

# Assessing the Quality of Fresh Chicken Meat in Tray Packaging: A Comparative Study of Various Wrap Films in Refrigerated Storage

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## ABSTRACT

The final stage of the food production chain and the initial stage of product marketing is packaging. An investigation was carried out to assess the impact of different packaging materials, specifically Low-Density Polyethylene (LDPE), High-Density Polyethylene (HDPE), Linear Low-Density Polyethylene (LLDPE), and Polyvinyl Chloride (PVC) on the quality and safety characteristics of fresh chicken meat held at a temperature of  $4\pm 1^\circ\text{C}$ . The study analyzed various physicochemical parameters including pH, ERV, drip loss, Warner-Bratzler shear force, TBARS value, tyrosine value, water activity, total volatile basic nitrogen and instrumental colour. Additionally, sensory and microbiological parameters such as total plate count (TPC), yeast and mold count (YMC), coliform count (CC), and psychrophilic count (PC) were examined. These parameters were monitored at 3-day intervals for a period of 9 days. The tray-packaged chicken meat remained acceptable for a period of 6 days when wrapped with HDPE film, as against 3 days in case of the other wrap films. Nevertheless, among the various films being investigated in this research, tray-packaged chicken meat sealed with HDPE film showed better physicochemical, sensory and microbiological quality characteristics when compared with other wrap films. Therefore, it can be concluded that the food-grade polypropylene trays containing fresh chicken meat sealed with HDPE film would have a shelf-life of 6 days at  $4\pm 1^\circ\text{C}$  with superior keeping qualities.

**Key words:** Chicken Meat, Physicochemical and Sensory attributes, Refrigerated storage, Tray Packaging, Wrap films.

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## INTRODUCTION

Chicken is regarded as the universal meat as it is not having any religious taboos. India's consumers prefer to buy freshly butchered chicken meat at open or "wet" markets; such purchases constitute more than 90 % of total poultry sales volume. Chilled and frozen chicken parts are also now available in certain high-end groceries where more affluent consumers are willing to pay a 30 to 40% premium over wet market prices (GAIN Report, 2016). However, the major constraint in the marketing of fresh and processed meat, including poultry and poultry products, is the proper packaging method. Most of the time, the inside products are not visible to the consumers due to printing and labelling. It creates confusion in the consumers' minds regarding the products' quality.

During the last few decades, most developed countries entered into a new packaging trend in which trays with the food are wrapped with shrink films due to its benefits. Tray packaging has good appeal as the products are clearly visible from the outside. It extends the shelf life compared to simple flexible plastic packaging. It facilitates proper labelling of the product. Tray-packaged products are easy to store and transport. Due to its appealing nature, it increases the demand for the product. Even though tray packaging is used for packaging of different food products such as vegetables

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and fruits, fish and bakery items, its usage for meat and meat products packaging is unexplored in India.

Tray packaging is normally done with LDPE wrap films. LDPE films have poor barrier properties, low puncture and rupture strength, which shortens the shelf life of the products stored. Alternatively, LLDPE, HDPE and PVC food-grade films have comparatively better properties, thereby expected to have more strength as well as the capacity to extend the shelf life. By considering the valuable advantages of tray packaging,

such as better shelf-life and consumer acceptance, this research was carried out to determine the physicochemical, sensorial and microbial quality characteristics of fresh chicken meat in tray packaging using different wrap films, viz., LDPE, LLDPE, HDPE and PVC at refrigerated ( $4\pm 1^\circ\text{C}$ ) temperature.

## MATERIALS AND METHODS

The experiments were carried out by utilizing the facilities available at the Division of Livestock Products Technology, ICAR-IVRI, Izatnagar (UP, India). The fresh chicken meat was procured from ICAR-CARI, Izatnagar. All the chemicals and media used were of analytical grade and obtained from standard firms (Hi-Media, SRL, etc.). Plastic wares and glass wares for laboratory use were procured from standard firms (Tarson, Borosil, etc.). Food-grade polypropylene (PP) trays with a dimension of  $19\times 14\times 3\text{ cm}^3$ , sealing machine and different food-grade flexible films (LDPE/HDPE/LLDPE/PVC) were purchased from the local market of Bareilly. The LDPE, HDPE, LLDPE and PVC films used for wrapping had thicknesses of 0.03, 0.04, 0.025 and 0.025 mm, respectively. The oxygen transmission rates of the films were 7000, 180, 200 and  $250\text{ cm}^3/\text{m}^2/24\text{ h}$ , respectively. Similarly, the water vapour transmission rates were 20, 7, 15 and  $5\text{ g}/\text{m}^2/24\text{ h}$ , respectively.

