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Enhancing the Nutritional Quality, Sensory Characteristics and Refrigerated Storage Stability of Chicken Meat Patties Using Black Coffee Seed Powder

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Target audience: *Meat product producer, Food scientist, Nutritionist*

Abstract

Coffee contains significant amounts of antioxidant compounds such as chlorogenic whose potential has not been maximized in the meat industry.
Four emulsion each containing 0, 1.25, 2.50 and 3.75g Black Coffee Seed Powder (BCSP) were formulated. Emulsion was molded (approximately 50g) and oven-cooked (each batch separately and replicated thrice). Moisture (%), crude protein (%) and organoleptic characteristics (9-point hedonic scale) of fresh patties while Thiobarbituric Acid Reactive Substances (TBARS µgMDA/g) on 0, 7 and 14 days were accessed. Data were analysed using ANOVA and significance test P<0.05. Patties with 3.75 g BCSP contained higher (P<0.05) moisture (62.96) than 2.50 g (59.71), 1.25 g (56.82) and 0 g (42.19) BCSP. Crude protein 16.52 (1.25 g) and 16.64 (2.50 g) were similar but lower (P<0.05) than 17.76 (3.75 g) and higher (P<0.05) than 14.38(0 g) BCSP patties. No significant variation (P>0.05) in colour, aroma, flavour and overall acceptability among patties. The TBARS (1.59, 2.51, 3.21) of 3.75 g BCSP patties were lower (P<0.05) than 1.65, 2.60, 3.27 (2.50 g), 1.72, 2.67, 3.34 (1.25 g) and 2.19, 3.13, 3.82 (0 g) at 0, 7 and 14 days respectively.
Increased crude protein and reduced thiobarbituric acid reactive substances elucidated that black coffee seed can improve nutrient and also be a good antioxidant in chicken meat patties.

Keywords: Black coffee, antioxidants, patties, organoleptic characteristics, thiobarbituric acid reactive substances

Description of Problem

In the meat industry, lipid oxidation and microbial spoilage are important processes that occur during preservation, processing, and storage (1) which results in quality deterioration of meat and meat products (2, 3). This is due to the high nutrients coupled with the high polyunsaturated fatty acids in meat especially linoleic acid which is a significant fat in human diet (4). However, the severe effect of lipid oxidation in meat can be prevented, delayed or retarded

through the addition of antioxidants (5). These antioxidants can either be incorporated into the animal diet during feeding, directly on to the meat surface during processing or added during active packaging (6, 7). However, spraying or mixing with antioxidants is the most common method used by meat producers (8). The increased demand for natural food has made the food industry to continue to explore all natural sources of antioxidants. Significant effect on lipid stability in food has been achieved with different whole plant/herbs such as thyme, oleuropein, clove, oregano, sage or their extracts such as clove oil (9, 10, 11), seeds e.g. pomegranate seed powder (12).

Plants are potential sources of bioactive substances reported as been valuable and safe as natural antioxidants (13). The presence of these natural oxidative compounds in food may at the same time influence the nutritive value of such food (14). Thus providing safe food products with extended shelf-life and improved nutrition to consumers.

The ease of preparation, accessibility and affordability of beef patties made it to be one of the most globally consumed meat product (15). However, it's high protein, fat and free water (16, 17), make it prone to lipid oxidation and microbial spoilage (18) particularly when made from broiler chicken. Therefore, the inclusion of antioxidant in its preparation is of utmost importance.

Coffee has been consumed for its flavor and positive health benefits (19). It is a rich source of dietary antioxidants whose antioxidant property is attributed to its high concentration of polyphenols (20) such as hydroxycinnamic acids, caffeic and chlorogenic acid derivatives (21). It is also reported to contain several compounds that can exert beneficial biological activities for human health (22). These effects are mainly attributed to its caffeine content and other substances such as polyphenols which is mainly chlorogenic acids (23, 24). It also possesses anti-microbial properties which is attributed to the presence of caffeic acid (25). Chlorogenic acids, the main phenolic compound in coffee plant has its highest concentration in coffee seed than other coffee parts (26). Although antioxidant potential of coffee seed especially the green coffee has been established (21, 27), however, least attention has been given to the high bioactive compounds in coffee seed as an antioxidant in food especially in meat production.

