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Quality Characteristics of Breast and Thigh Chicken Meat from Free- Range System: Comparative Antioxidant Profile of Indigenous and Improved Germplasm

Renuka Sehrawat[1,4], Rekha Sharma[1], Sonika Ahlawat[1], Vivek Sharma[2], M.S. Thakur[3], Manjeet Kaur[4], A.K. Mishra[1], M.S. Tantia[1]

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ABSTRACT

Background: New chicken breeds are being evolved for backyard rural poultry production to overcome the slow growth, late sexual maturity and poor production of indigenous breeds. However, autochthonous poultry is epitomized for quality attributes of their products. With this in mind, the present study for the first time explored the antioxidant capacity of meat obtained from a unique Indian chicken, Kadaknath and a synthetic breed of poultry, Jabalpur colour (JBC).

Methods: During the period 2018-2020, breast and thigh meat were collected from chickens (n=20/group) at their commercial slaughter age (20 weeks). Meat extract was used for qualitative evaluation. Antioxidant activity was explored using five well established *in vitro* methods testing for different antioxidant mechanisms.

Result: Both, Kadaknath and JBC meat was proteinaceous with higher protein concentration (g/100 g of wet weight) in the breast (Kadaknath, 25.21±0.31 and JBC, 25.65±0.39) than the thigh (Kadaknath, 19.98±0.29 and JBC, 19.04±0.23). Both the groups exhibited antioxidant capacity in all the assays. They showed good radical scavenging for ABTS and DPPH free radicals. Superiority of Kadaknath meat was ascertained unequivocally by the three assays *viz*. Ferric reducing antioxidant power (FRAP), lipid oxidation inhibition (TBARS) and metal chelating capacity. FRAP values (mM Fe^{2+}/g of tissue) were 26.97±0.37 and 33.85±0.47 (Kadaknath) and 22.84±0.25 and 26.82±0.36 (JBC) for breast and thigh, respectively. Similarly, Kadaknath meat was more potent (% inhibition) iron chelator (breast, 62.71±0.99 and thigh, 75.07±0.98) in comparison to the JBC (breast, 46.30±2.36 and thigh, 63.12±1.87). Breast meat had better scavenging capacity than the thigh except in FRAP and metal chelating assays. Results provide insight into the antioxidant potential of backyard poultry germplasm thus, laying foundation for developing marketing strategies targeting consumers interested in nutritional quality, animal welfare and environmental sustainability. Furthermore, baseline data has been generated for studying medicinal properties attributed to the black chicken meat of Kadaknath.

Key words: Antioxidant capacity, Chicken, Jabalpur colour, Kadaknath, Protein.

INTRODUCTION

The backyard poultry farming in India is being recognized as a robust tool for the improvement of socioeconomic and nutritional status among rural masses. It can be used as a potential tool for eradication of malnutrition and poverty, for income generation and reduction of unemployment in rural areas (Conan *et al.* 2012 and Chakrabarti *et al.* 2014). Indigenous breeds of chicken, raised under free range backyard conditions are suitable for low-cost scavenging- type production systems due to their ability of converting kitchen waste, crop by products and other available feed stuff into highly nutritious products, *i.e.* meat and eggs (Pal *et al.* 2020). They have various desirable traits like broodiness, self-defense from predators, adaptability to adverse environments, disease resistance, minimal health care requirements, characteristic taste and flavor of the meat and a better price for the poultry products (Singh and Singh, 2005; Faruque *et al.* 2010). However, there are some major constraints of backyard poultry farming such as, high mortality rate in young chicks due to diseases, malnutrition, climatic exposure and lack of scientific knowledge. In order to overcome these constraints, there is a need of introducing improved indigenous varieties of poultry suitable for backyard farming. Another approach is to develop synthetic lines that are intermediaries between broiler and indigenous chicken to bridge the gap between

[1]ICAR-National Bureau of Animal Genetic Resources, Karnal-132 001, Haryana, India.
[2]ICAR-National Dairy Research Institute, Karnal-132 001, Haryana, India.
[3]Nanaji Deshmukh Veterinary Science University, Jabalpur-482 001, Madhya Pradesh, India.
[4]Maharishi Dayanand University, Rohtak-124 001, Haryana, India.

Corresponding Author: Rekha Sharma, ICAR-National Bureau of Animal Genetic Resources, Karnal-132 001, Haryana, India. Email: Rekha.sharma1@icar.gov.in

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quality and quantity of products obtained from indigenous chicken and commercial broiler, respectively. These crosses have advantage of having adaptability to harsh climatic conditions, disease resistance and colorful plumage of native birds and growth rate and feed conversion efficiency of broilers. In this perspective, an improved dual purpose synthetic line, Jabalpur colour (JBC), has been developed by crossing broiler control line with dwarf male line and maintained by inter se mating by Nanaji Deshmukh Veterinary Science University, Jabalpur, Madhya Pradesh, India. The laying potential of Jabalpur color in terms of egg production (254 eggs at 72 weeks) is better than the Kadaknath (130 eggs per annum) and their body weight gain is also 3.3 kg, while Kadaknath body weight is 1.7 kg at the age of marketing.

