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Research Paper

Quality and Shelf Life of Dressed Chicken from Different Sources under Refrigeration (4±1^{O}C)

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ABSTRACT

A study was carried out to examine the changes in quality of dressed chicken obtained from different sources of processing during storage under refrigeration at 4±1^{O}C for 9 days. During storage at 4±1^{O}C, pH of the samples (RSC: Road side slaughtered chicken; MSC: Market slaughtered chicken and SSC: Scientifically slaughtered chicken) decreased on day 3 of storage followed by gradual but significant ($p<0.05$) increase on day 9 of storage. Extract release volume (ERV) decreased non-significantly in all the samples up to 6th day followed by significant ($p<0.05$) decrease in RSC and SSC samples on 9th day of storage. There was significant increase ($p<0.05$) in TBA and Tyrosine values of all three samples during storage. SSC samples showed lower TBA and Tyrosine values throughout storage compared to RSC and MSC samples. Compared to RSC and MSC samples, SSC samples showed significantly lower ($p<0.005$) total viable count (TVC), coliform count, psychrophilic count (PPC) and yeast and moulds count (YMC) at initial stage and the same trend continued on subsequent days of storage. Sensory scores for attributes viz. appearance, flavour, texture, juiciness and overall palatability did not show any differences among the samples except on day 1 only for overall palatability. RSC and MSC samples were spoiled on 6th day while SSC samples got spoiled on 9th day indicating that SSC samples had better quality and shelf life under refrigeration (4±1^{O}C) storage compared to samples from other two sources.

Keywords : *Dressed chicken, Refrigeration storage, Sources of processing, Quality change*

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INTRODUCTION

Although Indian poultry industry has registered tremendous growth but commercial poultry slaughtering and further processing through modern processing plants for marketing of fresh meat has not developed with the same space as desired. Out of total poultry slaughtered, only 5-10% of poultry meat is processed through modern poultry processing plant maintaining the hygienic standard. Remaining birds are slaughtered and dressed in road side shops or in slightly better equipped retail outlets in the local markets in most unhygienic manners in the presence of consumers (Das and Biswas 2004).

Rapid growth in consumer demand for poultry meat and poultry meat products over the last few decades and increased international trade in these foods have focused attention on objective measures on food safety and quality. Chen *et al*. (2012) has reviewed comprehensively the possible technological interventions to ensure microbial safety of meat foods. In India consumption of hot meat (un-chilled meat) is preferred, as a result road side slaughtering, dressing and sale of poultry meat is prevalent in most cities, towns and villages and such meat is highly contaminated leading to public health problems (Mukhopadhyay *et al*. 2004; Pal *et al*. 2013). Due to busy life style of the modern population in big cities and towns in India, it is now becoming a common practice for many consumers to purchase hygienically produced meat and meat products from the refrigerated display cabinets of the super markets where these products are stored mostly in chilled and frozen conditions.

Quality evaluation of fresh chicken dressed under different processing conditions revealed marked differences in their physico-chemical and microbiological quality (Santosh Kumar *et al*. 2011 and 2012). Data on the quality of chicken meat produced under different slaughtering and dressing conditions and changes in quality of such meat during refrigeration storage (4±1^{O}C) for marketing is scanty. Hence, this study was planned to evaluate the changes in the quality of chicken meat dressed under different conditions during refrigeration storage (4±1^{O}C) for 9 days.

