

Effect of garlic paste, clove and mint powders on the shelf life of chicken meat

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ABSTRACT

Background: Natural preservatives are effective in inhibiting microbial growth and oxidation in foods. They offer a safer, eco-friendly alternative to synthetic additives, enhancing food shelf life and quality. **Objectives:** This research aimed to assess the shelf life of raw chicken meat after treatment with herbs. **Materials and Methods:** Meat samples were divided into five different treatment groups: T0=Control, T1= 0.2% clove powder, T2= 2% garlic powder, T3=1% mint leaves powder and T4= Combination of all three. The samples were assessed for physicochemical properties, oxidative stability, sensorial properties, and microbial counts on day 1, 3, 6, 9 and 12. **Results:** Results indicated that the addition of natural preservatives significantly ($p<0.05$) improved physicochemical properties, oxidative stability, microbiological and sensory attributes compared to the control. Through storage, pH and cooking loss were significantly lower ($P<0.05$) in treated batches than in the control. The T4 batch (combination) had significantly lower free fatty acid and peroxide values. TBARS values varied among treated batches, with T1 (clove) maintaining the lowest TBARS value. The T4 batch showed the lowest viable and coliform counts, while the T2 batch had the lowest yeast mold count. T1 batch had the highest color score, and T2 had the highest odor score. **Conclusion:** The study concluded that 0.2% clove, 2% garlic, and 1% mint leaves powder effectively extend meat shelf life. However, the combination of these three (T4) was the most effective as an antioxidant and antimicrobial preservative for raw chicken meat at refrigerated storage ($4^{\circ}\text{C} \pm 1^{\circ}\text{C}$).

Key words: Clove; Mint; Garlic; Raw chicken meat; Shelf life; Antioxidant; Antimicrobial

INTRODUCTION

Chicken meat is a major protein source in the world with almost 100 million tons production annually (Khiari et al., 2014; Selle et al., 2020). Fresh meat is enriched with protein, iron, zinc, fatty acids, vitamins and is a highly perishable product (Rahman et al., 2023). The high perishability might be due to its high nutritional value and water content (Höll et al., 2016). Meat's nutritional qualities, try to meet a significant number of customer needs. It is a digestible proteins with an important amino acid content, some vitamins

such as vitamin B and certain minerals (Marangoni et al., 2015; Dominguez et al., 2019; Smith et al., 2022). Chicken meat is preferred by consumers around the world because of its preferable nutritional qualities and inexpensive cost of production (Chouliara et al., 2007; Patsias et al., 2008). A variety of poultry-based goods, such as hotdogs, sausages, frankfurters, nuggets, and burgers, are provided on the market (Fletcher, 2004; Candan and Bağdatlı, 2017).

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Meat can be degraded because of microbial growth, oxidative degradation (Candan and Bağdatlı, 2017), and enzymatic activity (Iulietto et al., 2015; Abdel-Aziz et al., 2016; Pellissery et al., 2020). Microorganisms such as *Pseudomonas* spp., *Lactobacillus* spp., yeast, and mold are responsible for deterioration of poultry meat (Doulgeraki et al., 2012). These processes include discoloration, the buildup of unpleasant smells and odors, and changes in organoleptic qualities that render the meat unfit for consumption (Comi et al., 2017; Anas et al. 2019; Pellissery et al., 2020).

Spoilage of fresh poultry meat is a financial strait to producers (Odeyemi et al., 2022). Meat slaughtering and processing are considered as the main factors for meat spoilage (Addis, 2015; Baéza et al., 2022). So, it demands the development of new methods to prolong the shelf-life and quality of meat (Rahman et al., 2018; Odeyemi et al., 2022). An amazing amount of attention is being shown to extend the shelf life of poultry meat (Singh et al., 2011). Although the shelf life of meat is extended by using numerous synthetic preservatives (Petcu et al., 2023). While these synthetic antioxidants have various health effects and there is need to find effective antioxidants from natural sources to prevent degradation in poultry meat during processing and storage (Jiang et al., 2016; Caleja et al., 2016; Teruel et al., 2015). Microbiological quality of meat is varied with meat type, manufacturing, distribution, and storage conditions (Zhou et al., 2010; Doulgeraki et al., 2012).

