



Effect of Lychee Peel Aqueous Extract on Kadaknath and Cobb Chicken Meat Patties during Refrigerated Storage ($4\pm 2^{\circ}\text{C}$)

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ABSTRACT

This study was conducted to develop cobb and kadaknath chicken meat patties separately by incorporating Lychee fruit peel extract (LFPE) and BHT (butylated hydroxyl toluene) individually as antioxidant and to evaluate the effect on storage quality of developed products. Control patties were developed without adding any antioxidants. Sensory scores of kadaknath and cobb patties incorporated with BHT and LFPE were equivalent to respective controls on fresh basis. The sensory color scores of kadakanath patties were significantly lower than cobb patties however flavor, texture, tenderness, juiciness and overall acceptability scores were statistically comparable for both types of patties on fresh basis. Sensory scores decreased and microbial counts increased significantly during refrigerated storage for all the treatments but scores for treated patties were significantly higher than respective controls. At the end of storage TBA and microbial counts for LFPE treated patties were significantly lower than their respective control and BHT treatments. It is concluded that incorporation of 15 ml lychee peel aqueous extract per 100 g of kadaknath and cobb chicken meat resulted in the production of healthier patties. Lychee extract provides better protection against oxidative rancidity and microbial proliferation during refrigerated storage and can well used as a replacement of synthetic antioxidants like BHT.

HIGHLIGHTS

- The sensory color scores of kadakanath patties were significantly lower than cobb patties.
- Lychee extract provides better protection against oxidative rancidity and microbial proliferation during refrigerated storage of chicken patties.

Keywords: Kadaknath, cobb, chicken, lychee peel extract, meat patties, storage

The contribution of poultry meat in total meat production in India is 4.06 million tons which accounts for 50% of India's total meat production. Meat production has increased by 6.0% as compared to last year with poultry meat production increasing at 7.8% (BAHFS, 2019). Cobb-400 is a commercial poultry breed for efficient meat production. It has the lowest cost of live weight produced and shows a superior performance on low cost feed rations. In India, the native breeds also play a major role in the

total poultry production. Kadaknath chicken meat is famous for its taste and claimed aphrodisiac and medicinal properties. The blood, meat and body of the birds are black, as compared to other poultry breeds kadaknath meat is

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high in protein and also, contains essential amino acids and vitamins B-1, B-2, B-6, B-12, C and E (Chand *et al.*, 2011). Kadaknath is an important indigenous breed of poultry inhabiting vast areas of western Madhya Pradesh mainly, the Jhabua and Dhar districts and adjoining areas of Gujarat and Rajasthan. This breed is poor in egg production however their black flesh is very delicious and popular. Kadaknath chicken meat is famous for its taste and claimed aphrodisiac and medicinal properties. Kadaknath chicken meat is used by tribals for effectiveness in treating sterility, menoxenic conditions (abnormal menstruation), habitual abortion (Azad, 2018). Kadaknath are well known for their tropical adaptability and disease resistance (Verma, 2020).

In meat products, antioxidants are extensively employed to prevent oxidation and for conserving the quality attributes. The synthetic antioxidants used in meat products are nitrites and nitrates, ascorbic acid, butylated hydroxyl toluene (BHT), butylated hydroxyl anisole (BHA), may involved in etiology of stomach, bowel and food allergy (Pereira *et al.*, 2015). Besides, BHT and BHA can cause mutations in the DNA, triggering the onset of neoplasia (Aun *et al.*, 2011). Considering these health issues the meat industry now chooses natural antioxidants for various products to address health concerns, delay oxidative degradation of lipids and maintain quality and nutritional value of meat and meat products (Kumar *et al.*, 2015).

Lychee (*Litchi chinensis* Sonn.), a popular fruit cultivated commercially in tropical and subtropical regions, are favored by consumers for their fascinating taste and attractive red pericarps (Pareek, 2016). This fruit has been evaluated for high nutritional value by many types of researches. Researchers have verified a long series of beneficial health compounds including antioxidant, cancer preventive, antimicrobial, anti-inflammatory activities etc. So in 2012, *Lychee chinensis* was inserted in the list of functional foods (U.S.D.A, 2012). Usually, the pericarp of the lychee is wasted or thrown away. Lychee peel (LP) is reported to contain a large number and amount of phenolics which possess antioxidant, anticancer and immune modulatory activities. So, it is considered to be a good source of functional foods (Li *et al.*, 2012; Lin *et al.*, 2015). So, considering above facts lychee peel aqueous extract was incorporated to develop cobb and kadaknath meat patties.

MATERIALS AND METHODS

Procurement and processing of raw materials

Healthy cobb and kadaknath chicken reared under similar feeding and management conditions were procured from nearby market and slaughtered and dressed as per the standard procedure. The dressed carcasses were washed thoroughly and deboned manually after trimming of visible fat and connective tissue. Deboned meat was packed in colorless low density polyethylene (LDPE) bags at $-18\pm 2^{\circ}\text{C}$. The frozen chunks were taken out and thawed overnight at $4\pm 2^{\circ}\text{C}$ and used for preparation of chicken meat patties.

