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Research Article

Efficacy of some plant extracts in extending keeping quality of beef patties during storage

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Abstract

Three plant extracts (i.e. rosemary, aloe vera, and pomegranate rind) were used separately with minced beef (T1- Control, T2- rosemary extract, T3- aloe vera extract, and T4-pomegranate rind extract). The samples were stored at - 4±1 ºC for 21 days and examined for quality attributes after an interval of every 7 days. Beef patties without plant extract were also prepared and served as control (T1). The beef patties treated with plant extracts showed significantly different ($P< 0.05$) mean values for all parameters in comparison to control. Decrease for pH (5.46 to 5.24) was exhibited by T3, whereas the protein (20.59 to 20.39 %) and fat (4.31 to 4.29 %) were exceptionally maintained with a slight decline by T2 while T4 proved to uphold water holding capacity (55.62 to 54.0 %), moisture content (62.64 to 61.02 %) and total viable count (7.22 to 5.48 log10 CFU/g). TBARS was negligibly increased (0.06 to 0.22 mg/kg) by T4 during the storage period. The pH, water holding capacity, moisture, fat, protein, color, flavor, taste, aroma, overall acceptability of beef patties remained significantly higher. However, all treatments of beef patties excluding control have remained suitable for consumption up to 21 days of storage period. Therefore, results indicate that plant extracts can be used to prolong the shelf-life of the products and quality characteristics of beef patties possibly by delaying microbial spoilage.

Keywords: Beef Patties; Keeping Quality; Plant extracts; Storage Period

Introduction

The meat is the muscle tissue of slaughtered animal is composed of water, lipids, proteins, minerals and a little number of carbohydrates [1]**.** Meat is one of the highly perishable food commodities owing to its nutritional constituents. The quality characteristics of meat and its products are mainly damaged by microbial growth and lipid oxidation during storage [2]. Most meat spoilage processes also happen during low-temperature storage therefore to retard meat spoilage owing to either microbial growth or lipid oxidation, the meat and meat products are often treated with antioxidants or antimicrobial agents [3]. It is estimated that

the shelf life of precooked beef is very limited owing to the growth of food spoilage microorganisms which develop off-flavors in meat and thus poor overall acceptability. Quality precooked beef is highly variable with low microbial safety [4]. It is proven that the shelf life of beef and its products can be enhanced via transforming them into more reliable products by applying several processing techniques, adding antioxidant-rich ingredients, and treating them with natural meat preservatives. The utilization of natural antioxidants is generally preferred by consumers therefore natural antioxidants have gained legislative approval in comparison to synthetic antioxidants since they exert carcinogenic or mutagenic effects. Many scientific studies have proven the efficacious role of different plant extracts against meat spoilage in comparison to synthetic meat preservatives i.e. butylated hydroxytoluene, butylated hydroxyanisole, tertiary butylhydroquinone, propyl gallate and nitrites, etc. [5, 6]. Among different beef products beef patties are delicious and more susceptible to quality deterioration since have high nutritional value [7]. Raw red meats are prone to contamination during handling, processing, and storage. Most of the meat spoilage microorganisms are not eliminated by heat treatments [8] and can deteriorate the overall composition of meat. Moreover, lipid oxidation, free fatty acids, and unsaturated fatty acids may also alter the quality and acceptability of meat and meat products [9]. The exogenously added antioxidant-rich commodities can significantly lower the rate of spoilage in raw and processed meat-based products [10]. The utilization of antioxidant-rich plant extracts i.e. aloe vera, green tea, rosemary, oregano, clove, cinnamon, thyme, ginger, garlic, onion, tomato, pomegranate peel, olives, and curry leaves, etc.) may enhance product quality and shelf life. According to Hęś and [11] addition of antioxidants in meat and meat products limits or inhibits negative oxidative transformations.