The uses of natural preservatives and ecofriendly technologies have been recommended to extend the shelf life of meat (Artes et al., 2007; Véronique, 2008; Villalobos-Delgado et al., 2019; Awad et al., 2022). Due to antioxidant, chelating, and antimicrobial activities there is an extensive use of synthetic preservatives to prolong the shelf life of foods (Sharif et al., 2017; Mei et al., 2019; Amiri et al., 2021). Food preservatives enhance taste, preserve food, and protect against ROS-related diseases like cancer and aging. However, some can cause allergies and have potential carcinogenic risks despite being generally considered safe (GRAS) (Parke and Lewis, 1992). According to Molognoni et al., (2019) meat products are nutritious and can form carcinogenic compounds during processing, such as N-nitroso compounds and polycyclic aromatic hydrocarbons. So, it is highly

desirable to find effective and non-toxic measures to slow spoilage and prolong the shelf life of poultry meat (Gao et al., 2014; Chammem et al., 2015; Delgado et al., 2014)

Natural preservatives helped to extend the storage life of meat products, and their use is in trend (Karre et al., 2013; Bakirtzi et al., 2016). Spices like clove and garlic are effective against spoilage bacteria and fungi in foods (Subbulakshmi et al., 2002; Rajkumar and Berwal, 2003). Clove (*Syzygium aromaticum*) contains eugenol, offering strong antioxidants and antimicrobial properties (Sofia et al., 2007), inhibiting various bacteria in meat products (Zengin and Baysal, 2015). *Allium sativum* is commonly known as garlic and famous for its flavor and medicinal uses, containing allicin and strong antioxidants (Subroto et al., 2021). Numerous studies have examined the antioxidant and antibacterial properties of *Mentha* species' essential oils and extracts since they contain α -tocopherol, caffeic acid, rosmarinic acid, and eugenol (Kanatt et al., 2007; Biswas et al., 2012; Najeeb et al., 2014; Tafrihi et al., 2021). Various plant extracts have bacteriostatic effects against various bacterial species *S. aureus*, *S. pyrogens*, and *E. coli* (Elansary et al., 2015). The study was planned with the objective to estimate the effects of clove, mint leaves, garlic powder and their combination on storage of chicken meat for physiochemical, oxidative, microbial, and sensory parameters.

MATERIALS AND METHODS

Collection and preparation of samples

Almost 1250-grams of raw chicken meat was bought from the poultry market of Gujranwala and transported to the Science and Biology Laboratory of Excellence College Gujranwala by keeping the samples in ice boxes. The chicken meat was cleaned with distilled water and cut into small pieces of 4-5cm with the help of a sharp knife. Fresh *M. royleana* (mint) leaves, *S. aromaticum* (clove) and *A. sativum* (garlic) were obtained from the local market of Gujranwala city. The spices were thoroughly washed under running water, then dried under shade for two hours, and later in a hot oven at 50 °C for 2 h. The dried leaves were ground in a manual grinder and sieved through a fine mesh. The powdered leaves were stored in plastic jar in the freezer for further use. Similarly, *S. aromaticum* and *A. sativum* cloves were ground into powder using a

mortar and pestle. Garlic paste was packed in zipper polyethylene bags and stored in a deep freezer at ($-80^{\circ}\text{C} \pm 1^{\circ}\text{C}$) (Tareq et al., 2018).

Categorization of meat samples

Categorization of Chicken meat samples was carried out and total purchased meat was divided into five different treatment groups: T0=Control (no preservative), T1= 0.2% clove powder, T2= 2% garlic powder, T3=1% mint leaves powder, and T4= Combination of all three (T1, T2, T3). Each treatment group contained 250 gam meat of 10 pieces of 4-5 cm. The different groups were wrapped in various polythene zipper bags and kept in a refrigerator ($4^{\circ}\text{C} \pm 1^{\circ}\text{C}$) for 12 days. The samples were observed for physicochemical properties (pH, cooking loss), oxidative stability such as Peroxide Value (POV), Free Fatty Acids (FFA) and Thiobarbituric Acid Reactive Substances (TBARS) sensorial properties (color, and odor) and microbial counts such as Total Viable Count (TVC), Total Coliform Count (TCC), Total Yeast and Mold Count (TYMC) on 1, 3, 6, 9, and 12 day (Tareq et al., 2018).

Physicochemical properties

pH and Cooking Loss

For the determination of pH, samples were prepared by combining 1/4th piece of each sample with 10 ml of distilled water and preparing a homogenized solution. The pH values of the samples were taken at room temperature using a digital pH meter. To calculate the percentage of cooking loss meat pieces were kept in oven at 100°C after taking the initial weigh and methods of Masoumi et al. (2012) were followed.