### Preparation of Tray-Packaged Fresh Chicken Samples

After manual deboning, the fresh chicken meat was packed in food-grade polyethylene bags and brought to the laboratory. About 200 g of fresh deboned lean meat was aseptically packed in food-grade polypropylene (PP) trays using different wrap films and heat sealed under good manufacturing practices. The different films used were LDPE, LLDPE, HDPE, and PVC and were stored at refrigeration ( $4\pm 1^\circ\text{C}$ ) conditions up to 9 days for further study.

### Physicochemical Parameters

The pH was determined as per the method of Trout *et al.* (1992) using homogenate of 5 g sample with 45 mL of distilled water using a digital pH meter (Model CP 901, Century Instruments Ltd., Chandigarh). The extract release volume (ERV) was estimated according to the procedure described by Jay (1964) with suitable modifications. A tissue homogeniser blended 25 gm of the minced sample with 100 mL of distilled water. The homogenate was transferred into a funnel, equipped with a Whatman filter paper No. 1. The volume of filtrate collected in the first 15 min was recorded as the ERV of the respective sample. The meat samples were subjected to drip loss measurement during different storage periods as per the procedure of Roslan *et al.* (2019) with slight modifications. The meat samples were weighed and placed in polyethylene bags, which were then sealed, vacuum packed, and stored at  $4^\circ\text{C}$ . After 24 h of storage, the meat samples were removed from the bag and reweighed. The percentage

of drip loss was determined by subtracting final weight from initial weight divided by the initial weight  $\times 100$ .

Water activity was measured with the help of a water activity meter (Hygrolab 3<sup>®</sup>, Rotronics, Switzerland). The Total Volatile Basic Nitrogen (TVB-N) was estimated by Conway's Microdiffusion method according to FAO (1979). Color profile was measured using Hunter Color Lab (Mini XE, Portable type). The values are known as Hunter 'L', *a*, and *b* values. Hunter 'L' (brightness-100 or lightness-0), *a* (+redness/- greenness) and *b* (+yellowness/-blueness) values were recorded on a uniform layer of fresh chicken meat. The instrument was calibrated using a light trap/black glass and white tile provided with the instrument. The readings were directly taken at three different points.

The Warner-Bratzler Shear force value of meat samples was determined by the method of Berry and Stiffler (1981). Muscles were cut to a size of  $1\text{ cm}^3$  parallel to the longitudinal orientation of muscle fibre. The shear force was measured on the Warner-Bratzler apparatus (Model: 81031307, G.R. Elect MFGCo., USA) at a crosshead speed of 2 mm/s. The average values ( $\text{kg}/\text{cm}^2$ ) for each sample were recorded as a mean of triplicates. The TBARS value of the sample was determined by using the distillation method described by Tarladgis *et al.* (1960) and the value was expressed as mg malonaldehyde/kg of sample. For Tyrosine value, the procedure of Strange *et al.* (1977) was followed and it was calculated as mg of tyrosine per 100 g meat sample by referring to a standard graph.

### Sensory Evaluation and Microbiological Quality

A six-member panel of trained judges, consisting of faculty and postgraduate students of the LPT Division, ICAR-IVRI, Izatnagar, evaluated the samples for the attributes of colour and odour using a 5-point descriptive scale, where 5=extremely desirable and 1=extremely undesirable.

All the microbiological parameters of chicken meat during different storage temperatures were determined as per the methods described by APHA (2001). Readymade media from Hi-Media Laboratories (P) Ltd., Mumbai, and Sisco Research Private Limited, Mumbai were used for the enumeration of different microbes. Duplicate plates were prepared and counts were expressed as colony-forming units (cfu/g).

### Statistical Analysis

The data obtained in this study were statistically analyzed by using the approved statistical methods of IBM SPSS software (version 29.0.2).

## RESULTS AND DISCUSSION

### Physicochemical Properties: pH of Meat and Extract Release Volume (ERV) of Meat (mL)

Table 1 shows the pH and ERV values of fresh chicken meat, tray packaged with different wrap films during the refrigerated storage for up to 9 days. Statistical analysis revealed a significant ( $p<0.01$ ) decrease in the pH and ERV

values of chicken meat with the increase in storage period irrespective of the wrap film used. This decrease in pH during refrigerated storage could be attributed to the increasing proteolytic activity and the associated protein denaturation as well as bacterial action resulting in the release of hydrogen ions, thereby reducing the pH and ERV (Jay, 1964). The anaerobic glycolysis, resulting in the accumulation of lactate, and the protein denaturation, contributes to the increased concentration of hydrogen ions ( $H^+$ ), thus leading to the changes in muscle pH value (Leygonie *et al.*, 2011; Salwani *et al.*, 2016). Although, no significant difference ( $p \geq 0.05$ ) was found between various wrap films for ERV values, the chicken meat packed with HDPE showed higher ERV values when compared with other films. This could be attributed to the lower water vapour and gas transmission rate of HDPE and subsequently lower microbial growth leading to less hydrolytic changes in the meat.