Plant extracts may prevent meat deterioration by following ways (a) by preventing chain inhibition via scavenging free radicals, (b) by breaking chain reactions, decomposition of peroxide compounds, (c) minimizing localized concentrations of oxygen and binding of some chain initiating catalysts, i.e. metal ions [12]. In past, the major barrier against the use of naturally occurring plant extracts into the meat and meat-based products was the imposition of unpleasant odors and flavors while the technological developments have also enabled manufacturers of meat ingredients to utilize plant extracts that do not interfere with sensory characteristics and maintain quality attributes. The antioxidant-rich plant extracts can impart their crucial role in maintaining attributes of beef, present study is therefore conducted on the effect of selected plant materials as natural antioxidants and to examine their influence on keeping the quality of beef patties.

Materials and Methods

Sample collection

Fresh boneless beef meat from freshly slaughtered animals was purchased from a local market (Tandojam) and transported to the laboratory to IFST, Sindh Agriculture University, Tandojam under-insulated polystyrene iceboxes. Onion, salt, mixed spices, and flour were purchased from a local of Tandojam.

Plant extracts

The plant materials rosemary leaves (dried) were purchased from a local grocery. Aloe vera leaves were collected from the university garden and pomegranate rind was taken from pomegranate fruit.

Rosemary extract preparation

Plant powder (20 g) was thoroughly mixed with boiling distilled water (500 mL) for 5 min followed by filtration through filter paper (Whatman No. 1). The extract was

preserved in a sterile bottle in the freezer till further use.

***Aloe vera* extract**

Aloe vera leaves were properly washed to remove dust, dirt, and debris. Following washing, the leaves were air-dried after which the peel from the fleshy aloe vera leaves was removed via stainless steel knife. The peel was discarded, and the pulp of the leave was placed into a muslin cloth and hand pressed to obtain aloe vera extract. The extract was preserved in a sterile bottle in the freezer till further use.

Pomegranate extract

The pomegranate fruit was washed twice with tap water and cut into 6 pieces. The fruit was peeled off and its entire rind was collected. To prepare pomegranate rind powder extract, pomegranate rind (PR) was manually separated from the arils, washed, shredded into small strips. pomegranate rind powder extract was prepared by addition of 500 mL of distilled water to 20 grind powder. The mixture was then left to stand for about 10 min and the supernatant was finally filtered using a filter paper (Whatman No. 1). The extract was preserved in a sterile bottle in the freezer till further use.

Production processing of beef patties

The beef meat was minced using an electric mincer and distributed into four equal lots. Three lots were used to add individual plant extract (10 ml/100 g) to prepare three different treatments of beef patties i.e. T2-rosemary extract, T3- Aloe vera extract, and T4-pomegranate rind extract while T1 was served as control/without plant extract (Table 1). The plant extracts were recovered using the method described by **[13]**. All four treatments were molded to prepare patties (diameter=5.5cm, thickness=0.8cm, weight=15 grams), packed into polyethylene bags, coded, and stored at - 4±1 ºC ºC. All treatments were analyzed at 0 days and after an interval of every 07 days during 21 days of storage.

Table 1. Formulation of beef patties treated with different plant extracts

T1 (Control)	100: 0
T2 (rosemary treated beef patties)	100: 10
T3 (aloe vera treated beef patties)	100: 10
T2 (pomegranate rind treated beef patties)	100: 10

Sample analysis of beef patties

Physicochemical characteristics

The pH value of beef patties was determined by using a pH meter (Model HI, Hanna Instruments, Italy). The water holding capacity (WHC) was evaluated according to the method of **[14]**. The moisture, protein, and fat were determined by the procedures of **[15]**.

Sensory attributes

The panel of 10 judges measured the degree of preference among the samples for attributes i.e. color, flavor, aroma, taste, and overall acceptability using a nine-point hedonic scale (representing as, 1=Dislike Extremely, 2=Dislike Very Much, 3=Dislike Moderately, 4=Dislike Slightly, 5=Neither Like nor Dislike, 6=Like Slightly, 7=Like Moderately, 8=Like Very Much and 9=Like Extremely) as described by **[16]**.

Total viable count (TVC) and thiobarbituric acid reactive substances (TBARS)

The enumeration of total viable count (log10 cfu/g) of fresh beef patties and during storage was determined by the method described by **[17]**. TBARS value was determined according to **[18]**. The beef patty was homogenized with 4% HClO4 and 0.01% BHT and the mixture was filtrated. About 5 ml of filtrate was added with 5 ml of 2-thiobarbituric acid into a test tube and placed

in a water bath for an hour. The absorbance was measured on a spectrophotometer at 532 nm against blank.