Oxidative stability

Determination of Peroxide value (POV), Free Fatty Acids (FFA)

To extract lipid content, a 3g sample was mixed with 30ml of acetic acid-chloroform solution, heated, and filtered. The filtrate was titrated with sodium thiosulphate, and POV was calculated and expressed as milliequivalents peroxide per kg of sample. Free Fatty Acids (FFA) were determined by mixing a 5g sample with chloroform, filtering, and titrating the filtrate with 0.1 N alcoholic KOH using phenolphthalein as an indicator. To determine the Thiobarbituric Acid (TBA) value, 2g of meat was homogenized with trichloroacetic acid, filtered, and mixed with TBA indicator. The mixture was heated,

cooled, and its absorbance was measured at 532 nm using a UV-VIS spectrophotometer (Tariq et al., 2018).

Sensory Evaluation

A trained five-member panel was prepared after getting their consent and meat samples were assessed using a five-point hedonic scale, with scores below 3 deemed unacceptable. Panelists, trained per American Meat Science Association guidelines. The panelists evaluated color and odor of at least three samples per treatment on days 1, 3, 6, 9, and 12. The samples were stored at $4^{\circ}\text{C} \pm 1^{\circ}\text{C}$ in a refrigerator. The methods of Tareq et al. (2018) were followed with few modifications.

Microbiological analysis

A microbial estimation, of total viable, coliforms, and yeast-mold counts, was conducted on meat samples stored at 4°C at intervals of 1, 3, 6, 9, and 12 days. The samples were homogenized, diluted, and plated on respective agars, then incubated at specific temperatures for the required durations. 0.1 ml of each dilution was pipetted onto the surface of nutrient agar to obtain total viable counts (TVC), MacConkey agar for Total Coliform Count (TCC) and potato dextrose agar for Total Yeast and Mold Count (TYMC) were used. Each sample plate was made in triplicate and incubated for two days at 30°C to count TVC and TCC, while kept at 25°C for 5 days to count TYMC. Plates with 25-250 colonies were considered and counted. The number of colonies was multiplied by the reciprocal of each dilution and expressed as log CFU per gram.

Statistical analysis

All statistical calculations were performed using SPSS version 25 and One-way ANOVA was performed at significance level ($p < 0.05$).

RESULTS

Physicochemical analysis of pH and cooking loss

The pH of processed meat samples was monitored. It was noticed the pH values were gradually reduced in T1, T2, and T3 samples after three days of storage at 4°C . While these values were substantially increased at p value < 0.05 with the increased storage time (Table 1). It was noticed for the cooking loss the values were gradually reduced in all treated groups and the values were substantially decreased ($p < 0.05$) with the increased storage time. The cooking loss is a reduction

in weight of meat samples due to changes in water, fat, and soluble substances such as minerals and proteins.

Table 1: A record of pH and % cooking loss in different treatment groups

	Days	T0	T1	T2	T3	T4
pH	1	5.58 ±0.012	5.57±0.012	5.67 ±0.012	5.76 ±0.012	5.85±0.012
	3	5.59 ±0.012	5.58 ±0.006	5.72 ±0.006	5.78 ±0.006	5.87±0.012
	6	6.06 ±0.006	5.86 ±0.006	5.98 ±0.012	6.12 ±0.012	6.18±0.012
	9	6.68 ±0.009	6.14 ±0.006	6.37 ±0.012	6.40 ±0.012	6.46±0.006
	12	6.91 ±0.012	6.37 ±0.006	6.52 ±0.012	6.61 ±0.012	6.67±0.006
Cooking Loss	1	31.55±0.009	29.77 ±0.006	27.49±0.012	29.09 ±0.009	27.23 ±0.009
	3	29.85±0.006	28.51 ±0.006	24.50 ±0.012	27.90 ±0.006	24.45 ±0.006
	6	19.35±0.006	21.35 ±0.012	22.35 ±0.006	20.35 ±0.006	20.10 ±0.012
	9	18.41±0.009	19.03 ±0.009	19.65 ±0.006	17.95 ±0.009	19.25 ±0.009
	12	5.03±0.009	10.01 ±0.009	14.99 ±0.006	11.51 ±0.006	17.01 ±0.006

T0=Control (no preservative), T1= 0.2% clove powder, T2= 2% garlic paste, T3=1% mint leaves powder
T4= Combination of all three

Oxidative Stability

Determination of POV, FFA, and TBARS

It was observed that the POV, and FFA of the control group remained significantly higher on 3, 6, 9 and 12 day as compared to treatment groups. The peroxide values of control and treatments groups showed a significant difference at p value <0.05 in between the

storage period. The lowest values were recorded for T4 group compared to other treated groups (Table 2). For the TBARS values non-significant differences were noticed (P>0.05) in treated groups and control. The values significantly increased in T3 groups, particularly on the 12th days of storage. Among the five treated groups the most preferable TBARS values were recorded for T1 group (Table 2).