Now a day's focus has shifted to the healthy and natural foods that resulted in renewed interest in native chickens (Dyubele *et al*. 2010). Modern consumers perceive the meat of birds raised in alternative production systems (organic) as safer due to the absence of chemical residues. Meat of indigenous and local birdsis also preferred because of unique taste, firm texture and rich flavor. Moreover, the native breeds can be considered asthe reservoir of genes which are required for introducingdisease resistance and adaptability to tropical conditions inthe high yielding exotic germplasm (Padhi, 2016). In spite of all these, indigenous poultry is facing threat due to the industrialization and globalization of chicken production (Yadav *et al*. 2017).These developments are leading towards the loss of precious genetic material and consequently, to the loss of biodiversity. This could potentially drive the extinction of numerous indigenous chicken breeds (Pellattiero *et al.* 2020). One such breed of Indian chicken seriously endangered with extinction is Kadaknath, bred by tribals in the Jhabua and Dhar districts of Madhya Pradesh state. Kadaknath is the only all black chicken among the 19 diverse chicken breeds of India (www.nbagr.res.in). Their internal organs show intense black coloration due to genetic condition,fibromelanosis (Dharmayanthi *et al.* 2017). These are famous for flavorful lean meat that has gamey texture. The meat and eggs are considered to be the rich sources of protein and iron (Mohan *et al.* 2008). Its meat is used as folk medicine for proclaimed invigorating and medicinal properties. As a result, it is arousing interest among consumers due to the expectations of pharmacological benefits.

Poultry meat is considered one of the most desirable meats all over the world (Kamboh and Zhu, 2013) as it is rich in proteins, amino acids, carbohydrates, polyunsaturated fatty acids (PUFA), minerals and is low in fat. It is also a rich source of antioxidants. Endogenous antioxidants may be useful in preventing the deleterious consequences of oxidative stress and hence there is an increasing interest in the protective biochemical functions of natural antioxidants found in chicken meat (Kurutas, 2016). Regular dietary intake of chicken meat has been suggested to reduce the incidence of many diseases and exert a beneficial effect on human health (Jayasena *et al*. 2013). Many scientific studies are addressing the varied health benefits of antioxidants in processes like stress, pathogen infestation, aging, apoptosis and neurological diseases. Antioxidants play a vital role in both food systems as well as in the human body to reduce oxidative processes and harmful effects of reactive oxygen species (Cakmakci *et al.* 2015; Gocer *et al.* 2013). Therefore, the antioxidant potential of chicken meat could be the key not only in forecasting the prospective health benefits but also oxidative stability of the meat.

In complex heterogeneous foods such as meat and meat products, antioxidative potential cannot be evaluated by a single method (Perez-Jiménez and Saura-Calixto, 2005). Keeping all these facts in mind, a study was planned to compare antioxidative potential of meat obtained from backyard poultry germplasm, including both indigenous (Kadaknath) and improved synthetic broiler line (JBC). As per the best of our knowledge, no previous study on the comparative profile has been conducted on their antioxidant potential.

MATERIALS AND METHODS

This is an inter-institutional study that was carried out during the period February 2018 to March 2020. Birds were raised at Nanaji Deshmukh Veterinary Science University, Jabalpur and subsequent biochemical analysis was carried out at two ICAR Institutes at Karnal; National Bureau of Animal Genetic Resources and National Dairy Research Institute.

Reagents

Water, potassium persulfate, acetic acid (glacial), sodium acetate, ferric chloride, Folin Ciocalteu reagent, 2,2′ - azino-bis (3-ethylbenzothiazoline-6-sulfonic acid) (ABTS), 1,1 diphenyl-2-picryl-hydrazyl (DPPH) and 6-hydroxy-2,5,7,8-tetramethylchroman-2 carboxylic acid (Trolox) were purchased from Sigma Chemical (St. Louis, MO, USA). All other chemicals and solvents were of analytical grade.

Birds

The birds of Kadaknath and JBC (N=20, each) were reared at the experimental poultry farm of College of Veterinary Sciences and Animal Husbandry, Jabalpur, India under deep litter system (Fig 1). Open sided poultry houses were utilized under similar standard management conditions. The experiment was approved by the Institutional animal ethics committee (O No. 4040/Dean/Vety/2018 dated 18.12.2018). Animals were sacrificed at the respective age of marketing (20 weeks) in the abattoir following standard scientific procedures. Surface fat and connective tissue were dissected away from the primal cuts; breast (*pectoralis major* muscle) and thigh (*biceps femoris* muscle). Samples were covered by an aluminium sheet to avoid exposure to light, packed in PE plastic bags and frozen at -80°C for further analysis. Before analysis, samples were thawed at 20±2°C in a thermostatic bath.