### Drip Loss (%) and Water Activity ( $a_w$ ) of Meat

Drip loss in chicken meat during refrigerated storage refers to the amount of moisture lost from the meat due to various factors such as temperature, storage time, and packaging conditions. The Drip loss values of tray-packaged chicken meat with different wrap films during refrigerated storage are presented in Table 1. There was a significant ( $p < 0.01$ ) increase in the drip loss values of chicken meat with the advancement of the storage period irrespective of the wrap film used. This might be due to the biological activities of microorganisms and enzymes that can lead to protein breakdown and subsequent moisture loss over time. The reduction in pH, caused by the release of amino acids and

carbonyls from the protein denaturation, could have changed the isoelectric point of the myofibrillar proteins, thereby resulting in the loss of bounded water, and reduced water holding capacity of meat when stored for longer duration (Leygonie *et al.*, 2012). The results were in accordance with Ab Aziz *et al.* (2020), who reported that the storage duration significantly affected the drip loss percentage of chicken meat at the storage temperatures of 4°C and -10°C.

Water activity ( $a_w$ ) is a measurement of the amount of water available for microbial growth and chemical reactions within a product. The water activity of the chicken meat decreased significantly ( $p < 0.01$ ) in all four groups throughout the refrigeration storage period (Table 1), which might be due to the evaporative loss of moisture through the wrap film. However, the chicken meat packed with HDPE showed higher water activity than other wrap films, which could be attributed to the high moisture barrier property of HDPE film. Similar results were obtained by Turhan *et al.* (2005), who reported a decrease in water activity with the advancement in the storage period.

### Warner Bratzler Shear Force (WB-SF) ( $kg/cm^2$ ) and TBARS Value of Meat (mg MDH/kg)

Table 2 shows the WB shear force and TBARS values of tray-packaged chicken meat with different wrap films during the refrigerated storage. The WB-SF values of chicken meat showed a significant ( $p < 0.01$ ) decreasing trend and TBARS value showed increasing trend with the progressive storage period, which might be caused by the bacterial enzymes that can bring about the structural disintegration of denatured proteins, thereby affecting the shear force values. This is supported by the findings

**Table 1:** Mean ( $\pm$  SE) values of pH, ERV (mL), drip loss (%) and water activity ( $a_w$ ) of tray packaged chicken meat using various wrap films across different storage periods at  $4 \pm 1^\circ C$  ( $n=6$  each)

