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Qualitative improvement of low meat beef burger using *Aloe vera*

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ABSTRACT

Low meat beef burgers have found their niche in the food markets in developing countries because of their lower price. However, these burgers still lack an acceptable quality. This study investigates the effects of different concentrations of *Aloe vera* on the quality of this food product. For this purpose, beef burgers were produced with 0%, 1%, 3%, and 5% *Aloe vera* and the changes in their cooking parameters, lipid oxidation, texture, and appeal to consumers over 7 days of refrigerated storage were evaluated. Results indicate that *Aloe vera* contributed to some extent to decreased cooking loss and diameter reduction in the burgers. Increased concentrations of *Aloe vera* led to improvements in the water absorption and texture of the burgers as well as their lipid stability. However, a concentration level of 3% led to the most acceptability of the product to the panelists. Finally, it was found that *Aloe vera* acts as a hydrocolloid and improves the quality of burgers.

1. Introduction

The growing interest shown by the public in ready-made, fast, and easy foods stems from the busy life of modern consumers (Lawrie & Ledward, 2006). Hamburgers are among the attractive, ready-to-serve foods (Egbert, Huffman, Chen, & Dylewski, 1991) despite their failure to appear on everybody's plate due to their high fat and protein content. Over the last few years, a definite change in conceptual thinking stimulated by the need to satisfy regional preferences, optimization of food costs, and responsiveness to concerns about food safety has posed new challenges to food designers to address these needs (Modi, Mahendrakar, Narasimha Rao, & Sachindra, 2004). Meat processors should, therefore, be encouraged to provide a wider variety of products capable of winning consumer acceptance at affordable prices in order to increase the consumption of processed meats in developing nations. This necessitates a search for reduced formulation cost procedures while not compromising the quality and sensory attributes of the products (Akwetey & Knipe, 2012). Previous studies indicate that consumers are concerned about the high price and cholesterol content of beef burger (Menkhaus, Colin, Whipple, & Field, 1993). Moreover, beef burger contains about 20% fat which influences the quality perception of burgers (De Silva, Kalubowila, & Lalantha, 2011).

Partial substitution of meat with extenders/binders/fillers has been considered for improving the sensory quality and nutritional value of low meat burger at cheaper prices (Modi et al., 2004). Meat extenders are non-meat ingredients which are added to low quality meat products for economic reasons (Akwetey & Knipe, 2012). Up until now, different non-meat additives have been incorporated into meat products. For example, sodium caseinate and whey protein concentrate as dairy sources have been used in frankfurters (Atughonu, Zayas, Herald, & Harbers, 1998). Among the legumes, lupin, faba bean, chickpeas, and lentils in beef sausages (Bakr, Shekib, El-Iraqi, & Mohamed, 1986), soya beans in beef patties (Miles, Ziyad, Bodwell, & Steele, 1984), common bean flour in sausage (Dzudie, Scher, & Hardy, 2002), as well as cowpea and peanut flours in chicken nuggets (Prinyawiwatkul, Mcwatters, Beuchat, & Phillips, 1997) have been applied as extenders. Tubers and roots (Akwetey & Knipe, 2012; Kao & Lin, 2006), fruits and vegetables (Aleson-Carbonell, Fernández-López, Sayas-Barberá, Sendra, & Pérez-Alvarez, 2003), single-cell sources (Bruna, Fernández, Hierro, Ordóñez, & De La Hoz, 2000; Lin & Lin, 2004), and cereal grains (Beggs, Bowers, & Brown, 1997) are other extenders investigated for improving meat product quality.

Recently, *Aloe vera* has attracted attention in the food industry and used as a functional food ingredient in drinks, beverages, and ice cream and also as an edible coating to preserve grape fruit quality (Valverde et al., 2005). *Aloe barbadensis* belongs to the Liliaceae family with about 360 species. This cactus-like plant grows in hot and dry climates; however, it is cultivated in many areas of the world. The presence of 75 active components in *Aloe vera* meets the needs of the cosmetic and medicinal industries for the production of natural products (Vogler & Ernst, 1999). Anthrone, chromone, aloe verasin, hydroxyaloin, glycoprotein aloctin A, glucomannan, and acemannan are among the many active ingredients with wound healing, anti-inflammatory, anti-tumor, anti-ulcer, anti-neoplastic, and anti-viral effects (Hu, Xu, & Hu, 2003). A wide range of medical products made from *Aloe vera* are used for the treatment of diabetes, cancer, allergy, AIDS, and ulcer as well as gastrointestinal, kidney, and cardiovascular diseases (Valverde et al., 2005).

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The aim of the present study was to investigate the feasibility of using *Aloe vera* as a functional extender for improving the quality of low meat burgers and extending their shelf-life during refrigerated storage.