Statistical analysis

The data obtained so was analyzed according to the method of **[19]** using LSD at 0.05 % of probability level.

Statistical analysis

The data so obtained was analyzed according to the statistical procedure of the computerized statistical package (i.e. Student Edition of Statistics Version 8.1). ANOVA was performed to obtained differences in mean values via Least Significant Difference at $p<0.05$.

Results

Beef patties are typically prone to rapid spoilage owing to multiple biochemical changes during storage. Plants are persistently the generous source to supply man with valuable bioactive substances and thus different plant products are being evaluated as natural antioxidants to preserve and improve the overall quality of meat and meat products. In the present study, results achieved from the proximate analysis of the bread samples are presented in (Fig. 1 & 2). The analysis of variance for the present study showed significant differences in proximate composition among all three bread samples at $p<0.05$. The (Fig. 1) represents statistically different ($P<0.05$) for pH and water holding capacity (WHC) in beef patties treated with plant extracts during storage. At initial, pH was similar (5.32 to 5.46) in all treatments irrespective of plant extract type while during the consecutive interval of every 07 days a relatively intact pattern of maintenance in pH was determined in treatments with plant extracts rather than the control treatment. However, among all treatments of beef patties, T3 exhibited a minimally interrupted decline in pH i.e., from 5.46 to 5.24. The WHC also represented parallel average values (55.01 to 56.57 %) in all treatments at initial whereas it turned to decline in all treatments during the storage period. Among the beef patties treated with plant extracts, T4 proved to uphold WHC in a good manner i.e., from 55.62 to 54.0 % treatments and conversely, T1 exhibited a persistent noticeable decline in WHC from 56.57 to 52.16 %. The findings for chemical constituents of all treatments of beef patties are given in (Fig. 2). The findings for moisture, protein, and fat content in all-beef patties remained statistically different ($P<0.05$). The moisture content in all treatments of beef patties was ranged from 63.27 to 60.07 % at 0 day and it remained to drop during the entire storage period. Among the plant extract treated beef patties, a lower manner of fall in moisture content was exhibited by T4 (62.64 to 61.02 %) followed by T3, T2 and T1. Protein content was found similar (21.01 to 20.59 %) in all treatments of patties at initial whereas a pattern of reduction in average protein content was visible among all treatments. A minimal decrease of average protein content was recorded in T2 (from 20.59 to 20.39 %) during the storage period. At 0 day of storage, fat content was ranged from 4.59 to 3.59 % among the different treatments of beef patties. Fat content also declined during storage while T2 proved to maintain fat content with a negligible decrease (i.e. 4.31 to 4.29 %). The average score for sensory attributes of different beef patties treated with plant extracts during storage is shown in (Fig. 3). The statistical differences ($P<0.05$) for different sensory attributes in beef patties were observed from the findings. The average score for color remained significantly higher ($P<0.05$) in T3 and the same treatment perceived a lower rate of decrease in sensory scoring (i.e. from 8.55 to 7.91). Among the treatments, T3 again exhibited significantly higher ($P<0.05$) scores and a slower manner of decline in flavor (8.02 to 7.61), taste (8.35 to 7.56) and overall acceptability (8.13 to 7.77) of beef

patties. The results belonging to TVC and TBARS are presented in (Fig. 4 & 5). All treatments of beef patties (T1 –T4) showed statistically different (P<0.05) results for TVC and TBARS during storage. The TVC and TBARS remained markedly increasing in T1 i.e. 7.11 to 7.49 log10 CFU/g and 0.08 to 1.9 mg/kg, respectively during the storage period. However, slower mode of decrease in TVC (i.e. 7.22 to 5.48 log10 cfu/g) and a relative increase in TBARS (i.e. 0.06 to 0.22 mg/kg) was noticed in T4.

