Cooking Pattern and Quality Properties of Ground Pork Patties as Affected by Microwave Power Levels

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Abstract
This study was carried out to evaluate the effects of microwave power level on cooking properties of ground pork patties (fat level: 20%). Each patty was cooked from a thawed state to 76.7°C (center temperature) in a microwave oven with power levels of 40% (360 W), 60% (540 W), 80% (720 W), and 100% (full power, 900 W), respectively. Cooking rate increased with power level, and the non-uniformity also increased with time during cooking. Overheating at the edge of the patties was observed for all power levels, and maximum temperature differences in between the edge position and center position were found in patties cooked at the 900 W power level. Compositional properties, total cooking loss, and drip loss were not affected by power level, although moisture content was lower at the edge than at the center position. As the power level increased, the reduction in patty diameter of cooked patties increased while the reduction in patty thickness decreased. Pork patties cooked at lower power levels (360 W and 540 W) had higher shear force values than those cooked at higher power levels (720 W and 900 W). Few changes were observed in instrumental color values.

Key words : pork patties, microwave power level, microwave cooking, quality properties

Introduction

Microwaves used in the food industry are of the industrial, scientific, and medical (ISM) frequencies 2450 MHz or 900 MHz, corresponding to wavelengths of 12 or 34 cm, respectively. In this frequency range, the dielectric heating mechanism dominates up to moderated temperatures (Ohlsson, 1999). When microwaves generated by a magnetron encounter a food, the energy of the microwave may be reflected, transmitted, or absorbed. All three of possibilities are related to the dielectric properties of the product. While the energy previously absorbed is dissipated to the surroundings, that is, directly inside the food (Engelder and Buffler, 1991; Ohlsson, 1999).

In microwave cooking of foods, power levels affect
depends not only on cooking rate, but also cooking pattern and properties. It thus is considered to reduce the quality loss. Increasing the power output usually increases the speed of microwave cooking, which is the most attractive feature of microwave cooking. However, excessive speed may adversely affect the cooked product and result in non-uniform temperature distribution. This occurs because the cooking may be so fast as to prevent the effectiveness of thermal conductivity in transferring heat to the cooler areas (Schiffman, 1986). Thus, microwaves can produce uneven heating, which is one of the major problems in microwave processing of food products. Since microwaves penetrate from all sides, the geometrical shape of the food product may have a considerable influence on its pattern of heating. Center-heating effects for spherical or cylindrical shapes result from a concentration of energy to the center of the food. This effect depends not only on the processing frequency but also on the diameter and conductivity of the product (Mudgett, 1986; Ohlsson and Bengtsson, 2001). Another undesirable heating pattern dependent upon the geometric shape of the food involves overheating at the corner and edges. In a slab with sharp corners and edges protruding into the microwave fields, energy concentrations will occur causing selective heating, especially at the corners. A sharp edge or corner will act as an antenna and attract more energy than the surrounding areas (Ohlsson and Bengtsson, 2001; Ohlsson and Risman, 1978). These effects are well documented in many literatures (Chamchong and Datta, 1999; Ni et al., 1999; Ohlsson et al., 1974; Zeng and Faghri, 1994). Zeng and Faghri (1994) studied thawing patterns for cylindrically-shaped tylose samples with different aspect ratios. Chamchong and Datta (1999) also studied mathematical and experimental data to investigate the effect of power levels and power cycling levels on thawing time and non-uniformity of tylose samples with 2-4% salt.

The majority of the above studies were performed using homogeneous food materials. However, meat patties are multi-component foods that generally consist of water, protein, and fat. Thus, the cooking pattern and properties of meat patties may be differ substantially from previously studied foods with a homogeneous composition. According to Decareau (1985), multi-component foods present a problem for microwave cooking, particularly when the components have widely different cooking properties. However, very limited researches (Nykvist and Decareau, 1976; Zhang et al., 2004) have investigated the relationship between microwave power levels and the qualities of meat products. Therefore, the purpose of this study was to evaluate the cooking pattern and the quality properties of cooked ground pork patties at different power levels.

**Materials and Methods**

**Processing and preparation**

Six fresh pork hams, weighing 6.8-7.2 kg each, were purchased from a local processor at 48 hr postmortem. Pork backfat was also collected. All subcutaneous and intermuscular fat and visible connective tissue were removed from the fresh ham muscles. Lean materials were initially ground through a 13 mm plate and fat percentage was determined on raw materials before blending. The pork fat was ground through a 8 mm plate and added to the lean meat to create fat level of 20%. The mixtures were mixed by hand for 3 min and grind twice using 3 mm plate. The ground mixtures were hand-mixed and then formed into patties (90 g each) using sterile 15×90 mm Petri dishes. Patties were then randomly vacuum-packaged with Nylon/PE film, frozen, and stored at -20°C until testing. Pork patties processing was run in triplicate.

**Microwave cooking and temperature measurement**

Patties were cooked in a household-type microwave oven (Model MW5480W, Samsung Electronics Co., Ltd., Suwon, Korea) operating at 2450 MHz with power levels of 40% (360 W), 60% (540 W), 80% (720 W), or 100% (full power, 900 W), respectively. Patties were maintained at 5±1°C for 24 to 36 hr before cooking. Each patty was placed in the center of the oven on a microwave-safe plastic container (uncovered) with a plastic rack (approximately 8 mm from the bottom of the container), which allowed drips to escape from the underside, until the internal center of the patty reached the designated testing temperature (76.7°C). The container was rotated inside the microwave chamber during the cooking period. Preliminary trials were conducted to determine the cooking time required to reach the designated internal temperature. The temperatures of the ground pork patties were measured from two temperature sensing locations (at the center and edge position of the mid-depth) using a fiber optic system (Optical Slip Ring System, Fiso Technologies, Quebec, Canada) and a connecting fiber optic temperature sensor (FOT-L, Fiso Technologies, Quebec, Canada) (Fig. 1). The cooling period was followed by holding in an oven for 2 min. The above set-up was interfaced to a computer via a fiber optic system for temperature data acquisition. Immediately after microwave cooking and holding, the