Therefore, the present research investigated the nutritional advantages of black coffee seed powder (BCSP) as part of patty ingredients recipes and the sensory characteristics of freshly cooked chicken patties with untrained panelists. It further evaluated the effectiveness of BCSP against oxidative phenomena and also its role on the microbial counts of cooked chicken patties during cold aerobic storage.

Materials and Methods

Experimental Material

Black Coffee seeds (*Coffea arabica*) were sourced from Cocoa Research Institute of Nigeria (CRIN), Ibadan, Nigeria. The proximate composition of the coffee seed was 8.99% (moisture), 2.59 % (ash), 9.20 % (crude fibre), 2.81 % (fat) 9.49 % (crude protein) and 66.93 % (carbohydrate) (28). The coffee seeds were cleaned from

extraneous materials, milled and kept inside air tight container until further use.

Production of chicken meat patties

Six weeks old broiler chicken (twenty-four) fed basal diets only were procured from Teaching and Research Farm University of Ibadan. These were slaughtered (by cutting the jugular vein) allowed to bled thoroughly, defeathered (hot carcass defeathering), eviscerated and cut into different primal cuts. In order to represent the whole broiler carcass, meats were taken from almost every part of the broiler carcasses while removing the skin and bones and the meat refrigerated at -4°C The proximate composition of the broiler chicken meat (raw chunk) used in this study were as follows: 75.82%, 15.28%, 1.40% and 5.79% for moisture, crude protein, total ash and crude fat respectively (29).

Non-meat ingredients were iced water, bread crumbs, spices (salt, red pepper, cumin powder, coriander) and condiment mix (garlic, ginger, onion). The spices were procured from the local market and were sorted (except the salt) to remove extraneous materials, grounded and stored in an air-tight container. Ginger, garlic and onion were also ground (paste form) separately before mixing together in desired proportion. Composition of the ingredients are shown in Table (1). The fresh chicken meat was removed from the refrigerator and allowed to thaw, then cut into small chunks and minced in a commercial meat mincer/ grinder (Electric meat grinder, model KNG762, Kenwood) using a plate with 5 mm diameter holes. The ground meat was separated into four parts and four independent chicken patties were produced following the procedure of (30). The first part was control (without addition of BCSP) while patties requiring the addition of BCSP, was marinated with the meat at 1.25, 2.50, and 3.75gBCSP/ kg meat respectively (Table 1). All ingredients (each batch separately) were mixed thoroughly with the ingredients for about 4 minutes for a better homogeneity. The thoroughly mixed patties emulsion was weighed (50 g per patty) and shaped into patty mold using a Petri dish to obtain average dimensions (approximately 9 cm diameter and 0.6 cm a thickness). The molded raw patties were placed on cooking trays (each batch separately) and cooked in a preheated hot air oven at 180±2°C for 25 minutes with intermittent turning. Doneness was ensured and ascertained by measuring the internal cooking (internal core temperature 72°C) (31). After doneness, the patties were removed, spread on a clean tray and allowed to cool down to room temperature after which they were packaged separately in high density polyethylene Ziploc bags and stored in refrigerated temperature (4±1°C). The patties were evaluated for their quality at seven day interval up to 21 days.

Experimental design

Four different batches emulsion-type patties formulations were prepared (four treatments) comprising of 0g, 1.25g, 2.50, 3.75g BCSP/kg meat respectively. Each batch were produced in triplicates (three batches each prepared on the same day).

Parameters measured

Proximate composition

This was carried out both on coffee seeds

and chicken patties. The proximate analysis was determined according to the procedure of (32). The moisture, crude protein, crude fat and total ash was determined through the drying, Kheja flask, Soxhlet and furnace methods respectively.

Table 1: Ingredient formulation for broiler chicken patties

Ingredients	Quantity (%)
Broiler chicken meat	70
Whole egg	4
Breadcrumbs	10
Ice water	10
Condiment mix (Garlic, Onion, ginger)	3
Spice mix (salt, pepper, cumin, coriander)	3
Total	100

Panelist organoleptic assessment of broiler chicken patties

The organoleptic properties of the patties were assessed using the method described by (33). This was carried out in the Meat Science Laboratory, Department of Animal Sciences, University of Ibadan, where a total of twenty untrained students and staff of the Department were used to evaluate the sensory attributes of the chicken patties. The sample were coded with three-digit numbers before presentation to the panelists for evaluation. The sensory attributes evaluated for include flavour, tenderness, juiciness, texture and colour on a 9-point hedonic scale (34) where 9 = like extremely and 1 = dislike extremely. Water and biscuits (crackers) were provided for the panelists to chew and drink in order to eliminate the carry over effect of the previous sample.

