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Effects of glutinous rice flour on the physiochemical and sensory qualities of ground pork patties

Xueqin Gao [a,b], Wangang Zhang [a,c,*], Guanghong Zhou [a,c]

[a] Lab of Meat Processing and Quality Control, Ministry of Education, College of Food Science and Technology, Nanjing Agricultural University, Nanjing 210095, China
[b] Department of Food Science, Henna Institute of Science and Technology, Xinxiang, 453003 Henan, China
[c] Synergetic Innovation Center of Food Safety and Nutrition, Jiangnan University, Wuxi, 214122, China

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A B S T R A C T

The study investigated the effects of glutinous rice flour (GRF) on the quality of ground pork patties. Ground pork patties with 3% of GRF showed better quality compared to addition of 1% and 5% of GRF. Addition of 3% GRF was further compared with 0.5% carrageenan, 3% soy protein isolate, 3% corn starch and 3% potato starch in ground pork patties. The cooking yield in GRF group was significantly higher than that of other treatments due to the increase in moisture and fat retentions ($P < 0.05$). Comparing with other groups, GRF showed lower texture profile values for hardness and chewiness ($P < 0.05$). The ground pork patties with GRF were juicier, more tender and showed better flavor and overall acceptability compared to control and the treatments with other additives ($P < 0.05$). The results indicate that GRF could be an effective functional ingredient in ground pork patties.

1. Introduction

Ground pork products including patties, meatballs and sausages are very popular in China mainly due to their price, flavor and convenience. Plus with their flexibility and versatility, ground pork products are widespread in households, schools, restaurants, supermarkets and the fast-food industry (Brewer, 2012). However, the high fat contents in ground pork product are a major healthy concern since people are interested in reducing their dietary fat intake (Ressurreccion, 2003). Therefore, many non-meat ingredients and additives are added to ground pork products to lower the fat content and at the same time to improve the textural quality, the flavor and the overall acceptability (Sheridana & Shilton, 2002). These ingredients and additives mainly include proteins such as plant proteins and collagen, carbohydrates such as corn starch, potato starch and tapioca starch, salt and phosphates (Giese, 1992; Hsu & Yu, 1999; Riisom, 1991).

GRF is produced by soaked glutinous rice through grinding into powder. Due to the low content of amylase (0–2%, w/w) in GRF, GRF is not easily aged and the cooked glutinous rice is stickier, softer and easier to adhere together (Chueamchaitrakun et al., 2011; Keeratipibul, Luangsakul, & Lertsatchayarn, 2008). GRF contains rich nutritional components including protein, fat, moisture, vitamin B and others. In China, milled GRF is usually used as raw material in various processed products such as sweet dumpling, sweets, desserts, rice cakes, and baked rice crackers. The application of GRF in these products mainly takes advantage of the soft and sticky nature of cooked GRF. The special sticky characteristics of GRF also make it effective to improve the stability of puddings, sauces, gravies against water separation during freeze–thaw cycles (Bean, Esser, & Nishita, 1984; Juliano & Hicks, 1996). However, few studies have focused on the utilization of GRF in meat products especially in ground meat products. Some people reported that mixed gel containing rice starch could be effectively used in Chinese sausage (Feng et al., 2013). Others suggested that GRF may be an effective functional ingredient to improve the textural quality of seasoned beef patties (Yi et al., 2012). As for ground pork products, there has been no published study on the application of GRF based on our knowledge. The pork accounts for more than 60% percent in meat production in China, thus studying the application of GRF in pork product is significant (Zhou, Zhang, & Xu, 2012).

Therefore, the current study was aimed to determine the influence of GRF in the formulation of cooked ground pork patties. We further assessed the GRF as a functional ingredient in ground

Abbreviations: GRF, Glutinous rice flour; CAR, Carrageenan; SPI, Soy protein isolates; CS, Corn starch; PS, Potato starch; MSG, Monosodium glutamate.

* Corresponding author. 205 National Center of Meat Quality and Safety Control, College of Food Science and Technology, Nanjing Agricultural University, Nanjing, Jiangsu 210095, China. Tel.: +86 25 84385341; fax: +86 25 84395341.
E-mail address: wangang.zhang@yahoo.com (W. Zhang).

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pork patties by comparing with other commonly used food additives in ground meat products including CAR, SPI, CS and PS.

2. Materials and methods

2.1. Materials

Fresh pork legs and frozen pork backfat were purchased from a local market (SuShi Food Co., Ltd., Nanjing, China). GRF (Yangzhou Wenfeng Refined Oil and Rice Co., Ltd., Jiangsu, China), CAR (The Cargill Asia Pacific Food System Co., Ltd., Beijing, China), SPI (Linyi Biological Products Co., Ltd., Shandong, China), CS (Huachen Starch Sugar Co., Ltd., Hebei, China) and PS (Nailun Agricultural Technologies Co., Ltd., Inner Mongolia, China) were obtained commercially. Other seasonings were obtained from the pilot lab of National Meat Research Center of China, Nanjing Agricultural University.

The proximate composition of GRF in the current research was 9.68% of protein, 12.67% of moisture, 2.17% of fat and 0.83% of ash (AOAC, 1995).