Lychee peels after purchase from the local market were washed gently with clean water. Peels were then squeezed through a muslin cloth and dried in a hot air drier at $50-55^{\circ}\text{C}$ for 2-3 days. Dried peels were ground to a fine powder in a grinder, packed in a polythene bag and stored at $18\pm 2^{\circ}\text{C}$ for further use. For preparing lychee peel aqueous extract, 10 g of dried powder was mixed in 100 ml of distilled water. The mixtures were incubated for overnight at room temperature and filtered through filter paper and the filtrate was used to incorporate in chicken meat patties.

Preparation of chicken meat patties

Both kinds of deboned frozen meat were cut into small pieces separately and minced in an electrical mincer. For control meat patties of both types, 100 g of minced meat of both types was taken individually in which sodium chloride (1.9 g), sodium tripolyphosphate (0.4 g), sodium nitrite (150 ppm), spice mix (2 g), condiments (3 g) (ginger and garlic in the ratio of 1:1), bread crumbs (2 g), water (10 g) egg liquid (5 g) and fat (15 g) were added and blended with the minced meat in a mixer for 4 to 5 minutes and stable emulsions were prepared. For treated meat patties 15 ml of lychee powder aqueous extract were added separately. Approximately 60 g of meat emulsion was hand moulded into a patty shape with the help of a petri dish. Patties were prepared by baking in a preheated oven at a temperature of 160°C for 35 minutes (20 minutes first side and 15 minutes second side).

Analysis

Sensory Quality

A semi trained panel comprising of faculty and research fellows analyzed the chicken patties for the sensory quality in terms of color and appearance, flavor, texture, tenderness, juiciness and overall acceptability using 8 point descriptive scale (Keeton, 1983), where 8 indicating excellent and 1 showing extremely poor. The warmed test samples were served to the panelists after assigning the suitable codes. Water was rendered for rinsing the mouth between different samples.

pH and Thiobarbituric acid (TBA) value

The pH of chicken patties was determined with pH meter (Cyber Scan pH 510, Eutech Instruments; Thermo Fisher Scientific, Navi Mumbai) equipped with a combined glass electrode as per method of Trout *et al.* (1992). TBA value of raw emulsion and cooked patties was determined according to the method of Witte *et al.* (1970).

Microbiological evaluation

Total plate counts (TPC) and psychrotrophic counts of the samples were enumerated following the methods as described by FSSAI (2011).

RESULTS AND DISCUSSION

Sensory Quality

Color scores

No significant difference was noticed in color scores of control and treated cobb meat patties on 0 day of storage (Table 1). The findings were in favour with the findings of Verma *et al.* (2020) who reported the score of 7.24 for control and 7.15 for treatment. Das *et al.* (2016) also found score of 7.23 for control 7.12 for treatment in meat products with LFPE and LP incorporation respectively. For cobb meat patties scores for color decreased with an increase in storage period irrespective of the treatments. A significant decline in color scores in comparison to their fresh counterparts was noticed on the 8th day in C_C (cobb control), C_{BHT} (cobb BHT), C_{LFPE} (cobb LFPE) treatments. On the 8th day and onwards, treatments C_{LFPE} had significantly higher color scores in comparison to C_C and C_{BHT}. Pigment and lipid oxidation might have contributed to a decrease in color scores of chicken patties during refrigerated storage (Bhat *et al.*, 2011). Color scores of C_{LFPE} patties were near to 7.0 meaning very good acceptability. C_{BHT} treatment had color scores between 5.0 and 6.0 meaning slight to moderate acceptability on the 16th day of storage BHT, while C_C patties had color scores of 5.0 meaning slight acceptability.

Table 1: Effect of type of meat and incorporation of lychee fruit peel extract on color scores of chicken meat patties packaged in aerobic conditions and stored at 4±2°C (Mean±SD) (n=12)

Treatments	Storage days				
	0	4	8	12	16
C _C	7.79 ^{aA} ±0.25	7.58 ^{aA} ±0.51	6.95 ^{bB} ±0.62	6.41 ^{cdC} ±0.41	5.166 ^{dD} ±0.24
C _{BHT}	7.83 ^{aA} ±0.24	7.62 ^{aA} ±0.37	7.04 ^{bB} ±0.72	6.95 ^{bB} ±0.49	5.62 ^{cC} ±0.48
C _{LFPE}	7.79 ^{aA} ±.33	7.70 ^{aAB} ±0.39	7.58 ^{aAB} ±0.35	7.41 ^{aB} ±0.28	6.75 ^{aC} ±0.33
K _C	6.83 ^{bA} ±0.49	6.66 ^{bAB} ±0.38	6.33 ^{cBC} ±0.32	6.08 ^{dCD} ±0.41	5.79 ^{cD} ±0.54
K _{BHT}	6.87 ^{bA} ±0.48	6.75 ^{bAB} ±0.33	6.5 ^{cBC} ±0.36	6.33 ^{cdC} ±0.38	6.16 ^{bC} ±0.32
K _{LFPE}	7.08 ^{bA} ±0.56	6.87 ^{bAB} ±0.60	6.66 ^{bcBC} ±0.32	6.5 ^{cC} ±0.47	6.41 ^{bC} ±0.28

Means with different small letter superscripts in a column and capital letter superscript in a row differ significantly (P<0.05).

