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Physicochemical, microbiological and sensory evaluation of beef patties incorporated with destoned olive cake powder

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ABSTRACT

The biological efficacy of different concentrations (2%, 4%, and 6%) of destoned olive cake (DOC) as improvers of the quality, storability, and safety of beef patties was investigated. Increasing the percentage of DOC in the patties improved ($P \leq 0.05$) the protein and fat contents, cooking yield, moisture and fat retention, total phenolic, and DPPH radical scavenging activity, while the dimensional shrinkage and TBARS showed a progressive reduction. The pH of the patties decreased gradually with the storage time. DOC-incorporated patties showed significantly ($P \leq 0.05$) lower total plate count than untreated. Surface color values of raw beef patties were decreased gradually with the storage time. Throughout the storage period, all the sensory traits of non-formulated patties were significantly ($P \leq 0.05$) reduced, whereas the formulated patties revealed considerable stability of all characters. Overall, this study identified antioxidant and antimicrobial potentiality of DOC, which could pave the way for its use as an extender of the shelf life of the patties.

1. Introduction

Beef and meat products, particularly beef patties, exhibited considerable increases in production and consumption throughout the world in recent years. This is due to the rapid growth in the fast food market beside the exceptional nutritional quality of meat products as it contains appreciable amounts of protein, vitamins and trace minerals with significant health benefits (National Health and Medical Research Council, 2006). However, mincing beef meat before patty formation disrupt the integrity of muscle membrane and increase the surface area that promotes lipid oxidation and microbial growth of stored meat products. Lipid oxidation and microbial activity are the primary causes of food deterioration, and they strongly affected the safety and the nutritional and sensory qualities of stored meat products (Aguirrezabal, Mateo, Domínguez, & Zumalc_aarregui, 2000; Jayawardana, Ruvini, Nirosh, Supeshala, & Pabodha, 2015). Thus, controlling microbial growth and lipid peroxidation in beef patties is a crucial strategy for sustaining the safety, nutritional and sensory potentials of these products. Previous researches have been directed toward discovering and developing natural or synthetic food additives for controlling microbial growth and lipid peroxidation in meat products (Hayes & Brunton, 2011; Mielnik, Aaby, & Skrede, 2003). Synthetic antioxidants such as ascorbate/ascorbic acid, isoascorbates, tocopherols, gallates, butylated hydroxyanisole (BHA), butylated hydroxytoluene, (BHT), and tertbutyl hydroquinone (TBHQ) are commonly used to retard oxidative reactions in minced meat products (Honikel, 2014). Other synthetic antimicrobials such as nitrite, phosphate, potassium sorbate, propylparaben, lactic, citric, and acetic acids, sodium diacetate, acidified sodium chloride, acidified calcium sulfate, and cetylpyridinium chloride are used to inhibit the microbial growth in meat products (Mills, 2014). Nevertheless, the above synthetic additives are considered unsafe by both human health professionals and consumers (Tang, Kerry, Sheehan, Buckley, & Morrissey, 2001), which have prompted strict regulations for their use in food formulations. Consequently, interest in the development and use of naturally occurring safe alternatives has markedly increased in last decades (Jayawardana et al., 2015). In recent years, the addition of naturally occurring antimicrobial and antioxidant compounds derived from plant sources to meat products has increased because of their potential health benefits and safety (Hayes & Brunton, 2011).

The recent decades are witnessing a growing interest in olive oil production and consumption due to abundant health potentials of olive oil, as it believed to reduce the incidence of cardiovascular disease, certain types of cancer, and neurodegenerative disorders (Pérez-Jiménez, 2005). The protective effects of olives are predominantly attributed to its oleic acid and phenolic compound contents that possess free radical scavenging activity and protect organisms against oxidative damage (Covas et al., 2006). However, only 1–2% of the total phenolics of olive fruits are extracted in the oil and the majority (98–99%) remained in olive mill waste like alperujo and olive cake, which are obtainable in large amounts (approximately 3.5–6.0 million tons/year) (Rubio-Senent, Rodríguez-Gutiérrez, Lama-Muñoz, & Fernández-Bolaños, 2013). These olive oil by-products are harmful to the environment due to their heavy load of phenolic compounds, lipids and organic acids (Dermeche, Nadour, Larroche, Moulti-Mati, & Michaud, 2013). These compounds have adverse impacts on soil microbial communities

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(Paredes, Moreno, Ramos-Cormenzana, & Martinez, 1987), marine ecosystems (Della Greca et al., 2001) and air through emissions of phenol and sulfur dioxide (Rana, Rinaldi, & Introna, 2003). Therefore, numerous studies have intended to either decrease the environmental influence of olive cake or harness its potential economic value. Hence, it is frequently used as a natural fertilizer, substrate for fermentation and animal feeding, dying agent in biosorbing material, and for bioenergy utilization (Akar et al., 2008; Manios, 2004). Also, the olive cake is considered as a promising source of these phenolic compounds for the pharmaceutical, nutraceutical, cosmetic, and food industries (Rubio-Senent et al., 2013). Despite the fact that olive cake has massive amounts of phenolic compounds with antioxidant and antimicrobial activities, research on its application to extend the shelf-life of meat products is scarce (DeJong & Lanari, 2009). Therefore, in the present study, an attempt was made to investigate the effect of incorporation of olive cake on the physicochemical, microbiological and sensory quality of beef patties during cold storage (4 ± 1 °C).