Radical scavenging activity (Diphenylpicrylhydrazyl) of chicken patties

The antioxidant status of the cooked meat patties during cold storage were assessed by determining the radical scavenging capacity of the meat patties. The DPPH free radical scavenging capacity was evaluated by the fixed reaction time method of (35) with slight modification. The absorbance is measured at 517 nm and the percentage of the DPPH radical scavenging is calculated using the equation as given below.

% inhibition of DPPH radical= (Abr - Aar) /Abr x 100

Where Abr= Absorbance control

Aar= Absorbance of the sample reaction taken place.

Determination of Total Volatile Basic Nitrogen (TVB-N) of chicken patties

Each sample (100 g each) was weighed and blended with 300 ml of 5%

Tricholoroacetic acid. The blend was then centrifuged at 3000 ×g for 1 h to obtain clear extract. 5 ml of the extract was pipetted into the Markhan apparatus and 5 ml of 2 M Sodium hydroxide (NaOH) was added. This was steam distilled into 15 ml of standard 0.01 M hydrochloric acid (HCl) containing 0.1 ml rosolic indicator. After distillation, the excess acid was then titrated in the receiving flask using standard 0.01M NaOH to a pale pink end point. A procedural blank was done using 5 ml Trichloroacetic acid with no sample and titrated as before. The concentration of TVB-N (mgN/100 g sample) was computed as follows:

$$\text{TVBN } (mgN/100g \text{ sample}) = (M)(VB - VS)(14)(300 + W)$$

Where VB = ml NaOH used for blank titration

W = water content of sample in g/100 g

M = molarity of NaOH standard solution

VS = ml NaOH used for sample titration.

Thiobarbituric Acid Reactive Substances (TBARS)

The extend of lipid oxidation of the chicken patties during the three week storage was determined by measuring the Thiobarbituric Acid Reactive Substances (TBARS) levels of the sample at 0, 7, 14 and 21 days. The modified extraction assay technique method of (36) was employed. Each sample of chicken patties was placed in a polyethylene bag and fifty ml of chilled (4°C) solution of 20% trichloroacetic acid in 1.6% phosphoric acid was added to the same bag and massaged for two minutes in a stomacher to mix the sample. Fifty ml of chilled distilled water (4°C) was then added into the bag and the stomacher was again used to blend the sample for 30 seconds. The slurry was filtered through Whatman No. 1 filter paper into a 100 ml cylinder. Five ml of the filtrate was pipetted into a test tube, and five ml of fresh chilled 0.02 M 2-thiobarbituric acid solution was added to this tube. All samples in test tubes were placed in the dark at room temperature (25°C) for 15 hours in order to develop the colour reaction. The intensity of colour was measured in a spectrophotometer at 532 nm to calculate the TBARS value. The amounts of TBARS were expressed as micro milligrams of malondaldehyde (MDA)/g meat (µgMDA/g).

Microbiology assessment of chicken patties

The microbial analysis of broiler chicken patties samples was carried out according to (37) with slight modification. Samples of patties (10g each) were blended and diluted with 90 ml of 0.85 % sterile saline to create a 10^{-1} dilution for analysis The samples were transferred into Erlenmeyer containing 225 ml of 1% Buffered Peptone Water (BPW) (Merck 1.07228.0500), homogenized for 1-2 min, and made serial dilution. Serial dilution of the meat samples were done using five sterile test tubes each which were labeled 10^{-1}-10^{-5} and kept in a test tube rack; 9 ml of BPW media were then measured into the five test tubes. 1 ml of diluted meat sample was introduced into the first test tube labeled 10^{-1} and mixed thoroughly, and 1 ml was taken from the first test tube and transferred to the second test tube labeled 10^{-2}. This was continued until the 10^{-5} dilution was obtained. 1 ml of meat samples from 10^{-3}, 10^{-4}, and 10^{-5} dilutions were inoculated on each nutrient agar