2. Material and methods

2.1. Materials

All chemicals and solvents used in this study were analytical grade commercial products purchased from Merck Chemical Company, Germany. *Aloe vera* powder was obtained from Mexialoe Laboratorios S.A. de C.V., Mexico. The properties of *Aloe vera* declared by the supplier are listed in Table 1.

2.2. Production of beef burger

Frozen beef was allowed thawing before it was cut into chunks of 1–2 in. in size which were then passed through 8 mm plates. Beef burger was produced by mixing 30% lean beef meat with 12% grated onion, 12.5% texturized soy protein, 4% wheat flour, 1% gluten, 1% seasoning, 1.1% salt, 7.6% vegetable oil, and 30.8% water. The resulting mix was finally ground through a 5 mm plate and formed into burgers. Beef burgers were stored at 4 °C for one week and analyzed on days 1, 3, 5, and 7 of the storage period.

Three different treatments were prepared by adding 1%, 3%, and 5% *Aloe vera* to the formulation while an equivalent amount in each treatment was reduced from the texturized soy protein. No *Aloe vera* was added to the control treatment. Each of the four treatments was prepared in three separated batches.

2.3. Proximate analysis

The proximate composition of *Aloe vera* and raw beef burgers was determined according to the AOAC methods. Moisture content was determined in an oven at 105 °C until the weight became constant. Total crude protein was determined by the Kjeldahl method and lipid content was analyzed according to the Soxhlet method. Incineration in a muffle furnace at 550 °C was used for measuring the crude ash content of *Aloe vera* (AOAC, 1996). The available carbohydrate of *Aloe vera* was estimated by difference.

2.4. pH measurement

Using the IKA homogenizer (ULTRA-TURRAX, Germany), 5 g of raw burger was homogenized for 30 s with 45 mL of distilled water. A pH meter (JENWAY, USA) was used to measure the pH values of the samples.

Table 1
The declared and measured properties of *Aloe vera* obtained from Mexialoe Laboratorios, S.A. de C.V.

Property	Amounts (D.W.)
Moisture (%)	6.0
Protein (%)	0.92
Ash (%)	35.66
Fat (%)	0.65
Carbohydrate	56.77
Specific gravity at 25 °C (0.5% sol.)	1.0026
pH at 25 °C (0.5% sol.)	4.1
Solubility rate at 25 °C	15 seg.
Aloin solution 0.5%	Less than 1 ppm
Microbial count	<100 cfu/g
Pathogenic bacteria	<10 cfu/g

2.5. Water holding capacity (WHC)

Water holding capacity was expressed as expressible moisture according to method described by Jauregui and Regenstein (1981). The expressible moisture reported as percent weight lost from original samples.

2.6. Cooking loss

Three pieces 15 g in weight from each treatment was shaped to a circular disc and fried using a De'Longhi fryer (F38436, USA) in sunflower oil at 155 °C for 5 min. Cooking loss of the beef burgers was measured by weighing raw and fried burger according to the following formula (Akwetey & Knipe, 2012):

$$\text{Cooking loss }(\%) = [(\text{final weight-initial weight})/\text{initial weight}] \times 100.$$

2.7. Diameter reduction

The diameter of each beef burger was measured before and after frying with a digital caliper. Change in the beef burgers' diameter was determined using the following equation (Modi et al., 2004):

$$\text{Reduction in burger diameter }(\%) = [(\text{raw burger diameter} - \text{fried burger diameter})/\text{raw burger diameter}] \times 100.$$

2.8. Moisture retention

Moisture remaining in the products after frying was measured according to the following equation:

$$\text{Moisture retention }(\%) = (\text{moisture of raw beef burger}/\text{moisture of fried beef burger}) \times 100.$$

2.9. Fat absorption

Fat absorption was determined by calculating the difference between fat percentages in the raw and fried burgers.

2.10. Thiobarbituric acid value

Twenty grams of meat was blended with 50 ml of 20% trichloroacetic acid (TCA) for 2 min. The blender content was rinsed with 50 ml of water, mixed together, and filtered through a Whatman # 1 filter. Subsequently, 5 ml aliquot of the TCA extract was mixed with 5 ml of 0.01 M 2-thiobarbitoric acid and held at 100 °C for 1 h. The absorbance of pink color solution was measured at 532 nm using a UV/vis spectrophotometer. TBA was reported as mg of malonaldehyde/kg of the sample (Strange, Benedict, Smith, & Swift, 1977).

2.11. Texture analysis

All mechanical properties were made using the Instron Universal Testing Machine (Model 4302) equipped with flat plate probe for compression and blade for cutting (with 500 g–5 Kg load cell). Texture properties were evaluated in raw and fried samples. Raw burgers 5 cm in diameter and 1 cm in thickness were compressed to 50% of their original height in a one-cycle compression test at a constant speed of 50 mm/min using a circular flat plate. The force corresponding to the maximum compression was reported as the maximum force. At least 3 measurements were taken for each test. The shear force of the cooked burgers was estimated with a blade attached to the texture analyzer