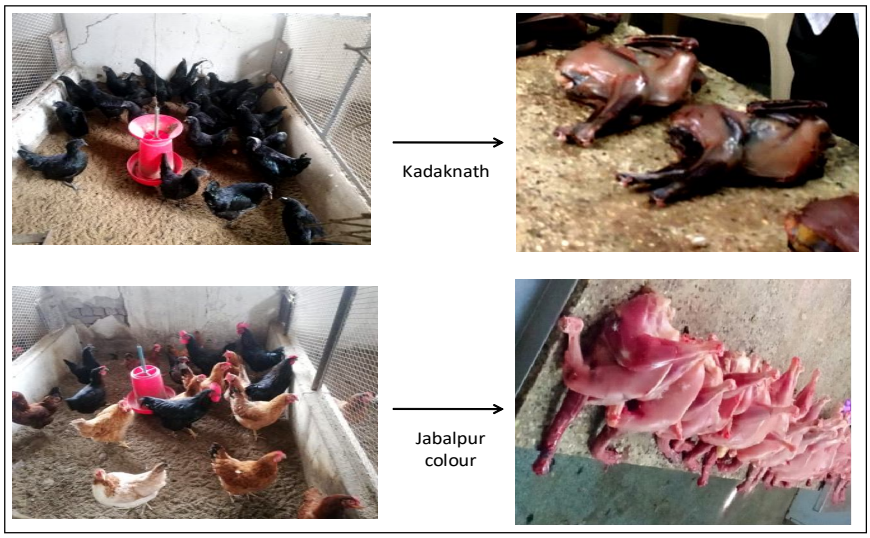

Fig 1: Representative flock and carcass of two groups of free range chicken considered in the study.

Preparation of hydrolysate

Two gram of each meat sample was homogenized in 20 ml of phosphate buffered saline (pH, 7.4) in an ice bath, using a homogenizer (Benchmark Scientific D1000, USA). The homogenate was extracted in dark for 20 minutes at 4°C followed by centrifugation at 2,346 g for 15 min at 4°C. The solid residue was discarded.

Protein estimation

Protein content of meat extract was determined by Lowry method (Lowry *et al.* 1951) using Bovine serum albumin (BSA) as a standard. Absorbance was recorded at 660 nm using a spectrophotometer (UV-Vis 2080 Plus; Analytical Technologies Ltd. India).

DPPH (1,1-diphenyl-2-picrylhydrazyl) radical scavenging activity

The assay based on scavenging DPPH radicals by antioxidants was assessed according to the method of (Brand-Williams, 1995) with slight modifications. Briefly, 1 ml of extract was diluted with 1 ml of water and 1 ml of ethanolic DPPH solution (0.2 mM). The mixture was vortexed and incubated at room temperature for 40 minutes in the dark. It was centrifuged at 4,500 rpm for 10 minutes at 4°C. The absorbance of solution was measured at 517 nm. Ascorbic acid was used as a positive control.

$$\text{Scavenging of DPPH radicals (\%)} = \frac{\text{Control absorbance-Sample absorbance}}{\text{Control absorbance}} \times 100$$

Where,
Control has ethanol instead of sample.

ABTS (2,2-azinobis (3-ethyl-benzothiazoline-6-sulfonic acid) antioxidant capacity

Method of Re *et al.* (1999) with some modi-fications was followed. The bleaching rate of ABTS radical cation in the presence of the sample was monitored at 735 nm. To generate the $ABTS^+$ radical, equal volumes of 14 mM $ABTS^+$ solution and a 5.9 mM potassium persulfate solution were mixed and reacted at 23°C±1°C for 12 h in the dark. The stock solution was diluted with distilled water to an absorbance of 0.70±0.02 at 735 nm at 30°C. Trolox (0-600 µM), the hydrophilic homologue of vitamin E was used as a standard reference to convert the inhibition capability of each sample to the Trolox equivalent antioxidant capacity (TEAC).

Ferric reducing antioxidant power (FRAP) assay

The antioxidant capacity of the meat extract was determined by using the kit (EIAFECL2) from Invitrogen, Thermo Fischer scientific. This kit measured the ability of sample to reduce ferric iron to ferrous iron. FRAP color solution was prepared by adding 3.4 ml of 1x assay buffer, 340 µl of FRAP reagent A, 340 µl of FRAP reagent B. 20 µl of sample solution was mixed with 75 µl of FRAP color solution and plate was incubated for 30 min at room temperature. The reduction of iron in the FRAP reagent led to the appearance of a blue product that was read at 560 nm. FRAP value was derived using $FeCl_2$ standard curve that was linear between 200 and 1000 µM (r^2 value = 0.998). Results were expressed in mM Fe^{2+}/g of meat.