MATERIALS AND METHODS

Sources of samples: Dressed boilers slaughtered under different conditions viz. (1) road side slaughtered chicken (RSC) from temporary road side chicken slaughter shop without any shelter; (2) market slaughtered chicken (MSC) from better equipped retail outlet of poultry meat having a permanent shelter and (3) scientifically slaughtered chicken (SSC) from hygienic semi-automatic poultry processing plant at the Department of Livestock products Technology, Rajiv Gandhi

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Institute of Veterinary Education and Research were procured. For each trial four dressed birds from each of the above mentioned sources were collected in low density polyethylene (LDPE) packages without any further contamination and transported to the laboratory under cold chain. Breast cut of each bird was separated and used for the study to maintain the uniformity of the samples. Each breast was cut longitudinally and subsequently made into 5-6 cm^3 chunks taking enough precautions to avoid further contamination. The chicken breast chunks were divided in to 250 g portions and packed in LDPE bags, sealed and stored at 4±1^{O}C. Samples were drawn and analyzed on 0, 3rd, 6th and 9th day to monitor the changes in physico-chemical, microbiological and organoleptic qualities during storage.

Analysis of samples: AOAC (1995) was followed to determine the pH of the samples using a digital pH meter (Model LE 120 Elico). Extract release volume (ERV) of the meat samples was estimated following the procedure described by Pearson (1968) with slight modification suggested by Santosh Kumar *et al*. (2012). Thiobarbituric acid (TBA) value of samples was determined following the method of Witte *et al*. (1970) and Tyrosine value (TV) was estimated following the procedures of Strange *et al*. (1977). All the samples were analyzed in duplicate. Total viable count (TVC), coliform count, psychrophilic count (PPC) and Yeast and mould count (YMC) of the samples were determined following the procedures laid down by APHA (1984) using different readymade media (Hi-Media Lab., Mumbai) for different microbial groups.

For sensory evaluation, chicken breast chunks were marinated using 1.5% salt (NaCl), 0.1% turmeric powder and 10% water for 10 minutes followed by pressure cooking at 1.1kg cm^{-2} pressure for 10 minutes. Organoleptic attributes, such as appearance, flavour, juiciness, texture and overall palatability of samples were evaluated by semi-trained panelists using 8 point hedonic scale (8 – like extremely; 1 – dislike extremely).

A total of four trials using 48 boiler carcasses were conducted. Data were analyzed following two-way Analysis of Variance (ANOVA) and levels of significance were tested using the least significant difference (LSD) test following Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

Perusal of Table 1 revealed that pH of all the samples decreased to the lowest values on 3rd day of refrigeration storage indicating attainment of ultimate pH as a result of anaerobic glycolysis and lactate formation in muscles (Warriss 2000). Thereafter, pH values showed an increasing trend reaching the highest values in all the samples on 9th day of storage. Similar trend in increase of pH values of chicken meat chunks during storage under refrigeration has been reported by Bhuvan (2013). This increase in pH on subsequent storage might be attributed to proteolysis and related changes due to inherent cellular enzymes and increased bacterial activity on refrigerated meat.

In all the chicken meat samples ERV decreased with progress of storage period. The highest ERV recorded was 15.34 ±0.18 ml in fresh SSC samples and the lowest value was found to be 10.76 ± 0.59 ml in the RSC samples on 9th day of refrigerated storage (Table 1). Almost similar values for ERV (17.08 ± 0.40 ml) in fresh chicken and stored chicken (13.0 ± 0.22) were reported by Sinhmahapatra *et al.* (2004). Abida (2012) also reported significant decrease in the ERV of marinated chicken during storage under refrigeration. Decrease in ERV values of meat during refrigerated storage might be due to increased microbial load, as a linear relationship between ERV and number of microorganisms had been confirmed in experiments with raw pork and beef (Lowis 2007). Murthy and Bachhil (1980) also reported a decrease in ERV with increase in microbial counts during storage of pork.

There was steady increase in TBA values of all the three chicken samples during storage. TBA values increased from an initial value of 0.38 to 0.89 mg malonaldehyde/kg in SSC samples and in RSC and MSC samples the values crossed the threshold level of 1.00 mg malonaldehyde/kg on 9th day of refrigerated storage (Table 1). Bhuvan (2013) reported similar increase in TBA values of chicken meat during 9 days of storage under refrigeration. The rise in TBA values in chicken meat recorded in the present study may be attributed to the fact that poultry meat contains relatively high levels of unsaturated fatty acids and low levels of natural antioxidants compared to buffalo meat or beef (Ajuyah *et al.* 1993).