(Merck 1.05450.0500) and then incubated at 37°C for 18-24 hours. The growing colony on the plate was counted as Total Plate Count (TPC)

Detection of *Staphylococcus aureus* was done by taking 0.1 ml sample from the first dilution (10^{-1}) at TPC testing, then inoculated into Mannitol Salt Agar (MSA) (Merck 1.05404.0500), and the plates were incubated at 37°C for 2 days. Yellow colonies growing on MSA were recognized as positive *Staphylococcus aureus,* (38). For Total Fungi Counts (TFC), the diluted samples were inoculated into the prepared *A. flavus* media. This was incubated for 30 minutes at 25°C, then kept for another 24hours at room temperature to allow and enhance fungal spore attachment. To calculate the colony-forming units per gram of sample (cfu/g) for *Pseudomonas* spp, identification, Pseudomonas agar (PA, Oxoid, Basingstoke, UK) was used, samples from the serial dilutions were incubated for 48 hours at 25°C under aerobic conditions. Isolation of *Enterobacteriaceae spp* was carried out on Violet Red Bile Glucose Agar (VRBL, Biocorp, France) and the inoculated plates were incubated at 37°C for 24 hours. Samples were assessed on days 0, 7, 14 and 21 days. The colony-forming units were calculated per gram of grounded sample.

Statistical Analysis

Results obtained were statistically analysed by One Way Analysis of Variance. Multiple comparisons of significant differences were determined by Duncan's Multiple Range Test at α 0.05.

Result and Discussion

Displayed on Table (2) is the proximate composition of the chicken patties marinated with BCSP. The moisture content (62.96%) of 3.75g BCSP patties was significantly higher ($P<0.05$) than 59.71% (2.50g BCSP), 56.82% (1.25g BCSP) and 42.19% (0g BCSP). The crude protein (16.52%) of 1.25g and 2.50g (16.64%) BCSP patties were significantly similar ($P>0.05$) but these are higher ($P<0.05$) than 14.38% (BCSP) and lower than 17.76% patties obtained in 0g/kg and 3.75g BCSP patties respectively. The ash content (0.88%) of patties with 3.75gBCSP was significantly higher ($P<0.05$) than 0.87% (2.50g), 0.73% (1.25g) and 0.55% (0g) while ether extract (6.35%) of 0g patties was significantly higher ($P<0.05$) than 5.55% (1.25g), 5.36 % (2.50g) and 5.23% (3.75g) BCSP patties.

The nutritional composition of BCSP patties were improved as shown in the proximate composition of the cooked chicken patties which could be attributed to the nutritional content of the coffee (Table 3). However, this is contrary to (39) who reported no significant changes in the proximate compositions of ground meat marinated with green coffee beans.

The organoleptic characteristics (Table3) showed that no significant variation ($P>0.05$) in colour (5.40-6.80), aroma (3.20-4.20) flavour (3.40-4.40) and overall acceptability (4.40-5.80) among the patties. The tenderness of patties marinated with 2.50g BCSP (6.00) and 3.75g BCSP (6.60) were similar but significantly higher ($P<0.05$) than 4.40 (1.25g BCSP) and 4.80 (0g BCSP).

Table 2: Proximate composition of broiler chicken meat patties marinated with black coffee seed powder

	Inclusion levels BCSP(g)				
Parameters %	0.00	1.25	2.50	3.75	P-value
Moisture	42.19^{d}	56.82^{c}	59.71^{b}	62.96^{a}	0.000
Crude Protein	14.38^{c}	16.52^{b}	16.64^{b}	17.76^{a}	<0.001
Ash	0.55^{d}	0.73^{c}	0.87^{b}	0.88^{a}	<0.001
Ether extract	6.35^{a}	5.55^{b}	5.36^{b}	5.23^{c}	0.001

^{a,b,c}: means in the same rows with similar superscripts are not statistically different (P<0.05)

Juiciness 4.20 marinated with 3.75g BCSP is significantly lower (P<0.05) than 6.60 (1.25g BCSP) 6.80 (2.50gBCSP) but similar to 5.60 (0gBCSP) patties.