C_C- Cobb control meat patties, C_{BHT}- Cobb chicken patties with 100 ppm BHT, C_{LFPE}- Cobb chicken patties with 15 ml lychee fruit peel extract
K_C- Kadaknath chicken control patties, K_{BHT}- Kadaknath chicken patties with 100 ppm BHT, K_{LFPE}- Kadaknath chicken patties with 15 ml lychee fruit peel extract.

On 0 day of storage, kadaknath meat patties had a significantly lower score than that of cobb meat patties (Table 1). Which might be due to its blackish color which is less likable than cobb patties. A significant decline in color scores in comparison to their fresh counterparts was noticed on the 8th day in K_C (kadaknath control), K_{BHT} (kadaknath BHT), K_{LFPE} (kadaknath LFPE) treatments. On the 8th day of storage, treatments K_{LFPE} had significantly higher color scores in comparison to K_C and K_{BHT}. On the 16th day extract treated and BHT kadaknath patties had higher color scores in comparison to control. Color scores of extract and BHT patties were around 6.0 meaning moderate acceptability on the 16th day of storage, while control kadaknath patties had color scores of 5.0 meaning slight acceptability. The decrease in the color score with an increase in the storage time of kadaknath meat products was also reported by Badole (2019). These findings were also in conformance with Kandeepan (2010) and Nayak (2014).

Flavor scores

Flavor scores declined significantly in all the treatments with the advancement of storage days during refrigerated storage (Table 2). Devatkal *et al.* (2003) reported that deterioration of flavor during storage might be due to microbial growth and oxidative rancidity. But the decline was more in control treatment as compared to treatments. The treated patties were able to maintain their flavor score in a better way in

comparison to control. Kadaknath has higher flavor scores compared to that of broilers as reported by Mir *et al.* (2017). The reason for flavor difference might be due to variations in the content of Inosine-50-monophosphate (IMP).

From the 4th day onwards, both controls had significantly lower flavor scores in comparison to LFPE treatments on each day of storage of both patties. On the 12th and 16th day of refrigerated storage, extract treated kadaknath and cobb patties had significantly higher flavor scores in comparison to respective control. Both types of extract treated patties had significantly higher flavor scores in comparison to BHT on the 16th day of storage. BHT patties also had significantly better flavor scores than control on the 12th and 16th day of storage. On the 16th day of storage, both types of extract treated patties had flavor scores more than 6.0 meaning moderate desirability.

The highest flavor scores of 6.33 were noticed in LFPE treated kadaknath patties. Both types of BHT patties flavor scores were between 5.0 and 6.0 indicating slight to moderate desirability whereas both control patties had flavor scores around 5.0 meaning slight desirability. Phenolic and bioactive compounds present in LFPE slowed down the development of oxidative rancidity and deteriorative changes. Similar results were also reported by Verma *et al.* (2020) and Das *et al.* (2016) as suggested in meat products with LFPE and LP incorporation respectively.

Table 2: Effect of type of meat and incorporation of lychee fruit peel extract on flavor scores of chicken meat patties packaged in aerobic conditions and stored at 4±2°C (Mean±SD) (n=12)

Treatments	Storage days				
	0	4	8	12	16
C _C	7.87 ^{aA} ±0.22	7.54 ^{aA} ±0.45	7.04 ^{cB} ±0.25	5.54 ^{cC} ±0.62	4.83 ^{dD} ±0.65
C _{BHT}	7.87 ^{aA} ±0.31	7.50 ^{aB} ±0.42	7.25 ^{bcB} ±0.26	6.16 ^{bC} ±0.38	5.37 ^{bcD} ±0.64
C _{LFPE}	7.83 ^{aA} ±0.24	7.62 ^{aA} ±0.43	7.66 ^{aA} ±0.32	6.75 ^{aB} ±0.58	6.29 ^{aC} ±0.54
K _C	7.91 ^{aA} ±0.19	7.62 ^{aA} ±0.37	7.12 ^{bcB} ±0.22	5.62 ^{cC} ±0.74	4.91 ^{cdD} ±0.73
K _{BHT}	7.95 ^{aA} ±0.14	7.58 ^{aB} ±0.41	7.33 ^{bcB} ±0.24	6.25 ^{bC} ±0.45	5.45 ^{bdD} ±0.6
K _{LFPE}	7.87 ^{aA} ±0.22	7.70 ^{aA} ±0.33	7.75 ^{aA} ±0.26	6.83 ^{aB} ±0.53	6.37 ^{aC} ±0.43

Means with different small letter superscripts in a column and capital letter superscript in a row differ significantly (P≤0.05).