In the present study tyrosine value of refrigerated chicken samples showed significant increase ($p<0.05$) over a period of 9 days (RSC: 10.65 ± 0.42 – 23.66 ± 0.21; MSC: 9.75 ± 0.79 – 21.82 ± 0.38; SSC: 8.63 ± 0.91 – 21.20 ± 0.65 mg/100g). This increase in tyrosine value might be due to both proteolysis and autolysis brought about by bacteria. Jay (1996) and Strange *et al.* (1977) emphasized that tyrosine value could be used as indicator for detecting microbial spoilage of meats, poultry and sea foods and also as an indicator of proteolysis. An increase in tyrosine value in chicken meat chunks stored under refrigeration for 9 days was reported by Bhuvan (2013) which is almost similar to the present findings Santosh Kumar

et al. (2012) also reported a low but significant increase in tyrosine values in chicken meat during frozen storage at –18°C for 90 days. Similar increase in tyrosine value was also recorded by Morrissey *et al.* (1980) in minces beef stored at 7 °C.

Table 1: Changes in the physico-chemical properties of chicken from different sources under refrigerated storage (Means± S.E)

		Storage days			
Parameters	**Samples**	**0**	**3**	**6**	**9**
pH	MSC	5.87 ± 0.04 ^{aA}	5.77 ± 0.01^{aB}	5.81 ± 0.03 ^{aB}	6.01 ± 0.03^{aC}
	RSC	5.82 ± 0.05 ^{aA}	5.78 ± 0.02^{aA}	5.75 ± 0.03 ^{aA}	5.95 ± 0.01^{bB}
	SSC	5.75 ± 0.03 ^{aA}	5.61 ± 0.02^{aB}	5.75 ± 0.04 ^{aA}	5.79 ± 0.01^{cC}
ERV (ml)	MSC	13.00 ± 0.19^{aA}	12.97 ± 0.37^{aA}	11.98 ± 1.61^{aA}	10.76 ± 0.59 ^{aA}
	RSC	13.65 ± 0.24^{bA}	13.49 ± 0.42^{aA}	12.73 ± 0.46^{bA}	11.53 ± 0.36 ^{aB}
	SSC	15.34 ± 0.18^{cA}	15.22 ± 0.45^{bA}	14.68 ± 0.57^{cA}	12.85 ± 0.22 ^{aB}
TBA (mg/kg)	MSC	0.48 ± 0.02^{aA}	0.56 ± 0.01^{aA}	0.76 ± 0.02 ^{aB}	1.00 ± 0.05 ^{aC}
	RSC	0.42 ± 0.03^{aA}	0.65 ± 0.03^{bB}	0.73 ± 0.03 ^{aB}	1.02 ± 0.05 ^{aC}
	SSC	0.38 ± 0.02^{bA}	0.61 ± 0.03^{aB}	0.73 ± 0.01 ^{aC}	0.89 ± 0.07 ^{aD}
Tyrosine (mg/100 g)	MSC	10.65 ± 0.42 ^{aA}	16.30 ± 0.54^{aB}	20.66 ± 0.68^{aC}	23.66 ± 0.21^{aD}
	RSC	9.75 ± 0.79 ^{aA}	15.83 ± 0.39^{aB}	19.82 ± 0.57^{aC}	21.82 ± 0.38^{bD}
	SSC	8.63 ± 0.91 ^{aA}	13.63 ± 0.51^{bB}	18.45 ± 0.32^{bC}	21.20 ± 0.65^{bD}

Means with different superscripts in a row (upper case letters) and in a column (lower case letters) within a parameter differ significantly ($p<0.05$). MSC- Market/ road-side shop slaughtered chicken; RSC- Retail shop slaughtered chicken; SSC- Scientifically/ hygienically slaughtered chicken.

