat category (Cosgrove *et al.* 2005). For example, the fat content of red meats such as beef, lamb and pork is higher than that of chicken and turkey (Chan *et al.* 1995; 1996). Meat has exerted a crucial role in human evolution and is an important component of a healthy and well balanced diet due to its nutritional richness (Pereira and Vicente, 2013). It is essential to know about the role of meat and its importance in human nutrition. Meat is an excellent source of good quality animal protein which provides all the essential amino acids (lysine, threonine, phenylalanine, tryptophan, leucine, isoleucine and valine) and various micronutrients in proper proportion to human being (NHMRC, 2006).

Consumption of poultry meat and poultry meat products is growing all over the world (Mielnik *et al.* 2002). The Japanese quails are most commonly bred and reared for human consumption. The quails are distributed worldwide overlarge areas of Asia, Europe and Africa, but they were first domesticated in Japan (Mizutani, 2003). The quail was introduced to the Indian sub-continent as an alternative of avian species from last two decades to alleviate chronic protein deficiency among the Indian population. In India domesticated quails differ from wild species which are protected under the Wild Life Protection Act, (1972).

Quail meat is an authenticated ideal food, which is tender, very delicious with low calorific value and high dry matter (Sonale *et al.* 2014). Quail meat is considered superior to red meat because it contains low fat content, low cholesterol and high amount of iron (Jaturasitha *et al.* 2004). Quail meat, particularly the breast fillet is very lean. Quail meat like most fowl meats is a valuable source of protein with very good amino acid profile. The essential amino acids content of quail breast meat is 6.5% higher than leg meat especially isoleucine and valine concentration (Genchev *et al.* 2008). Quail has unique qualities like hardiness and adaptability to diversified agro-climatic conditions. Earlier the development and popularization of quail meat was not possible due to ban on captivation of domestic quails, but now because of lifting of ban quail industry is in emerging

stage and in future it has tremendous scope to occupy a considerable portion of poultry meat.

With this in consideration, the objective of the present study was to compare the meat quality characters and nutritional composition of Nandanam Quail-III. The Nandanam Quail-III had been developed by continuous selective breeding of Nandanam-I and II through eighteen generations.

MATERIALS AND METHODS

Experimental design

A total number of twelve male Nandanam Quail-III of two different age groups *viz.,* young (5 weeks) and adult (27 weeks) were purchased from Institute of Poultry Production and Management, TANUVAS, Chennai. Each group consisted of six birds. The birds were transported to the department of Meat Science and Technology, Madras Veterinary College, Chennai. The birds were given with adequate rest and were slaughtered by neck severing method. The samples were taken from the breast (*Pectoralis major*) muscle (Boni *et al.* 2010a) immediately after slaughter and used for the analysis.

Analytical procedures

The pH of the meat sample was measured using a digital pH meter (Digisun electronic system, model: 2001) as per the method outlined by Troutt *et al.* (1992a) and the water holding capacity was assessed by adopting the filter paper press method with certain modifications (Grau and Hamm, 1957). Muscle fibre diameter was measured according to the method outlined by Jeremiah and Martin (1982). Myofibrillar fragmentation index (MFI) was determined by ‘‘Virtis homogeniser 45” (Virtis Company, Gardinar, New York, USA) with slight modifications (Davis *et al.* 1980). Proximate composition *viz.,* moisture, protein, fat and total ash content of meat samples were analyzed by following the standard procedure (AOAC, 1995). Amino acid content of meat was estimated by Chromatography (Bruckner *et al.* 1991) and by Standard hydrolysis procedure (Fountoulakis and Lahm, 1998) and fatty acid content was estimated (Palmquist and Jenkins, 2003) with slight modifications. Cholesterol content was determined using cholesterol test kit (Recombigen Pvt ltd., India) except that instead of blood serum, lipid extract was prepared (Folch *et al.* 1957) and the cholesterol content was estimated as per the method described by Wybenga *et al.* (1970).

Statistical analysis

The data obtained in the present study was analysed by unpaired t- test using IBM® statistical package for social sciences 20.0 for MS-Windows®.