Lipid oxidation inhibition in emulsion

Lipid oxidation inhibition capability was determined by ability of meat extract to inhibit iron/ascorbate catalyzed oxidation of phosphatidylcholine liposomes by measuring the thiobarbituric acid reactive substances (TBARS) value according to Gopalakrishnan *et al.* (1999) with slight modifications. Diluted sample (300 µl) was mixed with 500 µl of phoshphatidylcholine liposomes emulsion and incubated for 5 minutes at room temperature. 100 µl of $FeCl_2$ (1 mM) and 100 µl of sodium ascorbate (1 mM) were added to this mixture and vortexed vigorously. The oxidation mixture was incubatedat 37°C for 2 hours. Afterwards TBARS value was estimated using Lipid peroxidation (MDA) assay kit (MAK085, Sigma Aldrich). Briefly, 3 µl of butylated hydroxy

toluene (BHT) and 600µl of thiobarbituric acid (TBA) were added to the mixture.The tightly closed tubes were heated at 90°C for 1 hour. They were cooled under ice bath and centrifuged at 10,000g for 10 minutes. Absorbance of the supernatant was measured at 532 nm using the microplate reader (Infinite F200 Pro, Tecan Austria GmbH Austria). Concentration of MDA in oxidation system was calculated from the MDA standard curve (0-12 nmol) using the kit. The ability of lipid oxidation inhibition was calculated as follows:

$$\text{Inhibition (\%)} = \frac{\text{MDA conc. in absence of exrtract - MDA conc. in presence of extract}}{\text{MDA conc. in presence of extract}} \times 100$$

Metal chelating activity

Iron chelation activity was determined by measuring the formation of Fe^{2+} - Ferrozine complex by using the method of Dinis *et al.* (1994) with slight modifications. 100 µl of extract was added to 100 µl ferrous chloride solution (2 mM). The reaction was started by the addition of 0.2 ml ferrozine (5 mM) and incubated at room temperature for 10 minutes and then the absorbance of Fe^{2+} - Ferrozine complex is measured at 562 nm. The chemical metal chelator Ethylene diamine tetra acetic acid (EDTA) was used as a positive control and calibration curve was drawn with the concentration ranging from 25-200 µM. Results were expressed both as the EDTA equivalent chelating capacity (µM EDTA/g of tissue) and the iron chelating activity (% inhibition) which was calculated using following equation:

$$\text{Iron chelation activity (\%)} = \frac{\text{Absorbance of the control- Absorbance of the sample}}{\text{Absorbance of the control}} \times 100$$

Statistical analysis

Experimental results were expressed as means ± standard error of triplicate determinations. The data were analyzed by one-way analysis of variance. Tests of significant differences were determined by Duncan's multiple range or *t* tests at $P \leq 0.05$ using SPSS Version 24 (SPSS/IBM Corp, Armonk, New York, NY).

RESULTS AND DISCUSSION

Backyard poultry farming is preferred among rural and landless population in India as a lucrative source of supplementary income. It involves low investment and yields high economic returns and can be easily managed by women, children and the elderly. Meat and eggs from such birds are source of protein and energy for poor households. Backyard poultry farming is characterized by an indigenous night shelter system, scavenging, natural hatching of chicks, scant supplementary feed, local marketing and minimal health care practices. However, it suffers from the low productivity of birds. Thus, efforts are on to develop and introduce better performing backyard poultry germplasm such as Jabalpur colour (JBC), a synthetic broiler line. This research leads to antioxidant potential characterization of a unique backyard poultry breed, Kadaknath and an improved synthetic line for the low cost production system. Breast and thigh, two major cuts were investigated as chicken breast contains mainly fast-twitch glycolytic fiber (type-IIB) generating ATP by anaerobic fermentation, while thigh contains slow-twitch oxidative fiber (type I), where aerobic metabolism predominates (Intarapichet and Maikhunthod, 2005).

Protein concentration

Primary importance of meat in human nutrition stems from high quality proteins that provide essential amino acids on digestion. They also play an important role towards antioxidant activity of meat due to their ability of scavenging free radicals and chelating pro-oxidative metals (Serpen *et al.* 2012). Breast meat was significantly ($P<0.05$) proteinaceous than the thigh meat in both the groups. Kadaknath as well as JBC meat was found to be protein dense (Table 1). Average protein content (g/100 g of wet weight) of Kadaknath breast (25.21±0.31) and thigh (19.98±0.29) meat was similar to the corresponding values of JBC breast (25.65±0.39) and thigh (19.04±0.23) meat. Kadaknath had previously been reported to have the highest protein content among the Indian chicken breeds (Mohan *et al.* 2008). Protein concentration in Kadaknath breast meat 25.21 (g/100 g of wet weight) was even higher than the only other report on all black chicken, Silky fowl of China 22.8 (g/100 g of wet weight) (Wang *et al.* 2018). Protein content in chicken meat is influenced by several factors, amongst which genotype plays a crucial role. Previous studies have reported the lower protein concentration (22%) in the broiler chicken as compared to the free range chicken (24%) such as the Algerian crested (Zidane *et al.* 2018) and Chinese local chicken "Gushi" (Wang *et al.* 2009), even under similar management conditions. Kim *et al.* (2017) reported protein concentration of 20.80 (g/100 g of sample) and 16.93 (g/100 g of sample) for the commercial Cobb broiler breast and thigh, respectively. Similar to the current findings, Jayasena *et al.* (2013) reported that Korean indigenous or crossbred chickens had higher protein as compared to commercial broilers and attributed it to the differences in their growth rate. Therefore, both the backyard poultry groups can be considered as an excellent source of protein in human diet.