Total viable counts (TVC) and psychrophilic counts (PPC) cfu/g) in RSC and MSC samples reached to high levels of 6.86 and 6.84; and 6.73 and 6.81, respectively on 6th day of storage (Table 2) resulting in spoilage of both the samples as evident by emission of off-odour and discoloration. On the contrary, SSC samples had better microbial quality with a TVC of 4.56 and PPC of 4.66 on 6th day which reached to 6.95 and 6.08, respectively on 9th day of storage. These findings are similar to those recorded by Al-Mohizea *et al.* (1994) who recorded mean shelf life of 9.6 days for broiler chickens at 4°C. Bhuvan (2013) also recorded gradual and significant increase in TVC during refrigeration storage of minced chicken for 9 days. As observed in the present study, Arafa and Chen (1977) and Cunningham (1979) were of opinion that initial bacterial load greatly influenced the shelf life of broilers.

Table 2: Changes in the microbial quality (log cfu/gm) of chicken from different sources under refrigerated storage (Means± S.E)

		Storage days			
Parameters	**Samples**	**0**	**3**	**6**	**9**
TVC	MSC	6.28 ± 0.16^{aA}	6.36 ± 0.15^{aA}	6.86 ± 0.09^{aB}	7.22 ± 0.03^{aC}
	RSC	6.23 ± 0.10^{aA}	6.35 ± 0.10^{aA}	6.73 ± 0.17^{aB}	7.63 ± 0.08^{aC}
	SSC	3.03 ± 0.16^{bA}	3.55 ± 0.35^{bA}	4.56 ± 0.08^{bA}	6.95 ± 0.09^{bB}
Coliform	MSC	5.12 ± 0.34^{aA}	5.57 ± 0.10^{aA}	5.63 ± 0.12^{aA}	5.66 ± 0.13^{aA}
	RSC	4.97 ± 0.33^{aA}	5.25 ± 0.06^{aA}	5.38 ± 0.04^{aA}	6.22 ± 0.05^{aB}
	SSC	2.03 ± 0.41^{bA}	2.35 ± 0.56^{bA}	2.39 ± 0.58^{bA}	5.13 ± 0.07^{bB}
PPC	MSC	6.71 ± 0.07^{aA}	6.72 ± 0.02^{aA}	6.84 ± 0.02^{aB}	6.92 ± 0.07^{aB}
	RSC	5.63 ± 0.25^{bA}	6.55 ± 0.09^{aB}	6.81 ± 0.06^{aB}	7.16 ± 0.08^{bC}
	SSC	2.82 ± 0.11^{cA}	3.47 ± 0.49^{bA}	4.68 ± 0.11^{bB}	6.08 ± 0.08^{cC}
YMC	MSC	2.52 ± 0.07^{aA}	2.91 ± 0.22^{aA}	3.01 ± 0.04^{aB}	4.37 ± 0.03^{aC}
	RSC	2.26 ± 0.07^{bA}	2.49 ± 0.13^{aA}	2.71 ± 0.26^{aA}	3.00 ± 0.04^{bB}
	SSC	1.87 ± 0.13^{bA}	2.00 ± 0.12^{bA}	2.26 ± 0.16^{bA}	2.46 ± 0.06^{cB}

Means with different superscripts in a row (upper case letters) and in a column (lower case letters) within a parameter differ significantly ($p<0.05$). MSC- Market/ road-side shop slaughtered chicken; RSC- Retail- shop slaughtered chicken; SSC- Scientifically/ hygienically slaughtered chicken; TVC-Total Viable Count; PPC-Psychrophilic count; YMC-Yeast and mold count

Coliform counts (Table 2) remained almost static in all the chicken samples for 6 days of storage followed by significant increase in RSC and MSC samples on 9th day of storage at refrigeration temperature. Al-Mohizea *et al.* (1994) reported similar results on growth of coliforms in broiler chicken where they remained static for 7 days at 4^0C. Pal *et al.* (2002) also found non-significant increase in coliform counts in deboned marinated chicken during refrigerated storage for 9 days.

