Pak. j. life soc. Sci. (2024), 22(1): 4448-4457 E-ISSN: 2221-7630;P-ISSN: 1727-4915

Pakistan Journal of Life and Social Sciences
www.pjlss.edu.pk

https://doi.org/10.57239/PJLSS-2024-22.1.00326

RESEARCH ARTICLE

Evaluating the Efficacy of Aqueous Turmeric Extract as a Chicken Breast Preservative during Varied Storage Intervals

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ARTICLE INFO

Received: May 22, 2024

Accepted: Jul 12, 2024

Keywords

Extract from Turmeric

Dipping

Chicken Meat

Breast

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ABSTRACT

The nutritional industry faces a major issue in extending the shelf life of poultry meat due to its sensitivity to pathogenic bacteria and deterioration. Due to its well-known antibacterial and antioxidant qualities, turmeric may be a useful natural preservative. This study looked investigated how the quality of chilled chicken breast was affected by an aqueous extract of turmeric. Three treatments (control, T0), 2% extract of turmeric dip (T1), and 4% turmeric extract dip (T2) were applied to chicken breasts. This study checked at how turmeric aqueous extract affected the physicochemical, antioxidant capacity, oxidative stability, and pathogenic bacteria levels in chicken breasts saved in a refrigerator (4±1°C). The findings demonstrated a substantial ($P<0.05$) variation in the following parameters between treatments and storage times: pH, peroxide value, free fatty acid content, thiobarbituric acid reactive substances (TBARS), total volatile basic nitrogen (TVB-N), and total bacterial count (TBC). Ultimately, it was determined that dipping chicken breasts in 4% turmeric extract improved their physicochemical stability, increased their antioxidant potential, and decreased their microbiological load.

INTRODUCTION

A vital source of proteins, lipids, vitamins, and minerals, meat is the foundation of a healthy diet (**Ahmad *et al.*, 2018**). Though due to its high nutrient level, it is easily spoiled, hence preservation methods are required to keep it fresh and increase its shelf life (**AL-Shammari *et al.*, 2019**). Temperature changes and the oxidation of proteins, carbohydrates, and fats are some of the causes of spoilage (**Dave and Ghaly, 2011; Falowo *et al.*, 2014**). Effective preservation techniques are essential for preserving meat quality throughout storage and transit in light of the growing prevalence of supermarkets and the globalization of food supply chains (**Nychas *et al.*, 2008**).

The Investigation of natural preservatives derived from plants has gained momentum due to growing consumer demand for safe and sustainable food choices, even though conventional preservation techniques like heat treatment, cold logistics, and modified atmospheric packaging are widely used (**ur Rahman *et al.*, 2018)**. (**Zhou *et al.*, 2010**). Plant-based extracts have the potential to be used as natural preservatives because of their antioxidant and antibacterial qualities, especially when they are high in phenolic compounds (**Mohammed *et al.*, 2012; Abd Al-Jaleel, 2012; Jiang and Xiong, 2016; Maryoosh *et al.*, 2023**).

Turmeric (Curcuma longa) has long been utilized as a food preservative due to its rich phytochemical structure, which includes the powerful polyphenol curcumin (**Al-Obaidi, 2013; Simeon-Lancelot *et al.,* 2021; Shahidi and Ambigaipala, 2015; Jurenka, 2009; Deogade and Ghate, 2015; Sahar *et al.*, 2016**). Previous studies have demonstrated the effectiveness of turmeric extracts in the preservation of a variety of meats, including lamb **(Noori Mohammed and Sultan, 2020)** and beef **(Al–Mossawi and Al–thary, 2017**). Furthermore, a plethora of research has documented its antimicrobial, antiparasitic, antifungal, and antioxidant properties (**Al-Obaidi, 2013; Allawi *et al.*, 2009; Hussein, 2012; Muhsin, 2013; Al-ani and Al-Shahwany, 2018; Al-Maliki, 2012; Al-Jawad *et al.,* 2011; Obiad *et al.*, 2012; Ulaiwi *et al.*, 2015; Ibrahim, 2020; Selman *et al*., 2014; Saadon, 2016; Saadon and Al-sudani, 2010; Motar *et al.,* 2017; Al-musawi, 2015**).