C_C- Cobb control meat patties, C_{BHT}- Cobb chicken patties with 100 ppm BHT, C_{LFPE}- Cobb chicken patties with 15 ml lychee fruit peel extract
 K_C- Kadaknath chicken control patties, K_{BHT}- Kadaknath chicken patties with 100 ppm BHT, K_{LFPE}- Kadaknath chicken patties with 15 ml lychee fruit peel extract.

Texture scores, Tenderness and Juiciness score

A significant decline was noticed in texture, tenderness and juiciness scores of control and treated patties with an increase in storage period (Table 3, 4 and 5). However, the decline was more in control patties.

However, the rate of decline for these sensory attributes was less in treated patties resulting in significantly better texture, tenderness, and juiciness scores in comparison to control at the end of storage. On the 12th day of storage, both cobb and kadaknath patties treated with extract had higher texture, tenderness, and juiciness scores in comparison to respective control.

The similar results were reported by Das *et al.* (2016) in his study on the incorporation of lychee pericarp extract

in sheep meat nuggets. Verma *et al.* (2020) also reported a higher juiciness score of meat with treatment lychee pericarp incorporation. The decreasing trend in texture score during storage under refrigeration in meat products were also reported in chicken patties and in vacuum packaged restructured chicken steak by (Kala *et al.*, 2007; Sudheer *et al.*, 2011). The decreasing value of juiciness with the advancement of storage in chicken meat products was also reported by Uikey *et al.* (2018).

Overall acceptability scores

OAA scores decreased significantly in all the treatments with an increase in the storage period (Table 6). However, the decrease was less in both types of extract treated

Table 3: Effect of type of meat and incorporation of lychee fruit peel extract on texture scores of chicken meat patties packaged in aerobic conditions and stored at 4±2°C (Mean±SD) (n=12)

Treatments	Storage days				
	0	4	8	12	16
C _C	7.79 ^{aA} ±0.25	7.41 ^{aB} ±0.46	7.16 ^{aB} ±0.32	6.04 ^{dC} ±0.49	4.91 ^{cD} ±0.46
C _{BHT}	7.83 ^{aA} ±0.26	7.45 ^{aB} ±0.45	7.29 ^{aB} ±0.39	6.37 ^{cdC} ±0.67	5.45 ^{bd} ±0.39
C _{LFPE}	7.75 ^{aA} ±0.39	7.54 ^{aAB} ±0.39	7.33 ^{aB} ±0.38	7.00 ^{abC} ±0.36	6.16 ^{aD} ±0.44
K _C	7.87 ^{aA} ±0.22	7.5 ^{aB} ±0.42	7.20 ^{aB} ±0.39	6.12 ^{dC} ±0.60	5.04 ^{cD} ±0.49
K _{BHT}	7.87 ^{aA} ±0.31	7.54 ^{aAB} ±0.39	7.37 ^{aB} ±0.37	6.58 ^{bcC} ±0.55	5.50 ^{bd} ±0.36
K _{LFPE}	7.83 ^{aA} ±0.32	7.62 ^{aAB} ±0.37	7.37 ^{aBC} ±0.37	7.12 ^{aC} ±0.43	6.25 ^{aD} ±0.50

Means with different small letter superscripts in a column and capital letter superscript in a row differ significantly (P≤0.05).

C_C- Cobb control meat patties, C_{BHT}- Cobb chicken patties with 100 ppm BHT, C_{LFPE}- Cobb chicken patties with 15 ml lychee fruit peel extract
K_C- Kadaknath chicken control patties, K_{BHT}- Kadaknath chicken patties with 100 ppm BHT, K_{LFPE}- Kadaknath chicken patties with 15 ml lychee fruit peel extract.

Table 4: Effect of type of meat and incorporation of lychee fruit peel extract on tenderness scores of chicken meat patties packaged in aerobic conditions and stored at 4±2°C (Mean±SD) (n=12)

Treatments	Storage days				
	0	4	8	12	16
C _C	7.83 ^{aA} ±0.24	7.54 ^{aAB} ±0.54	7.25 ^{aB} ±0.54	6.5 ^{bcC} ±0.56	5.12 ^{dD} ±0.48
C _{BHT}	7.79 ^{aA} ±0.33	7.54 ^{aAB} ±0.54	7.29 ^{aB} ±0.45	6.58 ^{abcC} ±0.55	5.62 ^{bcD} ±0.48
C _{LFPE}	7.87 ^{aA} ±0.31	7.70 ^{aA} ±0.33	7.58 ^{aA} ±0.41	7.00 ^{aB} ±0.42	6.12 ^{aC} ±0.31
K _C	7.70 ^{aA} ±0.25	7.41 ^{aAB} ±0.55	7.16 ^{aB} ±0.49	6.41 ^{cC} ±0.55	5.04 ^{dD} ±0.39
K _{BHT}	7.75 ^{aA} ±0.26	7.41 ^{aAB} ±0.55	7.20 ^{aB} ±0.49	6.41 ^{cC} ±0.55	5.54 ^{cD} ±0.33
K _{LFPE}	7.79 ^{aA} ±0.25	7.45 ^{aAB} ±0.49	7.33 ^{aB} ±0.38	6.91 ^{abc} ±0.46	5.91 ^{abd} ±0.41

Means with different small letter superscripts in a column and capital letter superscript in a row differ significantly (P≤0.05).