2. Materials and methods

2.1. Materials

Thirty-six kilograms of boneless beef rounds (*Musculus semimembranosus*) of young Holstein Friesians (*Bos taurus*) male and 4.5 kg of beef back fat from the same beef carcasses were obtained from a commercial market (Riyadh, King Saudi Arabia) within an hour of slaughter. About 6 kg of olive cake (Cultivar K18) was kindly donated by Dr. Dakhiel Allah Turki Al-Shamdain (Olive oil processing unit, Al-Jouf City, Saudi Arabia). Unless otherwise stated, all reagents used in this study were of analytical grade.

2.2. Sample preparations

The fat and visible connective tissues of the meat were removed manually and then lean meat and fat were separately ground for 2 min using a kitchen blender (Kenwood Manufacturing Co. Ltd., UK) under cold conditions to avoid an increase in temperature during blending. The olive cake was freeze-dried (Viritis Unitop 600SL, New York). Three patches for each beef burger formula were processed, and all treatments in each patch were replicated three times. For each patch, 12 kg beef meat was used, and four blends (3 kg each) were prepared by combining minced beef with 0, 2, 4 or 6% (w/w) destoned olive cake (DOC) and spices according to percentages specified in Table 1. All ingredients in each blend were mixed to homogeneity using a Stephan UM 12 (Stephan U. Sohner GmbH & Co., Germany) mixer. After mixing, 100 g portions of each blend were formed into patties (approx. 100 g) using a burger-forming device (Expro. Co., Shanghai, China). The patties were cooked for 20 min at 160 °C in a Hobart CN85-19 convection oven (Hobart Corp., Troy, Ohio, USA) until the internal temperature attains 80 °C as measured at the geometrical centre using a digital probe thermometer (Oakton, Eutech Instruments, China). At intervals of 10 min, the patties were turned upside down to ensure uniformity of cooking. Triplicate samples from each batch of DOC-formulated and non-formulated patties were analyzed for the quality characteristics on the same day. For storage stability studies, raw DOC-formulated and non-formulated patties were separately placed in polyethylene bags and stored in a refrigerator (4 ± 1 °C) for 0, 7, and 14 days. At the specified time intervals, raw patties were removed from the refrigerator and cooked as indicated above, and then both raw and cooked patties were assessed for quality characteristics.

Table 1
Formulation of beef patties with different concentration of destoned olive cake powder.

Ingredients (%)	Control	Olive cake powder level (%)		
		2	4	6
Lean meat	76.0	74.0	72.0	70.0
Added fat	9.0	9.0	9.0	9.0
Cold water	11.4	11.4	11.4	11.4
Salt	1.0	1.0	1.0	1.0
White pepper	0.2	0.2	0.2	0.2
Black pepper	0.2	0.2	0.2	0.2
Garlic powder	0.2	0.2	0.2	0.2
Onion powder	2.0	2.0	2.0	2.0
Olive cake powder	0.0	2.0	4.0	6.0

2.3. Approximate composition

Approximate composition (moisture, protein, ash and fat contents) of freeze-dried samples of DOC, raw and cooked patties was determined using the official standard method (AOAC, 2003).

2.4. Cooking properties determination

The cooking yield, fat retention, moisture retention, and dimensional shrinkage were determined using the methods and equations described elsewhere (Al-Juhaimi, Ghafoor, Hawashin, Alsawmahi, & Babiker, 2016). Briefly, cooking yield was determined following the procedure of Murphy, Criner, and Grey (1975). The weight of the patties was recorded before and after cooking, and the cooking yield was calculated by dividing the weight of cooked patties by the weight of raw uncooked patties and expressed in percentage. The fat retention values represent the amount of fat retained in cooked patties, were determined as described by Murphy et al. (1975), and expressed as a percent. The moisture retention values represent the amount of moisture retained in cooked patties and were calculated according to the equation of El-Magoli, Laroia, and Hansen (1996) and expressed as a percent. The dimensional shrinkage was calculated following the formula of Murphy et al. (1975) as follow:

$$\text{Dimensional shrinkage (\%)} = \frac{(\text{Raw thickness} - \text{Cooked thickness}) + (\text{Raw diameter} - \text{Cooked diameter})}{\text{Raw thickness} + \text{Raw diameter}} \times 100 \quad (1)$$

2.5. Preparation of extracts of DOC and beef patties

The DOC and raw and cooked beef patties were freeze-dried, ground to fine powder and sieved through a 1 mm sieve. Nearly 3 g of powdered sample was weighed and extracted with 30 mL of distilled water followed by continuous stirring for overnight using a magnetic stirrer (Fisher, 14-511-1A, USA) at 4 °C. Then the mixture was centrifuged (Hermle, Germany) at 4500 × *g* for 30 min. The supernatant was collected and subsequently used for the determination of total phenolic content (TPC) and antioxidant activity.

2.6. Determination of total polyphenols

The total phenolic contents were analyzed using the Folin-Ciocalteu method with slight modifications (Singleton & Rossi, 1965). Briefly, 1 g of freeze-dried samples of raw beef patties with or without DOC was extracted with 1 mL distilled water. After that, 200 μL of appropriately diluted sample or a standard solution (gallic acid) of varying concentrations were mixed with 400 μL of Folin-Ciocalteu reagent and the volume rise to 4.6 mL with deionized water. After standing for 10 min at room temperature, 1 mL of 10% Na_2CO_3 solution was added, then immediately mixed, and allowed to stand for 2 h at room temperature. The absorbance was read at 765 nm on a UV–visible spectrophotometer (Apel, Saitama, PD-303UV, Japan). The total phenolic content was calculated using gallic acid (1 mg/mL) as standard, and the results were expressed in milligram gallic acid equivalent per gram samples (mg GAE/g sample).