Although there is evidence that turmeric has the ability to act as a preservative, there is a dearth of study that focuses on turmeric's use in the preservation of chicken flesh. By assessing how well aqueous turmeric extract preserves chicken breast across various storage times, this study seeks to close this gap. We want to evaluate the effects of turmeric extract on chicken breast quality and shelf life in a comprehensive manner by looking at physicochemical, microbiological, and antioxidant characteristics.

2. MATERIAL AND METHODS

2.1 Plant and extraction

The dried roots of Curcuma longa, often known as turmeric, were procured at a nearby market in the province of Baghdad, Iraq. The Iraqi National Herbarium, Directorate of Seed Testing and Certification, and Iraqi Ministry of Agriculture provided official authentication for the roots. The dried roots of turmeric were ground into a fine powder using an electric blender in order to create the aqueous extract. Next, 100 mL of distilled water was combined with 6.8 g of weighed turmeric or curcumin powder. Following that, the mixture was allowed to boil for 12 minutes and then chilled for 15 minutes at room temperature. After that, the extract was filtered using Whatman filter paper and centrifuged for 10 minutes at 25 ºC at 6764 G-force (**ALsammarraie *et al.,* 2018**).

Sampling

Live birds were purchased from a local market in Iraq, and 50 samples of breast flesh were gathered for examination. Every time before dipping it, all objects that came into contact with the surface of the breast meat were cleaned. The three treatments that were administered were control (T0), 2% (T1), and 4% (T2) turmeric extract dips. On the zero, fourth, and eighth days of storage, the physicochemical quality, antioxidant activity, and bacterial contaminant analysis of chicken breast were assessed.

2.2 pH value

The **Sayre** (**1964**) method was followed in order to ascertain the pH of the samples. In summary, 100 mL of distilled water was used to homogenize 10 grams of each sample for a duration of one minute. After filtering the resultant homogenate, a calibrated pH meter was used to determine the filtrate's pH.

2.3 Peroxide value

The procedure outlined by **Egan and Sawyer (1981)** was used to determine the peroxide ratio. A Soxhlet extraction device was used to extract two grams of lipids, which were weighted precisely and dissolved into 30 milliliters of a 3:2 (v/v) solution of glacial acetic acid and chloroform. 30 mL of distilled water, 1 mL of 1% indicator of starch solution, and 0.5 mL of saturated potassium iodide solution were added to this solution. After then, the mixture was titrated using a 0.01 N sodium thiosulfate solution until the blue tint vanished, indicating that the iodine that had been released had

completely reacted with the thiosulfate. The following formula was used to determine the peroxide value:

Peroxide Value (milliequivalents/kg) = (Weight of the sample / Volume of sodium thiosulfate (ml)) × 0.01 × 1000

2.4 The value of thiobarbituric acid reactive substances

Using the method outlined by **Witte *et al.,* (1970)**, the amount of thiobarbituric acid reactive substances (TBARS) in the sample was quantified to ascertain the degree of lipid oxidation. 25 mL of a cooled solution containing 20% trichloroacetic acid (TCA) in 2 M phosphoric acid was used to homogenize a 1-gram specimen for two minutes. After that, the homogenate was moved to a 50 mL volumetric flask and distilled water was added to bring it to volume. A 25 mL sample was centrifuged at 30,000 rpm for 30 minutes following thorough mixing. Whatman No. 1 filter paper was used to filter the resultant supernatant, and 5 mL of the filtrate was then added to a test tube. The test tube was filled with five milliliters of a 0.005 M thiobarbituric acid (TBA) solution in distilled water. An identical blank was made without the sample. According to **Tarladgis** (**1964**), the contents of the tubes were combined, sealed, and either kept in the dark at room temperature for 15–16 hours or heated in a water bath at 100 °C for 30 minutes. Using spectrophotometry, the absorbance of the resultant pink chromogen was determined at 530 nm. The absorbance was multiplied by a factor of 5.2 to determine the TBARS value, which was then represented as malondialdehyde (MDA) equivalents in milligrams per kilogram of sample (mg MDA/kg) using the following equation:

TBARS (mg MDA/kg) = A530 × 5.2

2.5 The value of free fatty acids

The **Egan *et al.* (1981)** method was utilized to determine the concentration of Free Fatty Acids (FFAs). Ten grams of fat, 25 milliliters of diethyl ether, and 25 milliliters of 95% ethanol were mixed together and neutralized with one milliliter of phenolphthalein indicator solution. The mixture was titrated using 0.1 N sodium hydroxide solution up until the endpoint, which was indicated by the persistence of a light pink tint. The molecular weight of oleic acid was used to compute the percentage of FFAs.

2.6 Value of total volatile basic nitrogen

The procedure described by **Egan *et al.* (1981)** was used to calculate the total volatile basic nitrogen (TVB-N). Using this approach, 300 milliliters of a 5% trichloroacetic acid (TCA) solution were used to homogenize 100 grams of the pulverized material, and the resulting liquid extract was then filtered. 5 milliliters of the extract and 5 milliliters of a 2 M sodium hydroxide solution were added to a Kjeldahl flask. Following a heating process, the liquid was distilled into a receiving flask that contained a 4% boric acid solution along with only a few drops of the indicators bromocresol green and methyl red. The next part equation was used to compute the total quantity of volatile nitrogen:

Total volatile basic nitrogen (TVB-N) = (500/14) × (MO + 300) × V

2.7 Total bacterial count

To calculate the total number of bacteria in the samples, microbial analysis was used. Onto sterile Petri dishes that had already been loaded with Plate Count Agar (PCA), 0.1 mL were distributed. After that, the infected plates were incubated for 24 hours at 37°C. Prior preservation and at several times throughout storage, bacterial colonies were counted and the total viable count was expressed as colony forming units per gram (CFU/g) of material.

2.8 Statistical analysis

SAS (Statistical Analysis System – version 9.1) was used to do the statistical analysis of the data. To evaluate major variations between means, two-way ANOVA and the Least Significant Differences (LSD) post hoc test were used. It is deemed statistically significant when $P < 0.05$.

3. RESULTS AND DISCUSSION

3.1 pH value

When comparing the pH values of chicken breast samples after 8 days of preserving to 4 days and day 0, there was a significant change ($P<0.05$) seen in all treatment groups (T0, T1, and T2). This finding suggests that turmeric has a major effect on pH levels. At 4 and 8 days of storage, the T2 group (4% turmeric extract dip) had the lowest pH values. This may be because turmeric contains ascorbic acid, which can change how acidic food items are (**Augustyńska-Prejsnar *et al*., 2022**).

Treated samples exhibited significantly lower pH values compared to the control group, likely due to evaporation and drip loss in the meat. The readily evaporated bound water can potentially be utilized by microorganisms, leading to an increase in their population and consequently impacting the pH **(Chaillou *et al.*, 2015).** This observation aligns with **Sharma *et al.* (2017**), who reported that a higher pH value in chicken breast is indicative of an increased microbial load.