The mean sensory scores of the chicken patties obtained from the panel members showed that inclusion of black coffee seed powder directly during processing of chicken patties did not have any negative effect on the sensory characteristics when compared with the control patties. This is evidenced in the sensory attributes particularly in the overall acceptability where the panelist scores indicated that there are no differences in acceptance between the chicken patties marinated with black coffee and that without coffee. These observations were similar to the reports of (40) who opined that coffee still maintained sensory acceptability while exhibiting antioxidant properties. This further agreed with (41) who stated that the volatile profile of coffee silver skin did not seem to impair the flavour of burgers. The low juiciness rating of patties with 3.75g/kg coffee inclusion might be that the taste of caffeine (caffeic acid) at this inclusion level become more pronounced in the patties thus the low juiciness rating by the panels.

Table 3: Organoleptic properties of broiler chicken meat patties marinated with black coffee seed powder

Organoleptic properties	Inclusion levels BCSP(g)				
	0.00	1.25	2.50	3.75	P-value
Colour	6.80	6.00	5.40	5.40	0.442
Aroma	4.20	3.60	3.40	3.20	0.979
Flavour	4.40	3.80	3.40	3.40	0.971
Tenderness	4.80^{b}	4.40^{b}	6.00^{a}	6.60^{a}	0.003
Juiciness	5.60^{ab}	6.60^{a}	6.80^{a}	4.20^{b}	0.002
Overall acceptability	5.40	5.80	5.40	4.40	0.973

^{a,b}: means in the same rows with different superscripts are statistically different (P<0.05)

The display on Table (4) showed that the Total Volatile Basic Nitrogen (24.15) present in patties marinated with 0g/kg BCSP was significantly higher ($P<0.05$) than 21.97 (1.25g), 21.86 (2.50g) and 21.68 (3.75g) BCSP patties. The phenol (183.68) content and DPPH (60.05) of patties marinated with 3.75g BCSP was significantly higher ($P<0.05$) than 181.64; 58.22 (2.50g BCSP), 178.05; 55.83 (1.25g BCSP) and 163.96; 53.25 (0g BCSP) for phenol contents and DPPH respectively.

The Total Volatile Basic Nitrogen (TVB-N) content is an index use to express the production of ammonia and the content of nitrogenous compounds from protein decomposition (42). It is a direct measurement indicator of meat freshness and safety evaluation (43). However, it has been reported that an interaction exists between lipid and protein oxidation (44) because the formation of protein oxidation products in meat and meat products usually take place alongside with oxidation of lipids (45). The TVB-N, phenol contents and DPPH activity of the broiler chicken patties displayed here were pooled data over the storage time up to 14 days. These results showed that increased BSCP in the patties further reduced the TVB-N accumulations implying reduced spoilage rate of the patties during storage. This is because TVB-N are substances produced as a result of enzymatic degradation and microbial action during the spoilage of animal-based foods (46). The antioxidant status of the patties showed that the DPPH activity of the patties increased as BCSP inclusion increased which is higher than that recorded in the patties without BCSP. This confirmed the efficacy of black coffee seed powder as effective antioxidant because a higher DPPH implied higher antioxidative capacity which will result in reduced lipid oxidation. This implied that inclusion of BCSP improved the properties of the prepared chicken patties from quality (shelf stability) and safety (spoilage) perspective.

Table 4: Radical scavenging activity, Total Volatile Basic Nitrogen and Phenol contents of BSCP patties over a pooled storage period of 14 days

	Inclusion levels BCSP(g)				
Parameters	0.00	1.25	2.50	3.75	P-value
DPPH (%)	53.25^{d}	55.83^{c}	58.22^{b}	60.05^{a}	< 0.001
TVB-N (mgN/100g)	24.15^{a}	21.97^{b}	21.86^{c}	21.68^{d}	<0.0001
Phenol (mgGAE/g)	163.96^{d}	178.05^{c}	181.64^{b}	183.68^{a}	< 0.0001

^{a,b,c}: means in the same rows with different superscripts are statistically different ($P<0.05$)

DPPH= Diphenylpicrylhydrazyl (Radical scavenging activity)

TVB-N= Total Volatile Basic Nitrogen

The oxidative stability as displayed (Table 5) showed that the TBARS levels in patties marinated with 3.75g BCSP at 0 (1.59), 7 (2.51) and 14 (3.21) days are significantly higher ($P<0.05$) than 1.69; 1.72; 2.10 (0 day), 2.60; 2.67; 3.13 (7th day) and 3.27; 3.34; 3.82 (14th day) patties marinated with 2.50g, 1.25g and 0g BCSP respectively.