In the present study, yeast and mould counts in chicken meat samples remained comparatively lower than TVC, PPC and coliform counts which might be due to the fact that under similar conditions, bacteria generally outgrow yeast and mould (Hedrick *et al.* 1994). Similar to our findings, Anand *et al.* (1992) reported yeast and mould counts to the tune of $\log_{10}$ 3.5 – 3.8 cfu/g in broiler chickens on 7th day of refrigerated storage.

Sensory attributes of chicken meat samples viz. appearance, flavor, juiciness, texture and overall palatability did not show any appreciable differences during storage (Table 3). This might be due to the fact that all the samples had similar treatments viz. storage, marination and cooking processes before subjecting to sensory evaluation. Farmer (2005) reported that temperature of chilling, storage and cooking method could affect the flavor and other attributes of chicken meat. RSC and MSC samples were not subjected to sensory evaluation on 6th day of storage because of showing signs of spoilage with the development of off-odour and discolouration. However, SSC samples did not show any such sign of spoilage and their sensory scores were found to vary from 'good' to 'very good' for different attributes on 6th day of storage.

Table 3: Changes in the microbial quality (log cfu/gm) of chicken from different sources under refrigerated storage (Means± S.E)

		Storage days			
Parameters	**Samples**	**0**	**3**	**6**	**9**
Appearance	MSC	6.47 ± 0.08	6.52 ± 0.12	ND	ND
	RSC	6.69 ± 0.09	6.46 ± 0.09	ND	ND
	SSC	6.58 ± 0.10	6.65 ± 0.08	6.39 ± 0.09	ND
Flavour	MSC	6.50 ± 0.09	6.30 ± 0.17	ND	ND
	RSC	6.72 ± 0.10	6.37 ± 0.14	ND	ND
	SSC	6.58 ± 0.14	6.38 ± 0.13	6.17 ± 0.14	ND
Juiciness	MSC	6.53 ± 0.13	6.43 ± 0.15	ND	ND
	RSC	6.67 ± 0.12	6.34 ± 0.11	ND	ND
	SSC	6.61 ± 0.12	6.38 ± 0.12	6.53 ± 0.11	ND
Texture	MSC	6.44 ± 0.11	6.48 ± 0.15	ND	ND
	RSC	6.68 ± 0.10	6.42 ± 0.10	ND	ND
	SSC	6.72 ± 0.13	6.48 ± 0.12	6.39 ± 0.11	ND
Overall palatability	MSC	6.53 ± 0.12^a	6.48 ± 0.16	ND	ND
	RSC	6.75 ± 0.09^a	6.40 ± 0.11	ND	ND
	SSC	6.89 ± 0.14^b	6.45 ± 0.11	6.47 ± 0.12	ND

Means with different superscripts in a column (lower case letters) within a parameter differ significantly ($p<0.05$).

ND-Not done; MSC- Market/ road-side shop slaughtered chicken; RSC- Retail- shop slaughtered chicken; SSC- Scientifically/ hygienically slaughtered chicken

CONCLUSION

RSC and MSC samples were spoiled on 6th day while SSC samples got spoiled on 9th day indicating that SSC samples had better quality and shelf life under refrigeration (4±1 ºC) storage compared to samples from other two sources. Early spoilage of RSC and MSC samples compared to SSC samples may be attributed to the factors such as grossly unhygienic slaughter and dressing practices of birds leading to contamination followed by much higher initial microbial load and consequent very limited shelf life. Therefore, it may be recommended that for commercial supply of dressed chicken through cold chain or through cold storage retail outlets, scientifically slaughtered chicken is more ideal because of their better hygienic quality and shelf life.

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