Parameters	Packaging	Refrigerated storage ( $4 \pm 1^\circ C$ )			
		Day 0	Day 3	Day 6	Day 9
pH levels	LDPE	5.90 <sup>a</sup> $\pm$ 0.006	5.88 <sup>a</sup> $\pm$ 0.005	5.84 <sup>b</sup> $\pm$ 0.006	5.80 <sup>c</sup> $\pm$ 0.005
	HDPE	5.90 <sup>a</sup> $\pm$ 0.006	5.89 <sup>a</sup> $\pm$ 0.005	5.86 <sup>b</sup> $\pm$ 0.006	5.81 <sup>c</sup> $\pm$ 0.005
	LLDPE	5.90 <sup>a</sup> $\pm$ 0.006	5.89 <sup>a</sup> $\pm$ 0.006	5.85 <sup>b</sup> $\pm$ 0.006	5.81 <sup>c</sup> $\pm$ 0.004
	PVC	5.90 <sup>a</sup> $\pm$ 0.006	5.89 <sup>a</sup> $\pm$ 0.006	5.85 <sup>b</sup> $\pm$ 0.006	5.81 <sup>c</sup> $\pm$ 0.003
ERV values (mL)	LDPE	30.16 <sup>a</sup> $\pm$ 0.90	27.77 <sup>ab</sup> $\pm$ 0.66	26.37 <sup>b</sup> $\pm$ 0.82	23.83 <sup>b</sup> $\pm$ 0.84
	HDPE	30.16 <sup>a</sup> $\pm$ 0.90	29.20 <sup>a</sup> $\pm$ 0.95	27.04 <sup>b</sup> $\pm$ 0.98	25.71 <sup>b</sup> $\pm$ 0.97
	LLDPE	30.16 <sup>a</sup> $\pm$ 0.90	28.03 <sup>ab</sup> $\pm$ 0.83	26.78 <sup>b</sup> $\pm$ 0.79	24.30 <sup>b</sup> $\pm$ 0.74
	PVC	30.16 <sup>a</sup> $\pm$ 0.90	28.43 <sup>ab</sup> $\pm$ 0.82	26.98 <sup>b</sup> $\pm$ 0.66	24.61 <sup>b</sup> $\pm$ 0.77
Drip loss (%)	LDPE	1.49 <sup>a</sup> $\pm$ 0.16	2.39 <sup>b</sup> $\pm$ 0.17	3.97 <sup>c</sup> $\pm$ 0.14	4.64 <sup>d</sup> $\pm$ 0.12
	HDPE	1.49 <sup>a</sup> $\pm$ 0.16	2.06 <sup>a</sup> $\pm$ 0.17	3.64 <sup>b</sup> $\pm$ 0.14	4.27 <sup>c</sup> $\pm$ 0.13
	LLDPE	1.49 <sup>a</sup> $\pm$ 0.16	2.31 <sup>b</sup> $\pm$ 0.17	3.98 <sup>c</sup> $\pm$ 0.14	4.63 <sup>d</sup> $\pm$ 0.13
	PVC	1.49 <sup>a</sup> $\pm$ 0.16	2.23 <sup>b</sup> $\pm$ 0.17	3.87 <sup>c</sup> $\pm$ 0.14	4.50 <sup>d</sup> $\pm$ 0.13
Water activity ( $a_w$ )	LDPE	0.994 <sup>a</sup> $\pm$ 0.001	0.986 <sup>ab</sup> $\pm$ 0.001	0.980 <sup>bc</sup> $\pm$ 0.001	0.975 <sup>dc</sup> $\pm$ 0.001
	HDPE	0.994 <sup>a</sup> $\pm$ 0.001	0.992 <sup>abA</sup> $\pm$ 0.001	0.989 <sup>bA</sup> $\pm$ 0.001	0.985 <sup>bA</sup> $\pm$ 0.001
	LLDPE	0.994 <sup>a</sup> $\pm$ 0.001	0.989 <sup>bAB</sup> $\pm$ 0.001	0.984 <sup>cb</sup> $\pm$ 0.001	0.980 <sup>dB</sup> $\pm$ 0.001
	PVC	0.994 <sup>a</sup> $\pm$ 0.001	0.991 <sup>aA</sup> $\pm$ 0.001	0.987 <sup>bAB</sup> $\pm$ 0.001	0.983 <sup>cAB</sup> $\pm$ 0.001

Means bearing different superscripts within a row (lower case) and within a column (upper case) differ significantly ( $p < 0.01$ ) for a parameter.



**Table 2:** Mean ( $\pm$  SE) values of WB-SF, TBARS, Tyrosine, and TVB-N of tray packaged chicken meat using various wrap films across different storage periods at  $4\pm 1^\circ\text{C}$  (n=6 each)