C_C- Cobb control meat patties, C_{BHT}- Cobb chicken patties with 100 ppm BHT, C_{LFPE}- Cobb chicken patties with 15 ml lychee fruit peel extract
K_C- Kadaknath chicken control patties, K_{BHT}- Kadaknath chicken patties with 100 ppm BHT, K_{LFPE}- Kadaknath chicken patties with 15 ml lychee fruit peel extract.

Table 5: Effect of type of meat and incorporation of lychee fruit peel extract on juiciness scores of chicken meat patties packaged in aerobic conditions and stored at 4±2°C (Mean±SD) (n=12)

Treatments	Storage days				
	0	4	8	12	16
C _C	7.79 ^{aA} ±0.25	7.66 ^{aA} ±0.32	7.00 ^{aB} ±0.70	6.37 ^{bC} ±0.52	5.08 ^{cD} ±0.19
C _{BHT}	7.83 ^{aA} ±0.24	7.70 ^{aA} ±0.33	7.04 ^{aB} ±0.65	6.58 ^{bC} ±0.46	5.58 ^{bD} ±0.46
C _{LFPE}	7.83 ^{aA} ±0.24	7.75 ^{aA} ±0.26	7.41 ^{aB} ±0.51	7.00 ^{aC} ±0.42	6.20 ^{aD} ±0.49
K _C	7.91 ^{aA} ±0.19	7.70 ^{aA} ±0.33	7.20 ^{aB} ±0.45	6.45 ^{bC} ±0.54	5.16 ^{cD} ±0.32
K _{BHT}	7.87 ^{aA} ±0.22	7.75 ^{aA} ±0.36	7.25 ^{aB} ±0.39	6.54 ^{bC} ±0.49	5.66 ^{bD} ±0.49
K _{LFPE}	7.91 ^{aA} ±0.19	7.79 ^{aA} ±0.25	7.45 ^{aB} ±0.39	7.08 ^{aC} ±0.19	6.29 ^{aD} ±0.45

Means with different small letter superscripts in a column and capital letter superscript in a row differ significantly (P≤0.05).

C_C- Cobb control meat patties, C_{BHT}- Cobb chicken patties with 100 ppm BHT, C_{LFPE}- Cobb chicken patties with 15 ml lychee fruit peel extract
K_C- Kadaknath chicken control patties, K_{BHT}- Kadaknath chicken patties with 100 ppm BHT, K_{LFPE}- Kadaknath chicken patties with 15 ml lychee fruit peel extract.

Table 6: Effect of type of meat and incorporation of lychee fruit peel extract on overall acceptability scores of chicken meat patties packaged in aerobic conditions and stored at 4±2°C (Mean±SD) (n=12)

Treatments	Storage days				
	0	4	8	12	16
C _C	7.87 ^{aA} ±0.22	7.58 ^{aA} ±0.28	7.12 ^{bB} ±0.31	6.04 ^{bC} ±0.54	4.95 ^{cD} ±0.54
C _{BHT}	7.87 ^{aA} ±0.31	7.62 ^{aA} ±0.22	7.25 ^{bB} ±0.33	6.41 ^{bC} ±0.55	5.58 ^{bD} ±0.55
C _{LFPE}	7.87 ^{aA} ±0.22	7.66 ^{aA} ±0.32	7.62 ^{aA} ±0.22	6.87 ^{aB} ±0.50	6.25 ^{aC} ±0.50
K _C	7.95 ^{aA} ±0.14	7.66 ^{aB} ±0.24	7.20 ^{bC} ±0.25	6.12 ^{bD} ±0.39	5.04 ^{cE} ±0.39
K _{BHT}	7.91 ^{aA} ±0.19	7.70 ^{aA} ±0.25	7.29 ^{bB} ±0.25	6.45 ^{bC} ±0.51	5.58 ^{bD} ±0.51
K _{LFPE}	7.87 ^{aA} ±0.22	7.75 ^{aA} ±0.26	7.62 ^{aB} ±0.22	6.95 ^{aC} ±0.39	6.34 ^{aD} ±0.39

Means with different small letter superscripts in a column and capital letter superscript in a row differ significantly (P≤0.05).

C_C- Cobb control meat patties, C_{BHT}- Cobb chicken patties with 100 ppm BHT, C_{LFPE}- Cobb chicken patties with 15 ml lychee fruit peel extract
K_C- Kadaknath chicken control patties, K_{BHT}- Kadaknath chicken patties with 100 ppm BHT, K_{LFPE}- Kadaknath chicken patties with 15 ml lychee fruit peel extract.

patties. On the 8th day of refrigerated storage, LFPE treated both types of patties had significantly higher scores in comparison to both types of control patties.