Antioxidative capacity

It gives valuable indication of functional property of meat. Most natural antioxidants are multifunctional and in complex heterogenous foods such as meat, there activity cannot be evaluated by a single method. As a result, numerous methods have been developed over decades to test the antioxidative activity of food matrices (Liu *et al.* 2016). Therefore, we selected five different commonly accepted and validated methods for robust comparative evaluation of meat. Among selected methods, DPPH allows evaluation of the hydrogen-donating potency of compounds, ABTS radical scavenging estimates single electron transfer capabilities, FRAP assay measures the reductive antioxidant power and TBARS assaymonitors capacity to inhibit lipid

Table 1: Protein and antioxidant potential of breast and thigh meat extracts of Kadaknath and Jabalpur color chicken (N=20) for each group.

Parameter / group	Proteing /100 g of tissue	DPPH assay % inhibition	ABTS assay % inhibition	FRAP value Fe^{2+}(mM)/ gof tissue	Lipid oxidation % inhibition	Metal chelation activity	
						% inhibition	EDTA equivalent (µM/g of tissue)
Breast							
Kadaknath chicken	25.21±0.31[a]	73.26±0.70[a]	52.72±1.42[a]	26.97±0.37[a]	67.04±0.45[a]	62.71±0.99[a]	3254.18±74.37[a]
Jabalpur color	25.65±0.39[a]	73.92±0.44[a]	52.12±1.36[a]	22.84±0.25[b]	62.89±0.71[b]	46.30±2.36[b]	2468.22±112.81[b]
Thigh							
Kadaknath chicken	19.98±0.29[a]	66.75±0.55[a]	30.14±1.00[a]	33.85±0.47[a]	68.06±0.37[a]	75.07±0.98[a]	3845.99±46.94[a]
Jabalpur color	19.04±0.23[a]	67.26±0.63[a]	28.48±1.06[a]	26.82±0.36[b]	65.11±0.28[b]	63.12±1.87[b]	3273.85±89.61[b]

Values are mean ± Standard error. Values with different superscripts within same column differ significantly (P≤0.05).

peroxidation. Metal chelating activity against pro oxidant, iron was also monitored. Breast and thigh muscles as a typical representative of white and red muscles were selected. The antioxidant potential of breast and thigh meat extracts has been summarized in Table 1.

DPPH and ABTS generate a radical which, upon scavenging by antioxidants, will change colour, resulting in a decrease in the absorption (Damgaard *et al.* 2014). These are based on the electron transfer mechanism involving the reduction of a coloured prooxidant. Since both the assays are based on electron transfer mechanism, they would be expected to provide similar results. However, both the assays were explored as the DPPH assay is performed in an organic solvent system and hence more suited for lipophylic compounds whereas, ABTS assay is compatible with both aqueous and organic solvent systems. DPPH scavenging activity (% inhibition) was identified to be very high in the breast meat extract of both Kadaknath (73.26±0.7) as well as JBC colour (73.92±0.44). Similar trend was recorded in the thigh (Table 1). Breast meat had significantly higher ($p<0.05$) potential for scavenging DPPH radical than the thigh meat (Fig 2). The observations were parallel to the previous report (71.0%) in breast and thigh extract of chicken (Huang and Kuo, 2000) that was significantly superior to that of beef, pork and fish meat (Serpen *et al.* 2012). Similarly, $ABTS^{+}$ radical scavenging activity was of higher magnitude in breast meat extract as more than fifty percent inhibition was recorded (52.12±1.36) and (52.72±1.42) in JBC and Kadaknath, respectively. Once again, scavenging activity in the thigh was approximately half of the breast extract (Fig 3).

The FRAP method is based on the reduction of the Fe^{+3}-TPTZ complex to the ferrous form at low pH and estimates reducing potential. Kadaknath meat extract showed a higher degree of Fe^{+3} reduction than the JCB colour ($p<0.05$). ~~Its~~ FRAP value (mM Fe^{2+} / g of tissue) for breast and thigh meat was 26.97±0.37 and 33.85±0.47, respectively (Table 1). Corresponding values in JCB were 22.84±0.25 (breast) and 26.82±0.36 (thigh). Interestingly, thigh extract exhibited higher FRAP values than the breast (Fig 4). The high values of FRAP could be due to the different concentration of antioxidants present in Kadaknath meat for reducing ferric ion to its ferrous form. The current findings are concordant with the work of Serpen *et al.* 2012) reporting FRAP value to be higher in chicken meat as compared to pork, fish and goat meat.