Parameters	Packaging	Refrigerated storage ( $4\pm 1^\circ\text{C}$ )			
		Day 0	Day 3	Day 6	Day 9
WB-SF ( $\text{kg}/\text{cm}^2$ )	LDPE	2.71 <sup>a</sup> $\pm$ 0.10	2.27 <sup>b</sup> $\pm$ 0.08	1.89 <sup>c</sup> $\pm$ 0.09	1.62 <sup>d</sup> $\pm$ 0.09
	HDPE	2.71 <sup>a</sup> $\pm$ 0.10	2.42 <sup>ab</sup> $\pm$ 0.08	2.18 <sup>b</sup> $\pm$ 0.07	1.92 <sup>b</sup> $\pm$ 0.07
	LLDPE	2.71 <sup>a</sup> $\pm$ 0.10	2.38 <sup>a</sup> $\pm$ 0.07	2.01 <sup>b</sup> $\pm$ 0.09	1.74 <sup>b</sup> $\pm$ 0.10
	PVC	2.71 <sup>a</sup> $\pm$ 0.10	2.45 <sup>ab</sup> $\pm$ 0.07	2.09 <sup>b</sup> $\pm$ 0.08	1.82 <sup>b</sup> $\pm$ 0.10
TBARS (MDH, mg/kg)	LDPE	0.31 <sup>a</sup> $\pm$ 0.07	0.69 <sup>bA</sup> $\pm$ 0.01	1.07 <sup>cA</sup> $\pm$ 0.01	1.35 <sup>dA</sup> $\pm$ 0.02
	HDPE	0.31 <sup>a</sup> $\pm$ 0.07	0.51 <sup>bb</sup> $\pm$ 0.03	0.83 <sup>cc</sup> $\pm$ 0.03	1.08 <sup>dB</sup> $\pm$ 0.05
	LLDPE	0.31 <sup>a</sup> $\pm$ 0.07	0.61 <sup>bAB</sup> $\pm$ 0.02	0.94 <sup>cb</sup> $\pm$ 0.02	1.22 <sup>dAB</sup> $\pm$ 0.03
	PVC	0.31 <sup>a</sup> $\pm$ 0.07	0.57 <sup>bb</sup> $\pm$ 0.02	0.91 <sup>cb</sup> $\pm$ 0.02	1.16 <sup>dB</sup> $\pm$ 0.04
Tyrosine (mg/g)	LDPE	0.23 <sup>a</sup> $\pm$ 0.03	0.37 <sup>b</sup> $\pm$ 0.02	0.50 <sup>cA</sup> $\pm$ 0.02	0.61 <sup>dA</sup> $\pm$ 0.02
	HDPE	0.23 <sup>a</sup> $\pm$ 0.03	0.27 <sup>a</sup> $\pm$ 0.03	0.38 <sup>abB</sup> $\pm$ 0.03	0.44 <sup>bb</sup> $\pm$ 0.04
	LLDPE	0.23 <sup>a</sup> $\pm$ 0.03	0.32 <sup>a</sup> $\pm$ 0.02	0.46 <sup>bA</sup> $\pm$ 0.02	0.51 <sup>bAB</sup> $\pm$ 0.03
	PVC	0.23 <sup>a</sup> $\pm$ 0.03	0.31 <sup>a</sup> $\pm$ 0.02	0.43 <sup>bAB</sup> $\pm$ 0.02	0.48 <sup>bb</sup> $\pm$ 0.03
TVB-N (mg/100 g)	LDPE	8.92 <sup>a</sup> $\pm$ 0.40	12.54 <sup>b</sup> $\pm$ 0.30	15.71 <sup>c</sup> $\pm$ 0.48	17.62 <sup>dA</sup> $\pm$ 0.22
	HDPE	8.92 <sup>a</sup> $\pm$ 0.40	11.19 <sup>b</sup> $\pm$ 0.39	14.05 <sup>c</sup> $\pm$ 0.36	15.79 <sup>dB</sup> $\pm$ 0.35
	LLDPE	8.92 <sup>a</sup> $\pm$ 0.40	11.57 <sup>b</sup> $\pm$ 0.35	14.73 <sup>c</sup> $\pm$ 0.43	16.57 <sup>dAB</sup> $\pm$ 0.31
	PVC	8.92 <sup>a</sup> $\pm$ 0.40	11.31 <sup>b</sup> $\pm$ 0.39	14.52 <sup>c</sup> $\pm$ 0.43	16.37 <sup>dB</sup> $\pm$ 0.31

Means bearing different superscripts within a row (lower case) and within a column (upper case) differ significantly ( $p < 0.01$ ) for a parameter.

of Damaziak *et al.* (2016), who reported a decreasing trend of shear force values in both raw and smoked goose fillets during refrigerated storage. The TBARS (thiobarbituric acid reactive substances) value is a measure of lipid oxidation, often used to assess the extent of oxidative rancidity in meat. The change in TBARS value might be due to the lipid oxidation and subsequent production of volatile oxidative metabolites in the presence of oxygen that can initiate oxidative reactions in the unsaturated fats present in chicken meat, leading to increased TBARS values over time. Nevertheless, the chicken meat packed with HDPE showed a significantly ( $p < 0.01$ ) lower TBARS value, which could be attributed to the lower gas transmission rate of HDPE causing less oxidative changes in meat.

#### Tyrosine Value (mg/g) and TVB-N (mg/100 g) of Meat

Tyrosine value is an index of the degree of autolytic and bacterial proteolysis occurring in meat and meat products, whereas the TVB-N (total volatile basic nitrogen) value measures the amount of volatile basic nitrogen compounds, primarily ammonia and other amines, which are produced as a result of protein degradation during storage. The tyrosine and TVB-N values of chicken meat, irrespective of the wrap film used, exhibited a significant ( $p < 0.01$ ) increasing trend with an increase in days of refrigerated storage period (Table 2). Such increment in tyrosine value with the advancement of storage period might be due to the increased microbial load, and enhanced production of proteolytic enzymes

in the late logarithmic phase of microbial growth causing autolysis and bacterial proteolysis (Dainty *et al.*, 1975). Similarly, the increase in TVB-N values might be due to the degradation of proteins and other nitrogen (N)-containing compounds as a result of the spoilage mechanisms causing the accumulation of organic amines thereby elevating the levels of TVB-N (Bekhit *et al.*, 2021). The results were similar to the findings of Umuhumuza and Sun (2011), who reported that a rapid increase in the TVB-N concentration from 6 mg N/100 g to 13.5 mg N/100 g between the second and third day of storage at  $4^\circ\text{C}$  was found upon the depletion of glucose in meat. These authors also reported that the rapid increase was being attributed to the microbial degradation-related deamination of adenine nucleotide and conversion of Trimethylamine oxide (TMAO) in the meat to Trimethylamine (TMA), Dimethylamine (DMA) and formaldehyde.