The direct addition of black coffee seed powder to broiler chicken patties emulsion was evaluated against the formation of malonaldehyde and its compound resulting from lipid oxidation after cooking the patties.

As expected storage had effect on lipid oxidation as all chicken patties experienced lipid oxidation which gradually increased with storage time, however, the control sample had the greatest TBARS values irrespective of the days of storage. The effectiveness of black coffee seed as an antioxidant in reducing the rate of lipid oxidation in the patties was observed at day zero where the TBARS levels of all BCSP marinated patties were reduced when compared with patties with no BCSP. This demonstrated the efficacy of coffee as an efficient inhibitor of lipid peroxidation due to its high concentration of caffeic acid (19). The reduced TBARS in all BCSP marinated patties further showed that black coffee seed have a protective effect against lipid oxidation irrespective of the inclusion levels. This reduced effect might be attributed to the presence of chlorogenic acid which have been reported to possess antioxidative properties (47). Similarly, reduced TBARS values was reported in salted silver carp (Hypophthalmichthys molitrix) with pepper (*Zanthoxyoum bungeanum* maxim) leaf extract which is rich in chlorogenic acid (48). The result further showed that throughout the experimental storage period all patties with 3.75g BCSP inclusion had lower TBARS values when compared with other BCSP patties. However, the TBARS of patties batches with BCSP after 14 days of storage were slightly above the oxidation acceptability limit of 2.5 mg MDA/kg obtained after 7 days (49).

Table 5: Thiobarbituric acid reactive substances (μgMDA/g) of broiler chicken patties marinated with black coffee seed powder

Storage days	Inclusion levels BCSP(g)				
	0.00	1.25	2.50	3.75	P-value
0	2.19	1.72^{b}	1.65^{c}	1.59^{d}	<0.01
7	3.13^{a}	2.67^{b}	2.60^{c}	2.51^{d}	<0.001
14	3.82^{a}	3.34^{b}	3.27^{c}	3.21^{d}	<0.01

^{a,b,c,d}: means in the same rows with different superscripts are statistically different (P<0.05)

The microbiology properties (CFUlog10^{3}/g) (Table 6) during storage showed that at day 0, the TPC (1.92), TFC (1.05), *Enterobacteria* (0.92), of patties marinated with 3.75g BCSP were significantly lower (P<0.05) than 2.07; 2.21; 2.87 (TPC), 1.11; 1.24; 199 (TFC), 0.98; 1.06; 1.18 (*Enterobacteria*), found in patties marinated with 2.50g, 1.25g and 0g BCSP respectively. At day 0 the *Staphylococcus* (1.15; 1.10) and *Pseudomonas* (1.16; 1.14) present in patties marinated with 1.25g and 2.50g respectively were similar (P>0.05) but lower than 1.20; 1.31(0g) and higher than 1.02; 1.07 (3.75g) for *Staphylococcus* and *Pseudomonas* counts respectively. On the 7th day, the TPC (2.29; 2.15) and *Staphylococcus* (1.25; 1.24) of patties marinated with 1.25g and 2.50g

respectively were similar (P>0.05) but significantly lower (P<0.05) than 3.10; 1.94 (0g) and higher (P<0.05) than 1.16; 1.10 (3.75g) recorded for TPC and *Staphylococcus* counts respectively. The TFC (2.44), *Enterobateriacea* (1.53), *Pseudomonas* (2.28) present in 0g BCSP patties were significantly higher (P<0.05) than 1.67; 1.24; 1.16 (TPC), 1.24; 1.18; 1.16 (*Enterobateria*), 1.35; 1.27; 1.19 (*Pseudomonas*) recorded in patties marinated with 1.25g, 2.50g, 3.75g BCSP respectively. On 14th day, TPC (3.48), TFC (2.80), *Enterobacteria* (1.79), *Staphylococcus* (2.03) and *Pseudomonas* (2.34) recorded in patties marinated with 0g were significantly higher (P<0.05) than 1.38; 1.38;1.30 (TPC), 1.87; 1.42; 1.35 (TFC), 1.30; 1.27; 1.20 (*Enterobateria*), 1.43; 1.34; 1.14 (*Staphylococcus*), 1.58; 1.47; 1.29 (*Pseudomonas*) recorded in patties marinated with 1.25, 2.50g and 3.75g BCSP respectively.