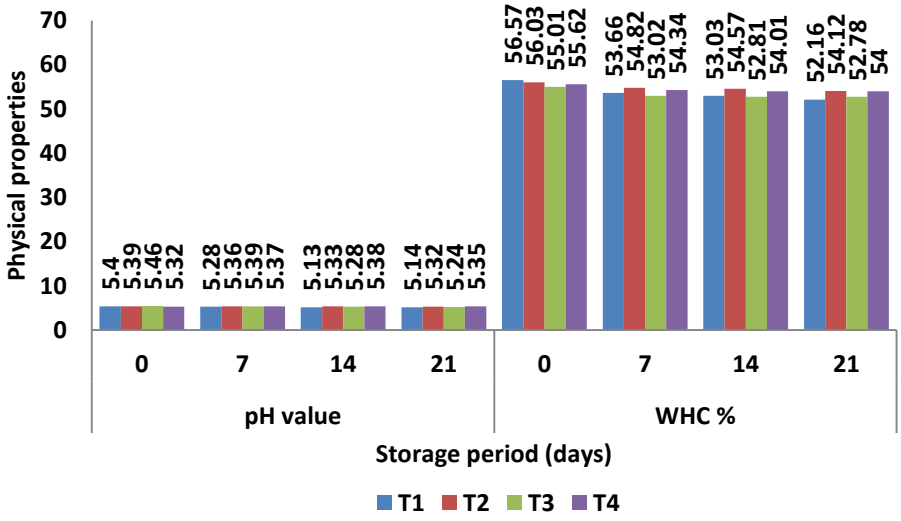

Figure 1. Impact of different plant extracts on pH and WHC (%) of beef patties

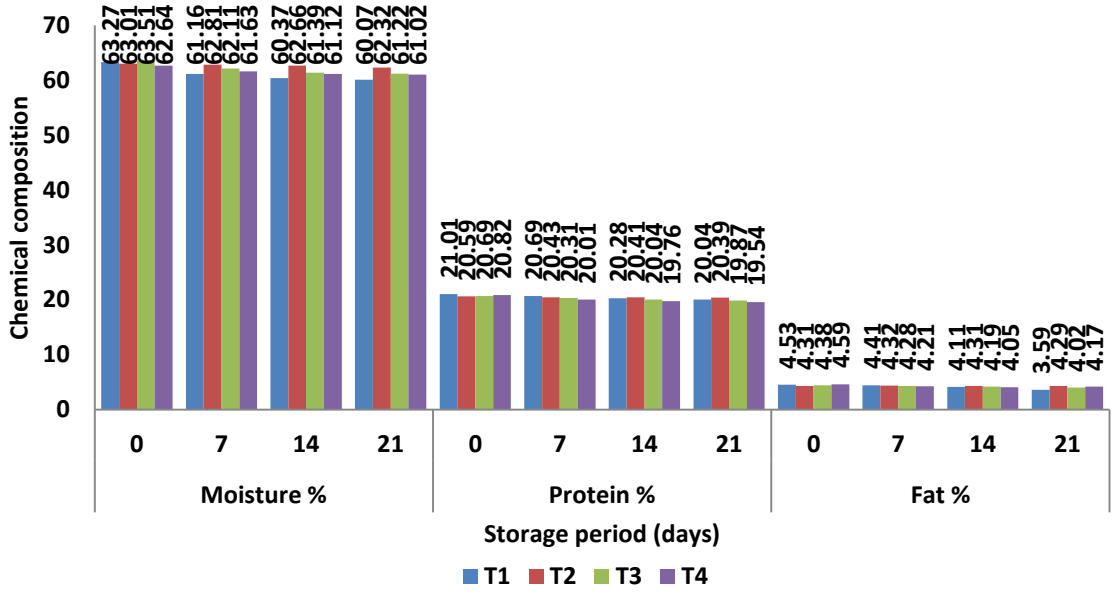

Figure 2. Impact of different plant extracts on chemical composition (%) of beef patties