2.2. Preparation of patties

The deboned pork leg was trimmed to remove connective tissue and visible fat by hand and was stored at 4 °C for 1 d after slaughter for aging. The preparation of pork patties was performed using the method of Gujral, Kaur, Singh, and Sodhi (2002) with slight modification. Initially, meat and backfat were coarsely minced in a mincer (TC, 12E, SIRMAN, Venezia, Italy) with a 10 mm diameter sieve and then with a 4 mm diameter sieve. The condiment paste was prepared by mixing with salt, sodium tripolyphosphate, ice water, nutmeg, sugar, black pepper, onion powder, MSG, soy sauce and rice wine.

The ground pork batters, fat and all condiments mixture were prepared by mixing all ingredients in a laboratory chopper (BZBJ-15, Expro Stainless Steel Mechanical & Engineering Co., Ltd., Hangzhou, China) for 2 min at speed 1. Firstly, GRF was added to the pork patties at three levels (1%, 3%, and 5%) in order to achieve the optimum level of GRF in ground pork patties. In the second part of the study, the mixed pork patty batters were assigned to one of the following 6 treatments: for control, 80% ground pork and 20% backfat without any functional ingredients; for GRF, CS, PS and SPI samples, 3% of the ground pork patty batters were replaced with 3% of additive respectively; for CAR samples, 0.5% of the ground pork batter was replaced with 0.5% of dry CAR according to the literature (Kumar & Sharma, 2004). After completely blending, the weighed patty mixture (120 g) was shaped by hand into a meat patty with a diameter of 80 mm and a height of 15 mm. Shaped pork patties (six replications for each treatment) were placed on an oven tray and cooked in a preheated commercial kitchen oven (VTO-34A, North America Appliance, Zhuhai Co., Ltd., Guangdong, China) at 190 °C for 10 min to achieve an internal end-point temperature of 75 °C. End-point temperature was monitored using a stainless probe-type digital (TM902C, Beijing Pute Instrument Complete Plant, Beijing, China). Following baking, the pork patties were cooled up to the room temperature, vacuum-packaged and then stored at 4 °C until the analysis for proximate composition of patties within 5 d. Analysis of cooking yield, color, texture profile analysis (TPA) and sensory characteristics were evaluated within 6 h after the samples were prepared.

2.3. Cooking yield and proximate composition

After cooking the pork patties and cooling them to the room temperature, they were wiped gently with a paper towel to remove visible exudates. Cooking yield of patties was determined by measuring the weight of six patties for each treatment and calculating the ratio of cooked weight to raw weight and expressed as a percentage as follows:

Cooking yield (%) = cooked weight/raw weight × 100.

Measurements of proximate composition of ground pork patties included protein content, crude fat content, and moisture content. These indices were measured according to the AOAC (1995) method. Protein content used Kjeldahl method (Kjeltec™2300 FOSS Company, Denmark). Crude fat content used a SOX406 Fat Analyzer (CR-400, Shanghai Hanon Experiment Instruments Co., Ltd., Shanghai, China). Both of moisture and fat retentions values represents the amount and fat retained in cooked product per 100 g of raw samples and was calculated according to the method described by others (El-Magoli, Laroja, & Hansen, 1996; Ikhlas, Huda, & Noryati, 2011) with slight modification. They were calculated using the following equations:

$$\text{Moisture retention}\ (\%) = (\text{Percent cooking yield} \times \text{moisture in cooked patties})/100$$

$$\text{Fat retention}\ (\%) = (\text{Percent cooking yield} \times \text{percent fat in cooked patties})/ \times (\text{percent fat in raw patties}).$$

2.4. Color determination

The Hunter L* (lightness), a* (redness) and b* (yellowness) values of cooked patties were measured using a color difference meter (Chroma Meter CR-400, Konica Minolta, Sensing, Inc., Sakai, Japan). Six samples from each treatment were analyzed, and the average value was determined by taking observations from three different locations on a given sample.

2.5. Texture profile analysis

Samples of cooked ground pork patties which were cooled to room temperature were cut into 10 mm high and 25 mm diameter with a round sample taker, and both baked surfaces of the patties were removed with a double-edged knife in order to have a sample with the same height of 10 mm. Then the samples were subjected to two-cycle compression test by using a TA.XT Plus with P50 probe (Stable Micro Systems Ltd., Godalming, Surrey, UK). Samples were placed on the center of the TPA plate and compressed to 70% of their original height at a constant test speed of 1 mm/min (pre test speed and post test speed were 5 mm/min and testing interval was 5 s). Hardness, chewiness, cohesiveness and springiness were computered from the curve adopting the method described by Brady, Mckeith, and Hunence (1985). Six different patties from each formula were analyzed. The results of TPA were processed by Texture Expert Exceed 2.64a inner macro TPA.MAC.

2.6. Sensory evaluation

Cooked ground pork patties at room temperature under bright light were evaluated for their color, juiciness, tenderness, flavor and overall acceptability by 10 numbers of the sensory panel who were experienced in sensory evaluation of foods but received no specific training relevant to these products. Panel members were recruited from students and staff in National Center of Meat Quality and Safety Control of China. Panelists were age 20–45, and five males and five females participated consisting of three undergraduates, four post-graduate students and three doctoral students. Panel members were given verbal instructions before they evaluated the products. Five-point scale was used according to Yi et al., 2012 with