#### Instrumental Colour of Meat

The colour values of fresh chicken meat, tray packaged with different wrap films during the refrigerated storage are presented in Table 3. Statistical analysis revealed a significant ( $p < 0.01$ ) decrease in lightness ( $L^*$ ), redness ( $a^*$ ) and yellowness ( $b^*$ ) colour values with the increase in refrigerated storage period irrespective of the wrap film used. This might be due to the formation of metmyoglobin that imparted brownish discolouration to the meat. The results are in accordance with Ab Aziz *et al.* (2020), who

reported that the meat samples stored at 4°C and -18°C for 72 h showed a significant ( $p < 0.05$ ) reduction in lightness and redness values when compared with those meat samples stored at similar temperatures for 24 h. These authors also reported that the discoloration of meat is associated with the increase in oxidative processes from lipid oxidation, for the formation of metmyoglobin.

### Sensory Evaluation of Fresh Chicken Meat at Refrigerated Storage

Table 4 shows the sensory attributes (colour and odour) of tray-packed chicken meat with various wrap films during the refrigerated storage. The mean scores of all the sensory attributes showed a significant ( $p < 0.01$ ) decreasing trend with the advancement in storage period regardless of the wrap film used. The decrement in colour score could be attributed to the pigment and lipid oxidation. In addition, a positive correlation was observed between the instrumental colour value and sensory colour score. The progressive decrease in odour score could be correlated

with the increased TBARS value and microbial count in the meat under aerobic conditions. Dainty and Mackey (1992), reported that the meat products stored in aerobic conditions might develop some bad odours such as fruity, putrid, sulphury and cheesy mainly as a result of microbial spoilage of the meat products.

### Microbial Quality of Fresh Chicken Meat at Refrigerated Storage

The microbiological characteristics of tray-packed chicken meat with various wrap films during the refrigerated storage are presented in Table 5. The psychrophilic count, total plate count, and yeast and mold count of chicken meat increased significantly ( $p < 0.01$ ) throughout the storage period irrespective of the wrap film used. The coliforms were found to be absent in all four groups throughout the storage period. The results were similar to the findings of Zhang *et al.* (2012), who reported an increasing trend of TPC in aerobically packaged poultry meat from 4.60 log<sub>10</sub> cfu/g on 0 day to 6.38 log<sub>10</sub> cfu/g on 4<sup>th</sup> day at 4°C.

**Table 3:** Mean ( $\pm$  SE) instrumental colour (score) of tray packaged chicken meat using various wrap films across different storage periods at 4 $\pm$ 1°C (n=6 each)