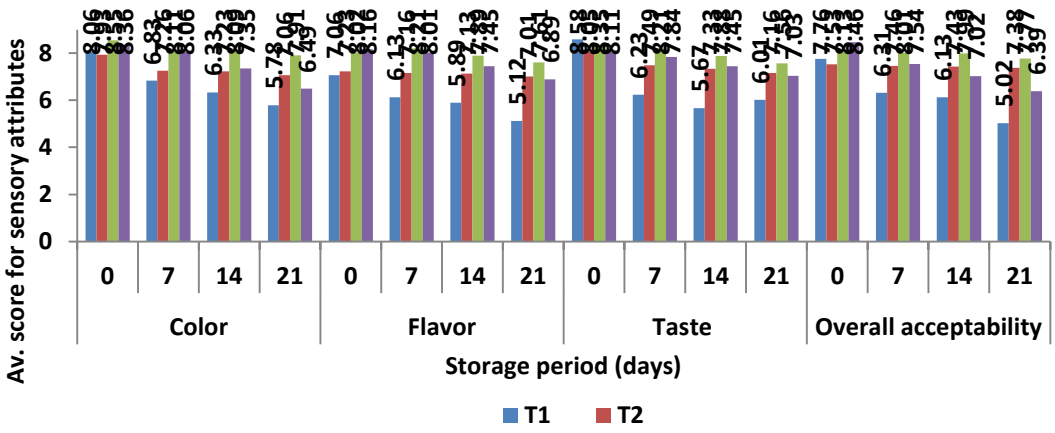

Figure 3. Impact of different plant extracts on sensory attributes of beef patties

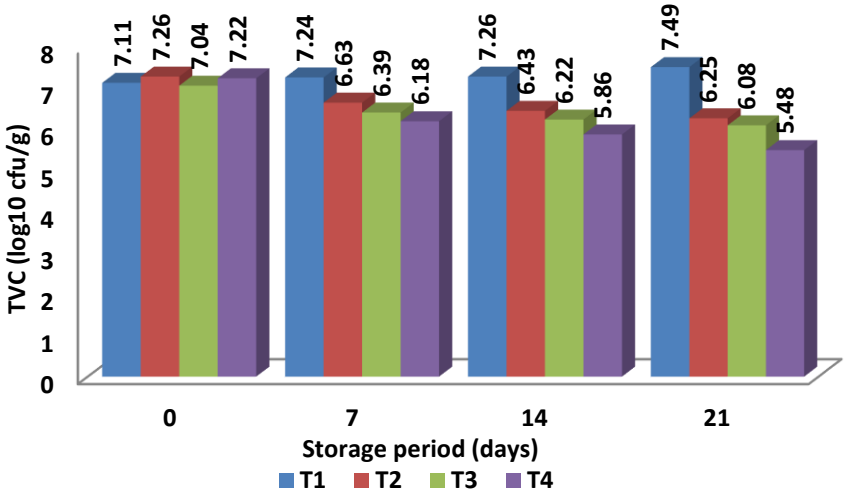

Figure 4. Impact of different plant extracts on TVC (log10 cfu/g) of beef patties