Table 2: A record of POV, FFA, and TBARS in different treatment groups

	Days	T0	T1	T2	T3	T4
POV (mg/kg)	1	1.20 ±0.006	1.30 ±0.150	1.16 ±0.150	0.85 ±0.150	0.54±0.150
	3	1.82 ±0.009	1.45 ±0.150	1.28 ±0.150	0.92 ±0.150	0.64±0.150
	6	1.92 ±0.009	1.51 ±0.150	1.32 ±0.150	0.97 ±0.150	0.71±0.150
	9	1.99 ±0.006	1.56 ±0.150	1.39 ±0.150	1.10 ±0.150	0.78±0.150
	12	2.11 ±0.063	1.63 ±0.150	1.44 ±0.150	1.16±0.150	0.85±0.150
FFA (%)	1	0.22±0.001	0.16±0.001	0.10 ±0.002	0.11±0.001	0.05 ±0.001
	3	0.28±0.001	0.22 ±0.001	0.16 ±0.001	0.14 ±0.001	0.06 ±0.002
	6	0.34±0.002	0.27 ±0.001	0.17 ±0.001	0.15 ±0.001	0.10 ±0.001
	9	0.40±0.001	0.30 ±0.001	0.20 ±0.001	0.18 ±0.001	0.12 ±0.001
	12	0.46±0.001	0.36 ±0.001	0.28 ±0.001	0.22 ±0.001	0.15 ±0.001
TBARS	1	0.185±0.001	0.110±0.001	0.173±0.001	0.16±0.001	0.15±0.001
	3	0.187±0.002	0.110±0.001	0.175±0.001	0.16±0.002	0.15±0.001
	6	0.187±0.002	0.112±0.001	0.177±0.001	0.17±0.001	0.16±0.002
	9	0.19±0.001	0.114±0.002	0.180±0.001	0.17±0.001	0.16±0.001
	12	0.31±0.001	0.211±0.001	0.301±0.003	0.27±0.002	0.26±0.002

T0=Control (no preservative), T1= 0.2% clove powder, T2= 2% garlic paste, T3=1% mint leaves powder
T4= Combination of all three

Microbiological Assessments of TVC, TCC, TYMC

A significant reduction at p values 0.031, 0.043, and 0.047 in TVC, TCC, and TYMC were noticed respectively in the treated groups as compared to

control. In four different treatment groups only T4 had the lower microbial load. This indicated natural preservatives such as clove, mint and garlic were

found to be effective in microbial growth during the storage period, but their combination was proved to be a preferred preservative ingredient (Table 3).

However, it was surprising that the microbial count increased with the storage period.

Table 3: Microbiological Assessments of TVC, TCC, TYMC (CFU/g)

	Days	T0	T1	T2	T3	T4
TVC	1	5.43±0.009	5.31 ±0.009	5.23 ±0.006	4.89 ±0.009	4.55±0.009
	3	5.47 ±0.012	5.35 ±0.006	5.30 ±0.012	4.99 ±0.006	4.65±0.006
	6	5.51 ±0.006	5.40 ±0.009	5.39±0.009	5.16 ±0.006	4.82±0.006
	9	5.77 ±0.009	5.54 ±0.012	5.57 ±0.006	5.48 ±0.012	5.14±0.012
	12	5.95 ±0.006	5.68 ±0.009	5.75±0.006	5.64 ±0.006	5.29±0.006
TCC	1	2.37±0.006	1.37 ±0.006	1.86± 0.006	1.71 ±0.012	1.56±0.012
	3	2.48±0.012	1.53 ±0.012	2.36 ±0.006	2.21 ±0.009	2.06±0.009
	6	2.60±0.009	2.34 ±0.012	2.45 ±0.009	2.42 ±0.009	2.39±0.009
	9	2.67 ±0.009	2.43 ±0.009	2.50 ±0.006	2.55 ±0.006	2.50±0.006
	12	2.89 ±0.006	2.45± 0.009	2.61 ±0.006	2.63± 0.006	2.64±0.006
TYMC	1	2.69 ±0.06	2.49 ±0.012	2.43 ±0.006	2.44± 0.006	2.45±0.006
	3	3.04 ±0.012	2.75 ±0.006	2.58 ±0.006	2.68±0.006	2.78±0.006
	6	3.27 ±0.009	2.90 ±0.006	2.64 ±0.012	2.85 ±0.009	2.95±0.009
	9	3.37 ±0.006	2.92 ±0.006	2.77 ±0.006	2.99 ±0.006	3.09±0.006
	12	3.50 ±0.006	3.10 ±0.012	2.90±0.006	3.17 ±0.012	3.35±0.012

T0=Control (no preservative), T1= 0.2% clove powder, T2= 2% garlic paste, T3=1% mint leaves powder
T4= Combination of all three

Sensory evaluation (Color and odor)

Table 4 shows that there was a substantial ($P<0.05$) difference in color and odor between the treated and control groups. The sample in the T1 group was with desirable color compared to the other treated groups.