On the 12th day, extract treated kadaknath and cobb patties had significantly higher OAA scores in comparison to control patties with extract treated patties having better scores in comparison to BHT patties also. Verma *et al.* (2020) reported higher overall acceptability of goat meat nuggets incorporated with LP. Das *et al.* (2016) also reported the comparable OAA of the meat nuggets with LFPE with that of BHT and control on a fresh basis.

pH

pH has a direct bearing on the meat quality attributes such

as tenderness, water-holding capacity, color, juiciness, and shelf-life (Table 7). The pH values ranged from 6.23 to 6.30 for cobb chicken fresh patties. The pH values ranged from 6.22 to 6.29 for kadaknath fresh patties. The addition of BHT, lychee aqueous extracts did not result in any significant effect on the pH of fresh and refrigerated stored kadaknath and cobb chicken meat patties.

There was a slight decrease in the pH of chicken meat patties on the 4th day of refrigerated storage in all the treatments. Subsequently, pH increased on the 12th and 16th day of storage. This pattern in pH might be due to the combine action of psychrotrophic bacteria which ferment carbohydrate present in the ingredients used in the formulation of the product. The subsequent increment in the pH value was due to the liberation of metabolites

Table 7: Effect of type of meat and incorporation of lychee fruit peel extract on pH value of chicken meat patties packaged in aerobic conditions and stored at 4±2°C (Mean±SD) (n=6)

Treatments	Storage days				
	0	4	8	12	16
C _C	6.30 ^{aBC} ±0.09	6.20 ^{aC} ±0.12	6.25 ^{aBC} ±0.04	6.34 ^{aAB} ±0.08	6.43 ^{aA} ±0.08
C _{BHT}	6.26 ^{aBC} ±0.06	6.15 ^{aC} ±0.08	6.24 ^{aBC} ±0.06	6.30 ^{aB} ±0.10	6.42 ^{aA} ±0.12
C _{LFPE}	6.23 ^{aBC} ±0.12	6.14 ^{aC} ±0.08	6.23 ^{aBC} ±0.06	6.27 ^{aAB} ±0.08	6.38 ^{aA} ±0.11
K _C	6.29 ^{aB} ±0.13	6.21 ^{aB} ±0.12	6.25 ^{aB} ±0.04	6.35 ^{aAB} ±0.07	6.44 ^{aA} ±0.14
K _{BHT}	6.24 ^{aBC} ±0.06	6.17 ^{aC} ±0.07	6.23 ^{aBC} ±0.06	6.30 ^{aB} ±0.10	6.41 ^{aA} ±0.12
K _{LFPE}	6.22 ^{aB} ±0.13	6.15 ^{aB} ±0.07	6.24 ^{aB} ±0.06	6.27 ^{aAB} ±0.08	6.38 ^{aA} ±0.11

Means with different small letter superscripts in a column and capital letter superscript in a row differ significantly (P≤0.05).

C_C- Cobb control meat patties, C_{BHT}- Cobb chicken patties with 100 ppm BHT, C_{LFPE}- Cobb chicken patties with 15 ml lychee fruit peel extract
K_C- Kadaknath chicken control patties, K_{BHT}- Kadaknath chicken patties with 100 ppm BHT, K_{LFPE}- Kadaknath chicken patties with 15 ml lychee fruit peel extract.

Table 8: Effect of type of meat and incorporation of lychee fruit peel extract on TBA value (mg malonaldehyde/kg) of chicken meat patties packaged in aerobic conditions and stored at 4±2°C (Mean±SD) (n=6)

Treatments	Storage days				
	0	4	8	12	16
C _C	0.56 ^{aD} ±0.07	0.64 ^{aD} ±0.27	1.06 ^{aC} ±0.04	1.63 ^{aB} ±0.24	1.94 ^{aA} ±0.14
C _{BHT}	0.54 ^{abC} ±0.10	0.62 ^{aC} ±0.20	0.88 ^{abB} ±0.04	1.21 ^{bA} ±0.22	1.41 ^{bA} ±0.30
C _{LFPE}	0.44 ^{bB} ±0.07	0.54 ^{aB} ±0.08	0.78 ^{bA} ±0.31	0.85 ^{cA} ±0.08	0.85 ^{cA} ±0.09
K _C	0.56 ^{aD} ±0.08	0.62 ^{aD} ±0.26	1.04 ^{aC} ±0.05	1.62 ^{aB} ±0.24	1.92 ^{aA} ±0.16
K _{BHT}	0.52 ^{abC} ±0.11	0.60 ^{aC} ±0.20	0.88 ^{abB} ±0.4	1.19 ^{bA} ±0.25	1.38 ^{bA} ±0.32
K _{LFPE}	0.44 ^{bB} ±0.07	0.56 ^{aB} ±0.08	0.79 ^{bA} ±0.31	0.86 ^{cA} ±0.99	0.87 ^{cA} ±0.08

Means with different small letter superscripts in a column and capital letter superscript in a row differ significantly (P≤0.05).