Table 1. Effect of different concentrations aqueous turmeric extracts on pH value of dipping breast chicken at different storage periods

Groups	Zero	4 days	8 days
T0	C5.91±0.01a	B5.96±0.008a	A6.55±0.01a
T1	B5.92±0.02a	B5.90±0.008b	A6.43±0.01b
T2	B5.94±0.01a	C5.83±0.007c	A6.25±0.02c
LSD	0.04		

Means with a different small letter in the same column are significantly different ($P<0.05$)
Means with a different capital letter in the same row are significantly different ($P<0.05$)

3.2 Peroxide value

At both 4 and 8 days of storage, the peroxide value (PV) of the turmeric-treated groups (T1 and T2) was significantly higher ($P<0.05$) in the control group (T0). The control group and the treated samples showed a significantly significant ($P<0.05$) difference in PV, suggesting that turmeric extract is effective at preventing lipid oxidation. Curcumin, a phenolic molecule and secondary metabolite present in turmeric that has strong antioxidant properties, is responsible for this protective action (**Sahar *et al.,* 2016**). Curcumin neutralizes reactive oxygen species by acting as a scavenger of free radicals (Al-Salman et al., 2022). Turmeric also has antioxidant qualities because of its ascorbic acid concentration. Through its interactions with reactive oxygen species, ascorbic acid neutralizes free radicals by transferring electrons (**Tambe and Bhambar, 2014; Diab, 2005; Azeez, 2021**).

Table 2. Effect of different concentrations aqueous turmeric extracts on PV (meq/kg) of dipping chicken breast at different storage periods

Groups	Zero	4 days	8 days
T0	C4.15±0.01a	B6.78±0.01a	A8.11±0.03a
T1	C4.05±0.02a	B4.34±0.01b	A5.14±0.01b

T2	C4.15±0.21a	B3.92±0.01c	A4.33±0.02c
LSD	0.23		

Means with a different small letter in the same column are significantly different (P<0.05)
Means with a different capital letter in the same row are significantly different (P<0.05)

3.3 TBARS value

Table 3 displays the substantial (P<0.05) impact of treatment and duration of storage on the thiobarbituric acid reactive substances (TBARS) levels of chicken breast. Interestingly, on days 4 and 8 of storage, samples treated with 4% turmeric extract (T2) had the lowest TBARS values. On the other hand, at both of these time points, the control group (T0) displayed the highest TBARS values.

The antioxidant properties of the "heno'Ic chemicals found in turmeric, especially curcumin, are responsible for the decrease in TBARS in the groups that received turmeric treatment. Due to its distinct structure, curcumin functions as a strong antioxidant, efficiently scavenging free radicals and preventing the chain reaction that causes lipid peroxidation (**Uroševic *et al.*, 2022**). This process helps explain the decreased TBARS levels in the turmeric-treated chicken breasts that have been found, which show less lipid oxidation and improved meat quality preservation.

Table 3. Effect of different concentrations aqueous turmeric extracts on TBA value (mg MDA /kg) of dipping chicken breast at different storage periods

Groups	Zero	4 days	8 days
T0	C0.03±0.001a	B0.05±0.001a	A0.07±0.003a
T1	C0.03±0.002a	B0.04±0.0001b	A0.05±0.0005b
T2	C0.03±0.0006a	B0.03±0.0006c	A0.04±0.0007c
LSD	0.002		

Means with a different small letter in the same column are significantly different (P<0.05)
Means with a different capital letter in the same row are significantly different (P<0.05)

3.4 Total volatile basic nitrogen (TVB-N)

Over the course of the storage period, the control group (T0) had a large increase in the total volatile basic nitrogen (TVB-N) value, which was most likely caused by endogenous enzymes and spoilage bacteria (**Sharma *et al.*, 2017**). Even though the turmeric-treated groups (T1 and T2) had the highest TVB-N values at 8 days, these values were still significantly lower than those of the control group at the same time. The storage interval had a substantial (P<0.05) impact on the growth in TVB-N over the storage duration, underscoring the importance of time in the spoiling process. The breakdown of nitrogenous substances by microbiological action is responsible for the increase in TVB-N observed throughout the storage of chicken flesh. The groups that were treated with turmeric exhibited the lowest TVB-N values at both 4 and 8 days. This suggests that dipping in turmeric extract effectively inhibits the growth of microorganisms, especially proteolytic bacteria, which play a significant role in the production of volatile nitrogen compounds.