Odor indicated that as storage time increased quality of the samples decreased. The T2 treatment produced the most desired scent, whereas the control group's smell was disagreeable and off-putting.

Table 4: Sensory Evaluation Color, and odor in different treatment groups

	Days	T0	T1	T2	T3	T4
Color	1	4.90 ±0.009	4.75 ±0.006	4.70± 0.006	4.74±0.006	4.78 ±0.006
	3	4.50 ±0.012	4.64 ±0.009	4.56 ±0.009	4.63 ±0.009	4.67±0.009
	6	4.10 ±0.009	4.20 ±0.009	4.16 ±0.006	4.12 ±0.009	4.16±0.009
	9	3.55 ±0.009	3.75 ±0.006	3.31 ±0.006	3.60 ±0.012	3.55±0.012
	12	3.42 ±0.008	3.64±0.009	2.55 ±0.008	3.22 ±0.012	3.26±0.012
Odor	1	4.81 ±0.012	4.70 ±0.009	4.78±0.006	4.71± 0.006	4.64±0.006
	3	4.38 ±0.006	4.42± 0.010	4.59±0.006	4.51± 0.009	4.43±0.008
	6	3.80 ±0.006	4.10 ±0.012	4.22± 0.012	4.12 ±0.012	4.02±0.008
	9	2.52 ±0.017	3.49 ±0.006	3.74 ±0.006	3.70 ±0.006	3.66±0.009
	12	1.97 ±0.009	3.32 ±0.009	3.57 ±0.009	3.47 ±0.006	3.37±0.010

T0=Control (no preservative), T1= 0.2% clove powder, T2= 2% garlic paste, T3=1% mint leaves powder
T4= Combination of all three

DISCUSSION

The pH values were generally increased in all treated and control groups. A clear increase in pH was noticed after 3 days of storage period. Comparable findings were observed by Mahdavi-Roshan et al. (2022) and Singh et al. (2014) in chicken meat preserved with

clove, garlic, and ginger powder. The increase in pH with natural preservatives in chicken meat might be due to the presence of alkaline compounds like eugenol, allicin and oxidative stability that helps to maintain a higher pH. Most preferable cooking loss

was observed in control as compared to treated groups. Cooking loss was decreased with the increased storage period. The most preferable cooking loss was observed at 12th day and less preferable cooking loss was observed on day 1. Cooking loss refers to the reduction in weight of meat during cooking process. A study by Tariq et al. (2018) and Masoumi et al. (2022) showed a similar trend with the present experiment. The decrease in cooking weight might be due to shrinkage, denaturation of meat protein, loss of water and fat (Serdaroğlu et al., 2005).

The POV, FFA, and TBARS in control samples remained significantly higher on 3, 6, 9, and 12 day compared to treatment groups. The results of oxidative parameters were very similar to studies of Tariq et al. (2018) and Masoumi et al. (2022). Obvious results were seen in T4 group where all three natural preservatives were used in combination.

A decrease in TVC, TCC, and TYMC were noticed in treated groups as compared to control groups. The increase in count was observed with the duration of storage. The findings of microbial assessment were very similar to studies of Tariq et al. (2018) and Masoumi et al. (2022). However, the increase in count with the storage period might be decreased if higher concentration of spices were used. (Salloum, (2020).

The sensory evaluation showed a decrease in color and odor changed, these findings were similar to Tariq et al. (2018) and Masoumi et al. (2022). There are several reasons for the reduction in color and odour of meat samples which were treated with natural preservatives as substances found in these preservatives like clove, garlic, and mint might react with meat pigments and cause color changes over time. Similarly, the meat's normal odor may be disguised or altered by the potent and distinctive scents of these natural preservatives, giving the impression that the meat's usual scent has diminished or developed unpleasantly because of chemical reactions between the preservatives and meat ingredients.

CONCLUSION

It was concluded by the study that adding 0.2% clove, 2% garlic, and 1% mint leaves powder to raw chicken meat significantly increased its shelf life. The combined treatment (T4), on the other hand, was the most successful in improving the physicochemical characteristics, oxidative stability, and microbiological safety. Therefore, it is advised to use

a combination of natural preservatives for the best possible meat preservation during refrigerated storage.

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