TBARS assay is the most widely used lipid based assay and is considered to be advantageous over the free radical assays. Here, antioxidant activity detection takes place according to the definition of an antioxidant, as a substrate is protected during the assay. It measures the effectiveness of an antioxidant in preventing or delaying lipid oxidation. Lipid oxidation is problematic in food systems, where oxidative rancidity leads to nutritional loss along with the formation of toxic compounds and in human physiology, where oxidation of lipids is the major contributor to diseases

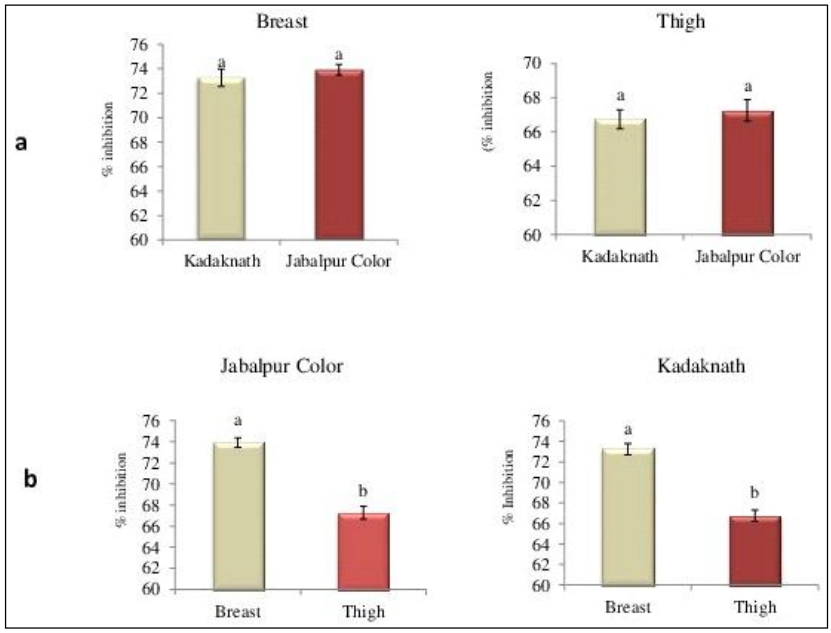

Fig 2: Antioxidant capacity measured by DPPH scavenging assay a) difference between Kadaknath and Jabalpur colour b) comparative profile of breast and thigh meat cuts. Error bar represents the mean standard error and different lowercase letters are statistically different (5% error probability).

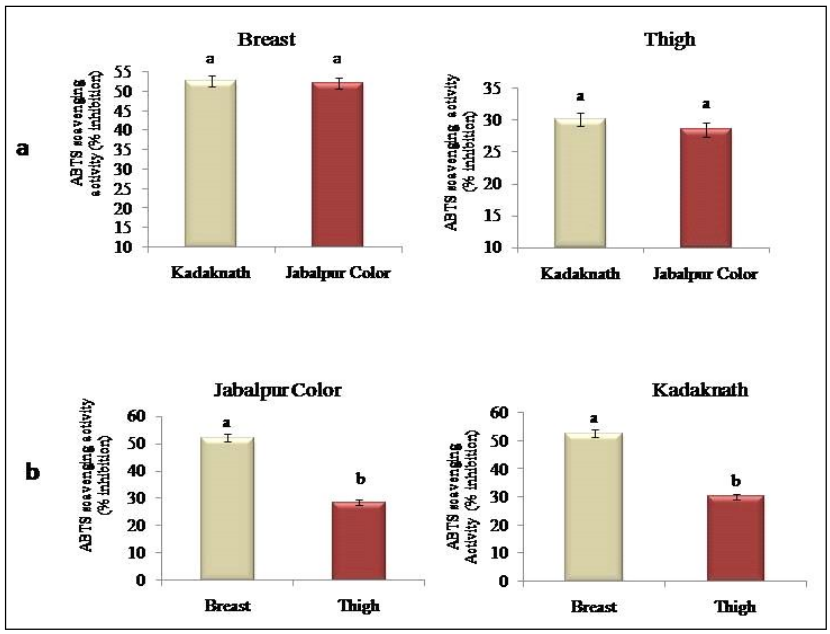

Fig 3: ABTS radical scavenging capacity a) difference between Kadaknath and Jabalpur colour b) comparative profile of breast and thigh meat cuts. Error bar represents the mean standard error and different lowercase letters are statistically different (5% error probability).

such as atherosclerosis (Ghani *et al.* 2017). The ability of hydrolysates to inhibit lipid oxidation in an emulsion is shown in the Fig 5 and mean values are presented in the fifth column of Table 1. TBARS value pointed towards the stronger antioxidant capacity of Kadaknath breast as well as thigh meat extract in comparison to the respective extracts of JBC.