Table 4. Effect of different concentrations aqueous turmeric extracts on TVB-N value (mg N/100g) of dipping chicken breast samples at different storage periods

Groups/	Zero	4 days	8 days

T0	C9.88±0.02a	B11.26±0.03a	A13.50±0.03a
T1	C9.89±0.01a	B9.99±0.03b	A11.81±0.03b
T2	B9.80±0.01a	B9.73±0.06c	A9.93±0.07c
LSD	0.09		

Means with a different small letter in the same column are significantly different (P<0.05)
Means with a different capital letter in the same row are significantly different (P<0.05)

3.5 Free fatty acid

A highly significant difference (P<0.05) in the free fatty acid (FFA) content was seen between the turmeric-treated samples (T1 and T2) and the control group (T0). Triglycerides are naturally fractured down into FFA in preserved meat through a process called lipolysis, which is mediated by both microbial lipases and endogenous tissue enzymes. The flavor and quality of meat are affected as spoilage microorganisms multiply because of their lipolytic enzymes, which enhance the generation of FFA. One of turmeric's main bioactive components, curcumin, has antibacterial qualities that may be responsible for the observed decrease in FFA concentration in samples treated with turmeric.

According to **Tyagi et al.** (**2015**), curcumin's antimicrobial mechanism of action involves causing bacterial cell membrane damage by making them more permeable, which allows cellular components to seep out. Because of the effective inhibition of microbial lipase activity caused by this disturbance of membrane integrity, lipolysis is decreased, which in turn reduces the accumulation of FFA.

Table 5. Effect of different concentrations aqueous turmeric extracts on FFA content (%oleic acid) of dipping chicken breast samples at different storage periods

Groups	Zero	4 days	8 days
T0	B0.33±0.008a	A0.51±0.008a	A0.60±0.12a
T1	A0.34±0.003a	A0.34±0.01b	A0.39±0.008b
T2	A0.34±0.01a	A0.32±0.07c	A0.36±0.03c
LSD	0.12		

Means with a different small letter in the same column are significantly different (P<0.05)
Means with a different capital letter in the same row are significantly different (P<0.05)

3.6 Bacterial contaminant

At 4 and 8 days of storage, the control group (T0) showed higher total bacterial counts (TBC), while treated samples T1 and T2 showed reduced TBC values. This discovery can be explained by curcumin, a substance well known for its antibacterial and antioxidant capabilities. Bacterial growth is efficiently inhibited by curcumin (**Gul and Bakht, 2015**). There was a significant difference (p<0.05) in the growth of TBC between storage intervals. This is consistent with the known fact that meat's microbial burden rises in direct proportion to the length of storage (**Gumus et al., 2018**). This implies that samples of chicken breasts that have been stored for longer have higher levels of bacterial contamination. This result is consistent with studies conducted by **Chaillou et al. (2015),** which discovered that temperature and storage duration had a significant impact on the development of bacterial populations on chicken breasts.

Table 6. Effect of different concentrations aqueous turmeric extracts on TBC (log CFU/gm) of dipping chicken breast samples at different storage periods

Groups/Time	Zero	4 days	8 days
T0	C4.20±0.06a	B5.12±0.07a	A6.18±0.08a
T1	C4.11±0.04b	B4.99±0.04b	A5.64±0.07b
T2	C4.07±0.02c	B4.83±0.13c	A5.04±0.05c
LSD	0.44		

Means with a different small letter in the same column are significantly different (P<0.05)
Means with a different capital letter in the same row are significantly different (P<0.05)

4. CONCLUSION

When chicken breasts were refrigerated at 4±1°C, the various concentrations of aqueous turmeric extract greatly enhanced their quality. Under these refrigerated conditions, the shelf life of chicken breast was increased to eight days by dipping it in a 4% aqueous turmeric extract solution.

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