C_C- Cobb control meat patties, C_{BHT}- Cobb chicken patties with 100 ppm BHT, C_{LFPE}- Cobb chicken patties with 15 ml lychee fruit peel extract
K_C- Kadaknath chicken control patties, K_{BHT}- Kadaknath chicken patties with 100 ppm BHT, K_{LFPE}- Kadaknath chicken patties with 15 ml lychee fruit peel extract.

from the bacterial activities as the microbial load enhance with the storage period. At the end of the storage period of 16 days, the pH of each patty was significantly higher in comparison to its fresh counterpart. The pH of all samples varied from 6.38 to 6.44 at the end of the refrigerated storage period of 16 days. Sasse *et al.* (2009) reported that pH increased significantly in BHT, BHA, grape seed extract and oregano extract treated cooked pork patties during frozen storage

Devi *et al.* (2018) in guinea fowl sausage and Dharmaveer *et al.* (2007) in restructured chicken chunk also observed an increasing pattern in pH under vacuum packaged at refrigeration temperature. The lower pH of sheep nuggets with LFPE as compared to control was also reported by Das *et al.* (2016). The results were comparable to the studies conducted by Verma *et al.* (2020) with incorporation

lychee pericarp and Lychee seed extract incorporation as suggested by Kumar (2014).

Thiobarbituric acid (TBA) value

The TBA value of both kadaknath and cobb fresh patties ranged from 0.44 to 0.56 mg malonaldehyde/kg (Table 8). LFPE treated patties had significantly lower TBA values in comparison to control and BHT treated patties on 0 day. TBA values increased significantly in all the treatments during storage. On the 8th day of storage, both kadaknath and cobb extract treated patties had significantly lower TBA values in comparison to control and this trend was maintained up to the end of the storage period. From 12th day onwards, extract treated patties had significantly lower TBA values in comparison to BHT. From the 12th

day of storage, BHT patties also had significantly lower TBA values in comparison to control patties up to the end of the storage. On the 16th day, both kinds of LFPE patties had lower TBA value than control and BHT. But overall TBA value of all the samples increased from the 0 day till 16 days. This could be due to increased lipid oxidation and the production of volatile metabolites in the presence of oxygen during storage.

A similar trend in TBA value was noticed in vacuum packaged meat patties and ready to eat Vawksa rep by Jimenez *et al.* (2007), Kala *et al.* (2007). It was observed that BHT, LFPE extracts had better protection against a rise in TBA values in comparison to control patties during refrigerated storage. It was also observed that LFPE extract resulted in more inhibition in TBA values in comparison to BHT during refrigerated storage. Kumar *et al.* (2014) also reported that during storage, the LSE treated samples showed significant fewer TBARS as compared to the control samples because the phenolic compounds might be involved in the inhibition of lipid oxidation, by inhibiting free radical formation, by preventing the propagation of free radical chain reactions through the chelation of transition metal ions. Ahmad *et al.* (2015), Jongberg *et al.* (2011) in their studies have also reported that the incorporation of plant extracts containing phenolic and flavonoid compounds retarded lipid oxidation in meat products during storage.

Microbiological evaluation

Total plate count (TPC)

The TPC values were statistically similar among control and treatments on day 0 of storage and varied from 2.38 log cfu/g to 2.52 log cfu/g in cobb patties (Table 9). On 0 day in kadaknath patties the count ranged from 2.36 log cfu/g to 2.49 log cfu/g. The TPC significantly increased with the progression of storage, irrespective of the treatment types. From 8th day onwards, LFPE patties had significantly lower TPC in comparison to controls. On the 16th day, treatments LFPE had lower TPC in comparison to control. LFPE treated patties had the lowest TPC of 4.60 log cfu/g and the control had the highest TPC of 5.92 log cfu/g on the 16th day of refrigerated storage. On the 16th day both BHT treated patties had TPC of 5.28 log cfu/g. Results indicate that Lychee peel extract possesses antimicrobial activity. Polyphenols play an important role in protein precipitation and enzyme inhibition of microorganisms. The mechanism responsible for phenolic toxicity to microorganisms is related to reaction with sulphhydryl groups of proteins and the unavailability of substrates to microorganisms (Machado *et al.* 2003; Naz *et al.* 2007).

Singh *et al.* (2013) reported that by comparing the inhibitory action of all three kinds of lychee peel extract *i.e.* acetone water and ethanol extract, it was found that the acetone extract has the most prominent effect on all

Table 9: Effect of type of meat and incorporation of lychee fruit peel extract on Total plate count (log cfu/g) of chicken meat patties packaged in aerobic conditions and stored at 4±2°C (Mean±SD) (n=6)