Parameters	Day 0	Day 3	Day 6	Day 9
<b>Lightness (L*)</b>				
LDPE	62.43 <sup>a</sup> $\pm$ 1.61	56.92 <sup>ab</sup> $\pm$ 1.43	53.63 <sup>b</sup> $\pm$ 1.78	49.69 <sup>b</sup> $\pm$ 1.48
HDPE	62.43 <sup>a</sup> $\pm$ 1.61	59.66 <sup>ab</sup> $\pm$ 1.39	55.98 <sup>b</sup> $\pm$ 1.53	52.33 <sup>b</sup> $\pm$ 1.45
LLDPE	62.43 <sup>a</sup> $\pm$ 1.61	57.99 <sup>ab</sup> $\pm$ 1.34	54.60 <sup>b</sup> $\pm$ 1.66	50.97 <sup>b</sup> $\pm$ 1.53
PVC	62.43 <sup>a</sup> $\pm$ 1.61	58.98 <sup>ab</sup> $\pm$ 1.44	55.69 <sup>b</sup> $\pm$ 1.62	52.04 <sup>b</sup> $\pm$ 1.50
<b>Redness (a*)</b>				
LDPE	9.26 <sup>a</sup> $\pm$ 0.08	8.70 <sup>b</sup> $\pm$ 0.08	8.36 <sup>cb</sup> $\pm$ 0.05	7.96 <sup>db</sup> $\pm$ 0.04
HDPE	9.26 <sup>a</sup> $\pm$ 0.08	8.97 <sup>a</sup> $\pm$ 0.11	8.63 <sup>ba</sup> $\pm$ 0.05	8.25 <sup>ba</sup> $\pm$ 0.06
LLDPE	9.26 <sup>a</sup> $\pm$ 0.08	8.76 <sup>b</sup> $\pm$ 0.07	8.41 <sup>cb</sup> $\pm$ 0.04	8.01 <sup>db</sup> $\pm$ 0.05
PVC	9.26 <sup>a</sup> $\pm$ 0.08	8.82 <sup>b</sup> $\pm$ 0.08	8.49 <sup>cAB</sup> $\pm$ 0.05	8.12 <sup>dAB</sup> $\pm$ 0.05
<b>Yellowness (b*)</b>				
LDPE	11.39 <sup>a</sup> $\pm$ 0.13	10.76 <sup>b</sup> $\pm$ 0.12	10.52 <sup>bc</sup> $\pm$ 0.15	10.24 <sup>c</sup> $\pm$ 0.08
HDPE	11.39 <sup>a</sup> $\pm$ 0.13	11.06 <sup>ab</sup> $\pm$ 0.12	10.85 <sup>b</sup> $\pm$ 0.14	10.63 <sup>b</sup> $\pm$ 0.13
LLDPE	11.39 <sup>a</sup> $\pm$ 0.13	10.90 <sup>ab</sup> $\pm$ 0.13	10.64 <sup>b</sup> $\pm$ 0.15	10.38 <sup>b</sup> $\pm$ 0.10
PVC	11.39 <sup>a</sup> $\pm$ 0.13	10.98 <sup>ab</sup> $\pm$ 0.12	10.73 <sup>b</sup> $\pm$ 0.15	10.53 <sup>b</sup> $\pm$ 0.12

Means bearing different superscripts in a row (lowercase) and a column (uppercase) differ significantly ( $p < 0.01$ ).

**Table 4:** Mean ( $\pm$  SE) sensory attributes (1-5 scale) of tray packaged chicken meat using various wrap films across different storage periods at 4 $\pm$ 1°C (n=6 each)

Parameters	Day 0	Day 3	Day 6	Day 9
<b>Colour</b>				
LDPE	4.75 <sup>a</sup> $\pm$ 0.11	4.29 <sup>b</sup> $\pm$ 0.10	4.00 <sup>bc</sup> $\pm$ 0.06	3.67 <sup>c</sup> $\pm$ 0.08
HDPE	4.75 <sup>a</sup> $\pm$ 0.11	4.46 <sup>ab</sup> $\pm$ 0.08	4.13 <sup>b</sup> $\pm$ 0.06	3.79 <sup>b</sup> $\pm$ 0.10
LLDPE	4.75 <sup>a</sup> $\pm$ 0.11	4.33 <sup>b</sup> $\pm$ 0.11	4.04 <sup>bc</sup> $\pm$ 0.08	3.71 <sup>c</sup> $\pm$ 0.10
PVC	4.75 <sup>a</sup> $\pm$ 0.11	4.38 <sup>ab</sup> $\pm$ 0.11	4.08 <sup>b</sup> $\pm$ 0.08	3.75 <sup>b</sup> $\pm$ 0.09
<b>Odour</b>				
LDPE	4.71 <sup>a</sup> $\pm$ 0.10	4.13 <sup>b</sup> $\pm$ 0.06	3.54 <sup>cb</sup> $\pm$ 0.14	3.04 <sup>d</sup> $\pm$ 0.14
HDPE	4.71 <sup>a</sup> $\pm$ 0.10	4.42 <sup>ab</sup> $\pm$ 0.08	4.08 <sup>ba</sup> $\pm$ 0.05	3.75 <sup>b</sup> $\pm$ 0.09
LLDPE	4.71 <sup>a</sup> $\pm$ 0.10	4.33 <sup>b</sup> $\pm$ 0.08	3.92 <sup>cAB</sup> $\pm$ 0.08	3.63 <sup>c</sup> $\pm$ 0.06
PVC	4.71 <sup>a</sup> $\pm$ 0.10	4.38 <sup>a</sup> $\pm$ 0.11	3.96 <sup>ba</sup> $\pm$ 0.10	3.67 <sup>b</sup> $\pm$ 0.08

Means bearing different superscripts in a row (lowercase) and a column (uppercase) differ significantly ( $p < 0.01$ ).