Chelation of pro-oxidant metal is among the significant mechanism of action of antioxidants. Iron enhances oxidation as it acts as the catalyst for free radical reaction. They catalyze the formation of radical oxygen species and stimulate lipid oxidation (Damgaard *et al.* 2014). Complex formation of iron with organic compounds decreases its pro oxidant impact by stabilizing oxidized form of the iron. Results (Fig 6) equivocally supported the better antioxidant potential of Kadaknath breast and thigh over and above that of the JBC due to high metal chelation capability. Inhibition was more than sixty percent in breast (62.71) and more than seventy per cent (75.07) in the thigh extract of Kadaknath whereas, it was only 46.3% in breast and 63.12% in the

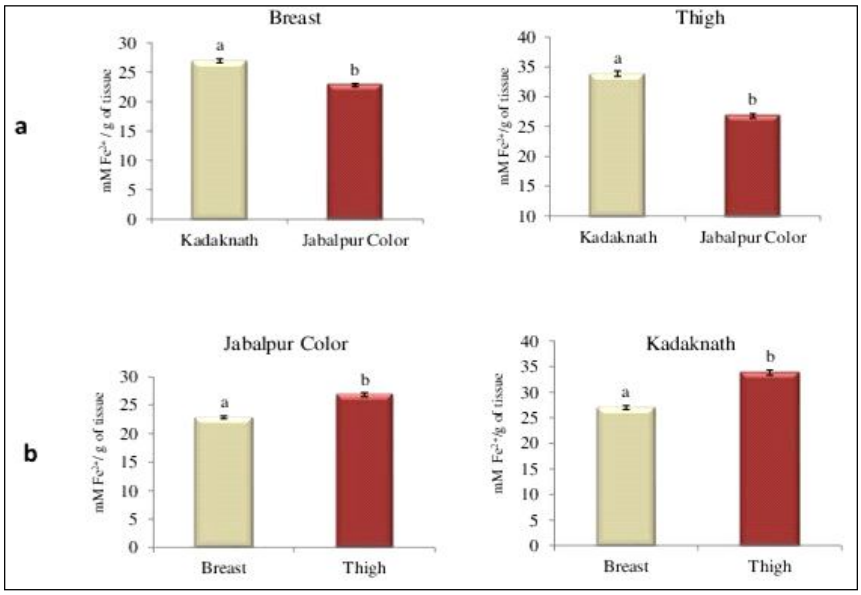

Fig 4: Total antioxidative capacity measured by FRAP assay a) difference between Kadaknath and Jabalpur colour b) comparative profile of breast and thigh meat cuts. Error bar represents the mean standard error and different lowercase letters are statistically different (5% error probability).

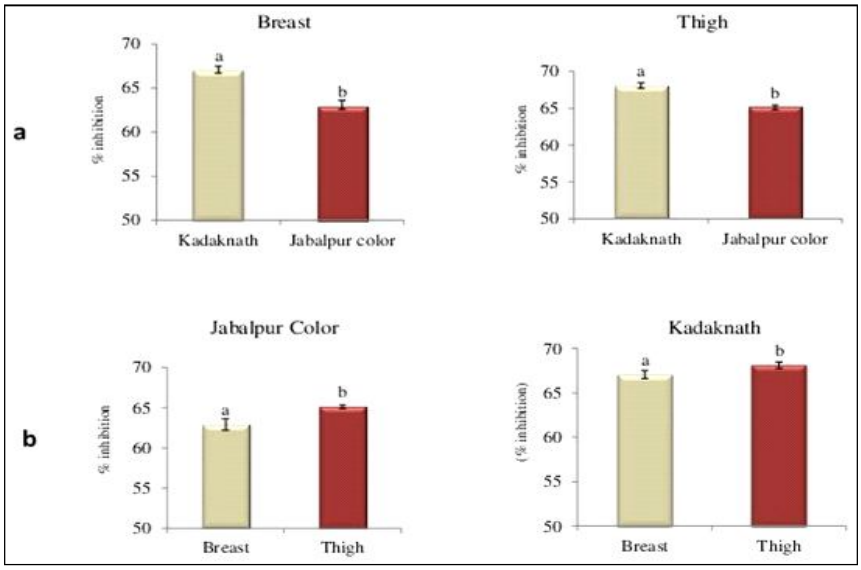

Fig 5: Inhibition of lipid peroxidation in phospatidylcholine liposomes a) difference between Kadaknath and Jabalpur colour b) comparative profile of breast and thigh meat cuts. Error bar represents the mean standard error and different lowercase letters are statistically different (5% error probability).

thigh of JBC (Table 1). Better iron chelating property of Kadaknath meat might be one of the reasons contributing towards efficient inhibition of lipid oxidation as reflected in TBARS values.