Treatments	Storage days				
	0	4	8	12	16
C _C	2.44 ^{aE} ±0.49	3.46 ^{aD} ±0.56	4.11 ^{aC} ±0.34	5.07 ^{aB} ±0.38	5.92 ^{aA} ±0.55
C _{BHT}	2.52 ^{aD} ±0.19	3.46 ^{aC} ±0.53	3.80 ^{abC} ±0.47	4.60 ^{abB} ±0.59	5.28 ^{abA} ±0.60
C _{LFPE}	2.38 ^{aA} ±0.59	2.96 ^{aB} ±0.41	3.42 ^{bBC} ±0.42	3.94 ^{bbB} ±0.58	4.61 ^{bA} ±0.36
K _C	2.41 ^{aE} ±0.58	3.38 ^{aD} ±0.69	4.09 ^{aC} ±0.42	5.05 ^{aB} ±0.53	5.89 ^{aA} ±0.63
K _{BHT}	2.49 ^{aD} ±0.26	3.43 ^{aC} ±0.59	3.78 ^{abC} ±0.54	4.58 ^{abB} ±0.68	5.28 ^{abA} ±0.66
K _{LFPE}	2.36 ^{aD} ±0.66	2.93 ^{aCD} ±0.37	3.37 ^{bBC} ±0.46	3.93 ^{bbB} ±0.66	4.60 ^{bA} ±0.40

Means with different small letter superscripts in a column and capital letter superscript in a row differ significantly (P≤0.05).

C_C- Cobb control meat patties, C_{BHT}- Cobb chicken patties with 100 ppm BHT, C_{LFPE}- Cobb chicken patties with 15 ml lychee fruit peel extract
K_C- Kadaknath chicken control patties, K_{BHT}- Kadaknath chicken patties with 100 ppm BHT, K_{LFPE}- Kadaknath chicken patties with 15 ml lychee fruit peel extract.

Table 10: Effect of type of meat and incorporation of lychee fruit peel extract on Psychrotrophic count (log cfu/g) of chicken meat patties packaged in aerobic conditions and stored at 4±2°C (Mean±SD) (n=6)

Treatments	Storage days				
	0	4	8	12	16
C _C	ND	1.31 ^{aC} ±0.66	1.96 ^{aB} ±0.29	2.51 ^{aAB} ±0.58	3.11 ^{aA} ±0.42
C _{BHT}	ND	1.16 ^{aC} ±0.62	1.81 ^{aB} ±0.38	2.29 ^{aB} ±0.61	2.96 ^{abA} ±0.37
C _{LFPE}	ND	0.92 ^{aC} ±0.65	1.59 ^{aBC} ±0.67	1.99 ^{aAB} ±0.51	2.50 ^{bA} ±0.39
K _C	ND	1.29 ^{aC} ±0.66	1.95 ^{aB} ±0.29	2.52 ^{aAB} ±0.57	3.10 ^{aA} ±0.43
K _{BHT}	ND	1.16 ^{aC} ±0.63	1.80 ^{aB} ±0.39	2.28 ^{aB} ±0.61	2.95 ^{abA} ±0.38
K _{LFPE}	ND	0.92 ^{aC} ±0.66	1.60 ^{aBC} ±0.67	1.98 ^{aAB} ±0.50	2.49 ^{ba} ±0.39

Means with different small letter superscripts in a column and capital letter superscript in a row differ significantly ($P \leq 0.05$).

C_C- Cobb control meat patties, C_{BHT}- Cobb chicken patties with 100 ppm BHT, C_{LFPE}- Cobb chicken patties with 15 ml lychee fruit peel extract
K_C- Kadaknath chicken control patties, K_{BHT}- Kadaknath chicken patties with 100 ppm BHT, K_{LFPE}- Kadaknath chicken patties with 15 ml lychee fruit peel extract.

bacterial species, followed by the ethanol extract. On the other hand, the moderate effect of water extract was observed on all gram-negative as well as gram-positive bacteria species.

Psychrotrophic count

On 0 day there were no psychrotrophic that could be due to the death of psychrotrophic because of heat treatment (Table 10). On 4th day Psychrotrophic count of control and treated cobb patties ranged from 0.92 log cfu/g to 1.31 log cfu/g.

On 4th day Psychrotrophic count of control and treated kadaknath patties ranged from 0.92 log cfu/g to 1.29 log cfu/g. An increase in storage period led to a significant increase in psychrotrophic counts in all the treatments. At the end of refrigerated storage, Psychrotrophic count in cobb patties varied from 2.50 to 3.11 log cfu/g and in kadaknath patties the count was 2.49 log cfu/g to 3.10 log cfu/g. LFPE treated patties had a significantly lower psychrotrophic count in comparison to control at the end of storage. Findings were in correlation with the study conducted by Sharma *et al.* (2019) in pomegranate powder aqueous extract incorporation in meat patties. Badole *et al.* (2019) reported that no Psychrotrophic were found on 0 day of storage periods of low fat kadaknath meat patties.

CONCLUSION

The study concluded that incorporation of 15 ml lychee

peel aqueous extract per 100 g of kadaknath and cobb chicken meat individually resulted in the production of healthier patties. Lychee peel extract-treated patties had significantly better sensory scores and were moderately acceptable at the end of storage of 16 days whereas control patties were slightly acceptable at the end of refrigerated storage. Lychee extract provided better protection against oxidative rancidity and microbial spoilage during refrigerated storage and can be used as a deserving substitute for synthetic antioxidants like BHT.

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