Table 1. Mean ± SE of meat quality characteristics of young and adult age groups of Nandanam Quail-III meat

Parameters	Young	Adult	t- value
pH	6.65 ± 0.02	6.73 ± 0.01	2.87*
Water holding capacity (cm^2)	2.10 ± 0.06	2.12 ± 0.06	2.00^{NS}
Fibre diameter (µm)	51.43 ± 0.69	69.92 ± 1.09	26.81**
Myofibrillar fragmentation index	761.33 ± 1.05	872.17 ± 1.74	54.48**

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. Mean ± SE of proximate composition (%) of young and adult age groups of Nandanam Quail-III meat

Parameters	Young	Adult	t- value
Moisture	73.89 ± 0.09	72.32 ± 0.12	10.48**
Protein	22.35 ± 0.12	23.64 ± 0.12	7.57**
Fat	2.51 ± 0.08	2.78 ± 0.03	3.33**
Total Ash	1.25 ± 0.02	1.26 ± 0.01	0.24^{NS}

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

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

RESULTS AND DISCUSSION

Meat quality characteristics

The meat quality characteristics *viz.,* pH, water holding capacity, muscle fibre diameter and myofibrillar

fragmentation index between two age groups Nandanam Quail-III were shown in Table 1. The meat of young quail had significantly (P<0.05) lower pH than adult which was confirmed with the results obtained by Boni *et al.* (2010b) in quails. Boni *et al.* (2010b) found lower pH value in quails than the present study. The lower pH of quail meat could be due to the better welfare conditions that reduce the stress pre-slaughter and thus consumption of glycogen (Castellini *et al.* 2002). However, contrary to the findings of this study a highly significant (P<0.01) decrease in pH with increase age in turkey has been reported (Sarica, *et al.* 2011).

Table 3. Mean ± SE of amino acid content (g/100 g of meat) of two age groups of Nandanam Quail-III meat (Wet basis)

Amino acid (g/100 g of meat)	Young	Adult	t- value
Essential amino acids			
Arginine	1.50 ± 0.01	0.74 ± 0.01	42.82**
Histidine	0.82 ± 0.01	0.33 ± 0.01	27.95**
Isoleucine	1.24 ± 0.02	0.62 ± 0.01	33.17**
Leucine	2.05 ± 0.01	1.01 ± 0.01	70.37**
Lysine	1.79 ± 0.02	0.84 ± 0.02	39.43**
Methionine	0.34 ± 0.01	0.33 ± 0.01	2.01^{NS}
Phenylalanine	0.99 ± 0.01	0.51 ± 0.01	28.92**
Threonine	1.82 ± 0.02	0.92 ± 0.01	44.13**
Valine	1.27 ± 0.01	0.59 ± 0.01	44.20**
Non-essential amino acids			
Alanine	1.58 ± 0.01	0.73 ± 0.01	48.40**
Aspartic acid	1.99 ± 0.01	1.00 ± 0.01	73.10**
Glutamic acid	4.24 ± 0.01	2.20 ± 0.01	156.21**
Glycine	1.23 ± 0.02	0.52 ± 0.01	26.72**
Serine	1.03 ± 0.01	1.02 ± 0.01	1.61^{NS}
Tyrosine	0.91 ± 0.01	0.86 ± 0.02	2.02^{NS}

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

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

Water holding capacity of quail meat decreased non-significantly with the increase in the age of the birds 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 buffaloes (Kandeepan *et al.* 2009) and in goat (Sivakumar, 2003).

There was highly significant difference (P<0.01) in fiber diameter of quail meat between two age groups. The higher the fibre diameter was observed in adult quails 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). The increased fibre diameter with increasing age was observed in both breast and thigh muscles of layer chicken (Singh *et al.* 1985). The results are in agreement with the findings of Romans *et al.* (1965) in beef and Appa Rao *et al.* (2009) in carabeef.

Myofibrillar fragmentation index is an accurate index of tenderness and is a useful indicator of the extent of proteolysis (Olson *et al.* 1976). There was a highly significant (P<0.01) difference in myofibrillar fragmentation index of quail meat between two age groups was observed. Significant differences in myofibrillar fragmentation index between age groups were also observed in emu meat (Ramani 2013) and goat meat (Ilavarasan *et al.* 2015).

Proximate composition

The proximate composition *viz.,* moisture, protein, fat and total ash content of Nandanam Quail-III meat of two age groups was presented in Table 2 along with test of significance. The meat of adult quail had significantly (P<0.01) lower moisture and higher protein (P<0.01), fat (P<0.01) and total ash content than young. The moisture content of quail meat decreases as age of the bird increase, which is probably associated with an increase in fat content (Lawrie, 1998). Fat is the last tissue to mature and older birds tending to be fatter (Warriss, 2000). Similar values were obtained by Boni *et al.* (2010b) in quail (P<0.05). The meat of Nandanam Quail-III had higher protein and lower fat content when compared to the results made by Boni *et al.* (2010b) in quails.