The result showed that microbial counts of all the patties increased significantly with the progressive refrigerated storage. However, inclusion of BCSP in the patties had significant effect on and positively altered the microbial status of the BCSP chicken patties throughout the storage period as the control patties had higher microbial counts. The study further elucidated that increasing the level of BCSP in the chicken patties further altered the microbial status of the samples by reducing the counts. This implied that coffee can exert an intense antimicrobial activity that can inhibit the growth of pathogenic bacteria in food products (50). This efficiency is attributed to the high caffeic and cholrogenic acids generally found in coffee (51). This implied that black coffee possesses antimicrobial properties and will be efficient as antimicrobial compared with other commonly used meat antioxidants such as acerola, which have no antimicrobial properties (37). This result also agrees with the review of (52), that phenolic compounds in foods possess positive attributes such as antioxidant potential and antimicrobial activities. This also conforms with the report of (43) that caffeine and polyphenolic compounds in coffee have the ability to control the growth of fungal and other pathogenic microorganisms. Similar trend was also observed by (53) who reported a decrease in microbial activity when coffee extracts was added to yogurts. This effect was also observed by (54) who opined that coffee can be used as a natural food ingredient due to its antibacterial properties.

Conclusion and Application

1. The incorporation of black coffee seed powder in patties increased the nutrient (protein and ash) contents of patties and panelist acceptability. Also, its inclusion up to 3.75g/kg does not have any negative impact on the palatability of the patties.
2. The presence of black coffee seed powder (up to 3.75g/kg) in the patties aided in the lowering of the fat content as evidenced in the reduced ether extract which will make the patties healthier for consumption.
3. The presence of black coffee seed powder (up to 3.75g/kg) improved shelf life of the patties by reducing the rate of lipid oxidation thus the

Table 6: Loads of selected microorganisms in broiler chicken meat patties marinated with varying inclusion levels of black coffee seed powder

Days	Parameters (CFUlog10^3/g)	Inclusion levels BCSP(g)				
		0.00	1.25	2.50	3.75	P-value
0	TPC	2.87^a	2.21^b	2.07^c	1.92^d	0.01
	TFC	1.99^a	1.24^b	1.11^c	1.05^d	0.02
	Enterobacteriaceae	1.18^a	1.06^b	0.98^c	0.92^d	0.01
	Staphylococcus	1.20^a	1.15^b	1.10^b	1.02^c	0.01
	Pseudomonas	1.31^a	1.16^b	1.14^b	1.07^c	0.01
7	TPC	3.10^a	2.29^b	2.15^b	2.07^c	0.02
	TFC	2.44^a	1.67^b	1.24^c	1.16^c	0.01
	Enterobacteriaceae	1.53^a	1.21^b	1.18^{bc}	1.16^c	0.03
	Staphylococcus	1.94^a	1.25^b	1.24^b	1.10^c	0.02
	Pseudomonas	2.28^a	1.35^b	1.27^{bc}	1.19^c	0.01
14	TPC	3.48^a	1.38^b	1.38^b	1.30^c	0.01
	TFC	2.80^a	1.87^b	1.42^c	1.35^d	0.001
	Enterobacteriaceae	1.79^a	1.30^b	1.27^{bc}	1.20^c	0.01
	Staphylococcus	2.03^a	1.43^b	1.34^c	1.14^d	0.02
	Pseudomonas	2.34^a	1.58^b	1.47^c	1.29^d	0.01

^{a,b,c,d}: Means in the same rows with similar superscripts are not statistically different (P<0.05)

BCSP= Black Coffee Seed Powder

TPC= Total Plate Counts

TFC= Total Fungi Counts

reduction of TBARS and TVB-N levels in the patties consequently.

4. These findings emphasized that direct inclusion of black coffee seed in chicken meat patties formulation is an effective natural antioxidant and the patties can be stored and quality maintained without any marked loss in quality for a period of three weeks under refrigerated storage conditions.

Conflict of interest

The authors declare that there is no conflict of interest in the research work

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