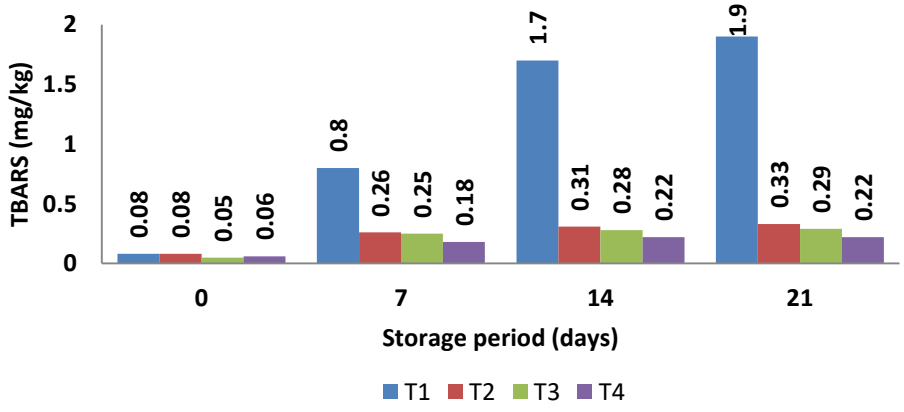

Figure 5. Impact of different plant extracts on TBARS (mg/kg) of beef patties

Discussion

The plant extracts are loaded with antioxidants and antimicrobial agents [20]. Treating meat and meat products with antioxidant-rich plant extracts is gaining new dimensions for prolonging the shelf life and quality characteristics of finished meat products without possible hazards of chemical meat preservatives [21]. In this study, a 21 day storage period was consecutively determined for evaluating the impact of some phenolic compound bearing plant extracts i.e. on maintaining the keeping quality of beef patties. The major possible biochemical changes responsible for spoilage of meat and related products are lipid oxidation, microbial growth, and protein degradation [3] while the intensity of these changes can be lessened by phenolic compounds. In the present study, the pH and sensory attributes of beef patties were excellently maintained by T3 (ABP) however in a similar study [22] examined no effect on pH value in minced beef treated with galangal (*Alpina galangal*) extract. This exhibits that aloe vera extract may exert a supportive role in maintaining pH. Many scientists have also examined the impact of different plant materials on the sensorial attributes of beef patties. According to [23], *Zataria multiflora* Boiss essential oil and grape seed extract exerted a palatable effect on the sensory properties of beef patties. [24] Observed preferences in sensorial characteristics of mutton goshtaba treated with guar gum powder. In another study, [20] studied that pomegranate peel extract in meatballs remained better for maintaining sensory properties. The WHC, moisture content, TVC and TBARS were better maintained by T4 (PRBP). [25] Found that olive leaf extract can improve the water holding capacity of beef patties. During the storage period, the moisture content declined in all treatments (T1-T4) however, the rate of declination was mild among beef patties treated with different plant extracts. Similarly, [26] recorded a slight increase in moisture content of beef patties with green tea extract while moisture lowering effect in beef patties with ulam raja leave extract. [27], and [28] also revealed that polyphenol compounds could act as stabilizers that reduce moisture loss during storage and defrosting.

The findings from the present study are in agreement with the findings of [29], which evaluated the impact of aloe vera gel and Arjun *(Terminalia arjuna)* bark extract on microbial load of beef rolls prepared under refrigeration conditions and found that these plant materials inhibited microbial growth. The beef patties treated with different plant extracts showed consecutively lowers values for TBARS during the storage period in comparison to the control treatment. Present findings are in line with [30], according to their study aloe vera-enriched chicken nuggets exhibited significantly lower TBARS values (0.48 mg/kg) in comparison to control nuggets (0.73 mg/kg). However, according to [31], rosemary extract remained an effective antioxidant and lowered the TBARS value three times less than that of control samples of pork batters. The protein content and fat remain maintained by T2 (RBP) of beef patties treated with plant According to [32], plant extracts have a tendency to reduce the chances of protein degradation by exerting their role as an antioxidant.

Conclusion

It is concluded that all treatments of beef patties showed variable impact on physicochemical properties, sensorial attributes, TVC, and TBARS values. The plant extracts from rosemary, aloe vera, and pomegranate rind altered the quality attributes of beef patties during storage periods. During storage, T3 remained suitable for maintaining pH and sensory profile of beef patties, T4 uphold WHC,

moisture content, TVC and TBARS, T2 proved to maintain protein and fat content of beef patties while control treatment (T1/ without plant extract) exhibited extremely poor performance in keeping quality characteristics of beef patties in an acceptable limit. It is also to conclude that keeping quality of beef patties was minimally compromised during storage. All beef patties treated with plant extracts showed negligible deterioration during storage, but it is important to notice that the rate of deterioration was slower and milder whereas beef patties were still acceptable for consumption with characteristics palatability at the end of the storage period. Further research is required in order to recognize the composition and content of these compounds in plant foods.

Authors' contributions

Conceived and designed the experiments: AH Soomro & A Marri, Performed the experiments: ND Unar, Analyzed the data: DK Lohano, Contributed reagents/ materials/ analysis tools: N Shaikh & TF Miano and AH Shah, Wrote the paper: N Shaikh & SG Khaskheli.

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