Antioxidant potential of breast meat extract was higher than that of thigh meat extract in DPPH (Fig 2) and ABTS (Fig 3) whereas, opposite was true for the FRAP (Fig 4) and metal chelation capacity (Fig 6). Iron and iron binding proteins are relatively elevated in the thigh than the breast meat and the iron binding proteins are related to the abolition and inhibition of free radicals (Kojma *et al.* 2014). It might be the reason for better reducing (FRAP value) and higher metal chelation values of the thigh meat. Anatomically the breast (white) and thigh (red) muscles are different. Myoglobin content and capillary density is also more abundant in the red muscles. Moreover, high fat in the thigh might also be responsible for low free radical scavenging activity (Sacchetti *et al.* 2008).

Various bioactive molecules such as functional dipeptides (carnosine and anserine) and aromatic amino acids (histidine, tyrosine and tryptophan) can donate proton or electron to deficient radicals and also interrupt the

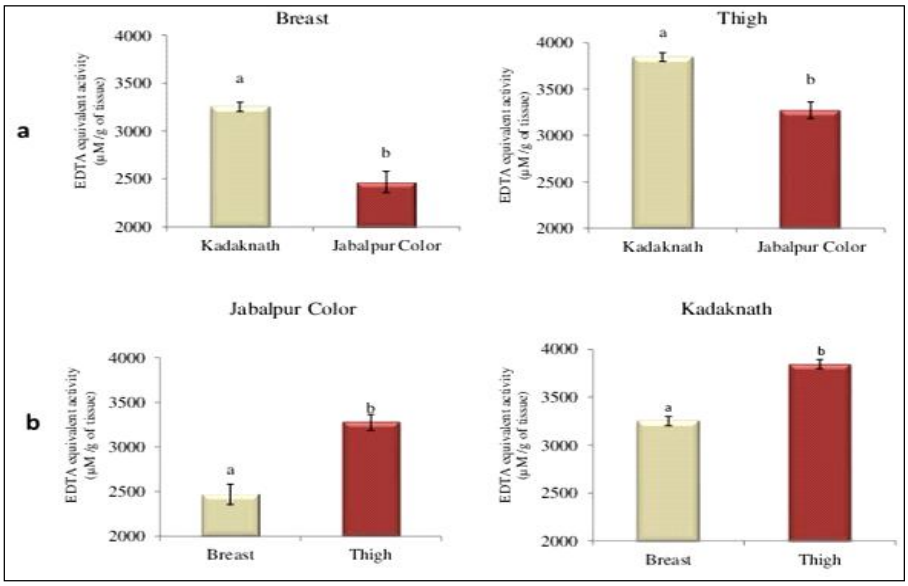

Fig 6: Antioxidant capacity characterized by iron chelation a) difference between Kadaknath and Jabalpur colour b) comparative profile of breast and thigh meat cuts. Error bar represents the mean standard error and different lowercase letters are statistically different (5% error probability).

oxidation reaction (Manihaini *et al.* 2013). Similarly, cysteine, a non-aromatic amino acid can directly interact with free radicals (Sarmadi and Ismail, 2010) while, polyamines can also contribute towards radical scavenging activity (Sacchetti *et al.* 2008). Chicken meat is reported to be enriched in histidine-containing dipeptides (carnosine and anserine) having strong antioxidant activities, more than that of the beef and pork (Serpen *et al.* 2012). Among different chicken breeds, dark chicken meat from all black silky fowl has been reported to have higher histidine dipeptides, thus higher antioxidant activity (Kojima *et al.* 2014). Black bone chickens are supposed to have medicinal utility in general and have been utilized to boost the human immune system, cure diabetes, check emaciation and treat female reproductive ailments such as menstrual irregularity and postpartum complications (Li *et al.* 2020). Nanaji Deshmukh Veterinary Science University, Jabalpur, Madhya Pradesh, India has also developed commercial dual purpose colour bird "Narmada Nidhi" with strains of 25% Kadaknath and 75% JBC. Looking into the production quality of JBC and better antioxidant capacity of Kadaknath, it will be further interesting to explore their qualitative parameters.

CONCLUSION

Kadaknath as well as JBC meat extract are potent antioxidants according to the results. Their free radical scavenging capacity, metal chelation ability and lipid oxidation inhibiting property contributed towards the antioxidant capacity. Among the two, Kadaknath meat has superior antioxidant potential due to the better metal chelation, inhibition of lipid peroxide formation as well as total antioxidative potential as reflected in the better FRAP value. Antioxidants have an important role in preventing a variety of diseases and aging because they inhibit or delay the oxidation process by either blocking the initiation or propagation of oxidizing chain reactions. Thus, Kadaknath chicken meat is a better source of the dietary antioxidants to protect the human body from damage of oxidative stress and hence risk of various degenerative diseases.

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