**Table 5:** Mean ( $\pm$  SE) microbial qualities ( $\log_{10}$  cfu/g) of tray packaged chicken meat using various wrap films across different storage periods at  $4\pm 1^\circ\text{C}$ 

Parameters	Day 0	Day 3	Day 6	Day 9
<b>Psychrophiles (<math>\log_{10}</math> cfu/g)</b>				
LDPE	2.22 <sup>a</sup> $\pm$ 0.01	3.50 <sup>bA</sup> $\pm$ 0.01	3.71 <sup>cA</sup> $\pm$ 0.00	4.26 <sup>dA</sup> $\pm$ 0.02
HDPE	2.22 <sup>a</sup> $\pm$ 0.01	2.29 <sup>bC</sup> $\pm$ 0.01	2.86 <sup>cC</sup> $\pm$ 0.01	3.58 <sup>dB</sup> $\pm$ 0.04
LLDPE	2.22 <sup>a</sup> $\pm$ 0.01	3.47 <sup>bA</sup> $\pm$ 0.01	3.69 <sup>cA</sup> $\pm$ 0.01	4.19 <sup>dA</sup> $\pm$ 0.02
PVC	2.22 <sup>a</sup> $\pm$ 0.01	3.19 <sup>bB</sup> $\pm$ 0.01	3.55 <sup>cB</sup> $\pm$ 0.01	4.16 <sup>dA</sup> $\pm$ 0.02
<b>Total plate count (<math>\log_{10}</math> cfu/g)</b>				
LDPE	3.35 <sup>a</sup> $\pm$ 0.01	4.54 <sup>bA</sup> $\pm$ 0.01	5.08 <sup>cA</sup> $\pm$ 0.03	7.12 <sup>dA</sup> $\pm$ 0.02
HDPE	3.35 <sup>a</sup> $\pm$ 0.01	3.85 <sup>bD</sup> $\pm$ 0.01	4.61 <sup>cC</sup> $\pm$ 0.02	6.23 <sup>dD</sup> $\pm$ 0.03
LLDPE	3.35 <sup>a</sup> $\pm$ 0.01	4.16 <sup>bB</sup> $\pm$ 0.02	4.95 <sup>cB</sup> $\pm$ 0.01	6.93 <sup>dB</sup> $\pm$ 0.01
PVC	3.35 <sup>a</sup> $\pm$ 0.01	3.96 <sup>bC</sup> $\pm$ 0.01	4.67 <sup>cC</sup> $\pm$ 0.03	6.72 <sup>dC</sup> $\pm$ 0.01
<b>Yeast and Mold (<math>\log_{10}</math> cfu/g)</b>				
LDPE	1.79 <sup>a</sup> $\pm$ 0.01	2.98 <sup>bA</sup> $\pm$ 0.01	3.35 <sup>cA</sup> $\pm$ 0.03	3.94 <sup>dA</sup> $\pm$ 0.02
HDPE	1.79 <sup>a</sup> $\pm$ 0.01	2.57 <sup>bD</sup> $\pm$ 0.02	2.88 <sup>cD</sup> $\pm$ 0.01	3.22 <sup>dD</sup> $\pm$ 0.02
LLDPE	1.79 <sup>a</sup> $\pm$ 0.01	2.83 <sup>bB</sup> $\pm$ 0.01	3.08 <sup>cB</sup> $\pm$ 0.01	3.75 <sup>dB</sup> $\pm$ 0.01
PVC	1.79 <sup>a</sup> $\pm$ 0.01	2.68 <sup>bC</sup> $\pm$ 0.01	2.97 <sup>cC</sup> $\pm$ 0.00	3.56 <sup>dC</sup> $\pm$ 0.01

Means bearing different superscripts in a row (lowercase) and a column (uppercase) differ significantly ( $p < 0.01$ ).

## CONCLUSION

Refrigerated storage time significantly ( $p < 0.01$ ) influenced the physicochemical, oxidative, sensory, colour, and microbiological quality of tray-packaged fresh chicken meat, irrespective of the wrap film used. Progressive storage led to a decline in pH, extract release volume, water activity, shear force, and instrumental colour values, alongside a significant increase in drip loss, lipid oxidation (TBARS), proteolysis (tyrosine value), and TVB-N, indicating moisture loss, protein degradation, oxidative changes, and spoilage development. These instrumental changes were accompanied by a marked deterioration in sensory colour and odour scores and a significant increase in total plate count, psychophilic bacteria, and yeast and mould counts, while coliforms remained absent throughout storage. Although wrap films showed no major differences, HDPE provided comparatively better quality retention by limiting oxidative changes, attributable to its superior moisture and gas barrier properties. Overall, the results emphasize that storage duration is the primary determinant of quality deterioration in refrigerated fresh chicken meat, with HDPE offering a modest advantage in preserving quality under aerobic storage conditions.

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