Table 4. Mean ± SE of fatty acid analysis (%) and cholesterol content (mg/100 g) of young and adult age groups of Nandanam Quail-III meat

Fatty acid type	Fatty acid (Per cent)	Young	Adult	t - value
(SFA)	Myristic Acid (C14:0)	0.77 ± 0.06	1.73 ± 0.03	13.11**
	Palmitic Acid (C16:0)	24.45 ± 0.45	25.88 ± 0.01	3.18**
	Stearic Acid (C18:0)	11.62 ± 0.25	12.42 ± 0.07	3.19**
	Arachidic Acid (C20:0)	0.30 ± 0.05	0.59 ± 0.07	3.46**
	Behenic Acid (C22:0)	2.06 ± 0.11	2.53 ± 0.12	2.83*
(MUFA)	Palmitoleic Acid (C16:1)	5.66 ± 0.67	5.66 ± 0.67	1.19^{NS}
	Oleic Acid (C18:1)	31.97 ± 0.73	33.54 ± 0.29	1.99^{NS}
(PUFA)	Linoleic Acid (C18:2)	16.53 ± 0.38	15.13 ± 0.76	1.64^{NS}
	Linolenic Acid (C18:3)	0.85 ± 0.13	0.41 ± 0.05	3.04*
	Ecosapentaenoic Acid (C20:5)	0.44 ± 0.05	0.30 ± 0.02	2.54**
	Docosohexanoic Acid (C22:6)	0.76 ± 0.08	0.49 ± 0.08	2.30*
Total saturated fatty acids (SFA)		39.19 ± 0.32	43.15 ± 0.12	11.49**
Total mono unsaturated fatty acids (MUFA)		37.63 ± 1.10	40.17 ± 0.45	2.14^{NS}
Total poly unsaturated fatty acids (PUFA)		18.58 ± 0.33	16.33 ± 0.78	2.64*
Total unsaturated fatty acids (UFA)		56.21 ± 1.13	56.51 ± 0.86	0.21^{NS}
Total P/S		0.47 ± 0.01	0.38 ± 0.02	4.40**
Cholesterol (mg/100 g)		71.50 ± 0.27	74.04 ± 0.25	6.89**

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).

Amino acid

The amino acid content of young and adult age groups of Nandanam Quail-III meat was summarized in Table 3 and it revealed highly significant difference (P<0.01) in arginine, histidine, isoleucine, leucine, lysine, phenylalanine, threonine, valine, alanine, aspartic acid glutamic acid and glycine contents. Glutamic acid was found to be higher among the amino acids. Similar results were obtained by Wattanachant *et al.* (2004) in 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).

Fatty acid

The fatty acid content of young and adult age groups of Nandanam Quail-III meat was summarized in Table 4 and it revealed highly significant difference (P<0.01) in myristic acid, palmitic acid, stearic acid, arachidic acid and ecosapentaenoic acid and significant difference (P<0.05) in behenic acid, linoleic acid and docosohexanoic content between two age groups of Nandanam Quail-III meat. Palmitic acid was the predominant saturated fatty acid which was higher in adult age groups. Oleic acid was the predominant monounsaturated fatty acid. The young quails had higher quantities of polyunsaturated fatty acids especially linoleic, linolenic, ecosapentaenoic and docosohexanoic acids. The mean total saturated and total mono unsaturated fatty acids content were significantly (P<0.01) increased whereas the total poly unsaturated fatty acids and total P/S ratio content were decreased as age at slaughter increased. The similar results were observed in ostrich (Girolami, *et al.* 2003), Thai indigenous chicken (Wattanachant, 2004) and in quail (Boni, *et al.* 2010b). Saturated fatty acids (except stearic acid) have a tendency to increase total cholesterol levels (Bananome and

Grundy, 1988). In the present study on fatty acid analysis revealed that meat of young birds had less saturated fatty acids than the meat of adult birds. 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 (Owen *et al.* 1978; Kirton 1988). 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). The mean cholesterol content was significantly higher in adult Nandanam Quail-III meat than young. Similar results were obtained in ostrich meat (Girolami *et al.* 2003). The climate, soil content, water composition and breeding policies of the various regions may affect the nutrient content of the animal feed and thus the nutrient content of the animal's meat (Greenfield and Southgate, 2003; Okeudo and Moss, 2005).

CONCLUSION

Based on the results obtained in this study on meat quality characters and nutritional composition of Nandanam Quail-III meat, it was concluded that the age of the meat had the significant effect on it. The young Nandanam Quail-III meat had the better meat quality characters in terms of lesser muscle fibre diameter, higher myofibrillar fragmentation index and nutritional composition in terms of lesser fat, cholesterol and higher essential amino acids, poly unsaturated fatty acids, P/S ratio than adult. The Nandanam Quail-III can be slaughtered at five weeks of age for balanced nutritional composition thereby increasing economical returns to the farmers for sustainable production.

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