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Physicochemical properties and sensory evaluation of *Mesona Blumes* gum/rice starch mixed gels as fat-substitutes in Chinese Cantonese-style sausage

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ABSTRACT

Effect of *Mesona Blumes* gum (MBG)/rice starch mixed gels on the fat substitute of Chinese Cantonese-style sausage was investigated in this study, monitored with physicochemical properties and sensory evaluation analyses. Experimental results suggest that there were no significant differences among pH, yield, residual nitrite and TBARS of high-fat (28%), low-fat (18%) and fat-substituted (18%) sausages. The same fat content of low-fat and fat-substituted sausages would aid to compare their physicochemical properties more effectively. In addition, the emulsifying stability and water holding capacity of fat-substituted sausages were better than those of the other groups. During refrigerated storage (4 °C, 3 weeks), fat-substituted sausages reflected similar hardness, chewiness and shear force properties with those of high fat sausages and higher than those of low fat sausages. Furthermore, results of the sensory evaluation indicated that fat-substituted sausages showed superior total acceptability compared with low-fat one after a 2 week refrigerated storage, but was slightly less than that of high-fat one at the same condition. Therefore, MBG/rice starch gels can be effectively used as a fat substitute in Chinese Cantonese-style sausage allowing the manufacture of healthier sausages.

1. Introduction

Sausages are worldwide consumed food products generally manufactured from ground meat mixed with spices due to their nutritious, delicious and portable features. Consumers preferred not only low fat sausages, but also meat products in general containing healthier fats. It does depend not only on the quantity, but also on the quality of fats. However, sausages high in saturated fat (approximately 20–30%) cause an increasing health concern associated with cardiovascular disease, dyslipidemia, and cancer (Shalene, Kerri, Thomas, & Mary, 2011), although the production of sausage needs a certain amount of saturated fat to remain in shape at room temperature (Eva, de la H., & Juan, 1997) and flavor development of products benefits from the presence of saturated fat (Campagnol, dos Santos, Wagner, Terra, & Pollonio, 2011). The increasing demand for low-fat diets has led the food industry to develop or modify traditional food products to contain less fat. A number of commercial products have been successfully developed to reduce fat in foods such as Simplesse (egg protein, milk protein), Simplesse 100 (whey protein), LITA (zein),Trailblazer (whiter egg protein, serum protein with xanthan gum), N-Flate (nonfat milk, gums, emulsifier, and modified starch), olestra (sucrose polyester), Sorbestrin (hexa-fatty acid ester of sorbitol), EPG (esterified propoxylated glycerol esters), and TACTA (trialkoxytri-carballylate) (Sedef & Sebnem, 2012).

Animal fat substitutes made from vegetal oils have gained much attention in the processed meat industry. Such fat substitutes can be classified into two groups: liquids and plastics (Ospina-E, Sierra-C, Ochoa, Perez-Alvarez, & Fernandez-Lopez, 2012).

Liquid fats such as sunflower, maize, peanut, tea seed, coconut, palm, soy, and olive oils as well as fish oil have been evaluated to have a positive impact on reducing cholesterol and improving PUFA/SFA and $n-6/n-3$ ratios (Ospina-E et al., 2012).

Plastic fats are obtained by partial hydrogenation or interesterification which can simulate the consistency and melting point of animal fat. These plastic fats have a variety of sources including palm, cotton, olive, hazelnut and their mixtures (Ospina-E et al., 2012).

The three-dimensional structure of proteins can be altered by pH, heat or enzymatic denaturation, which enables them to behave more like fat. After denaturation, the texture, gel-forming and water holding capacities of proteins such as whey, soy, wheat, pea and peanut can be altered. Micro-particulated proteins can be resulted from micro-particulation and simultaneous heating and high shearing. These proteins which can function as fat replacer can coat the mouth allowing flavor to reach receptors more slowly (Brewer, 2012).

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Carbohydrates are composed of polymers of repeating sugar (glucose, galactose, etc.) and sugar derivatives which can bind water and increase viscosity or gel. Processed starches and fibers of various origins including cornstarch, rice starch, modified potato starch, and tapioca can be effectively used in meat formulations. Most carbohydrate-based fat replacers mimic fat by stabilizing the added water in a gel-like matrix that can release the water in a way similar to fat release (Brewer, 2012).

Therefore, several studies have been conducted on the corresponding saturated fat substitutes by using sorts of oligosaccharides and polysaccharides. For example, Caceres, Garcia, Toro, and Selgas (2004) added 2–12% oligo-fructose into the Bolora sausage, for the reduction of the fat content to 40%. In addition, other polysaccharides for instance, β-glucan(Morin, Temelli, & McMullen, 2004), maltodextrin (Crehan, Hughes, Troy, & Buckley, 2000) carboxyl methyl cellulose (Mittal & Barbut, 1993), amorphous cellulose gel (Campagnol et al., 2011), konjac gel (Jiménez-Colmenero et al., 2012), dietary fiber prepared from wheat, oat, peach, apple and orange (Garcia, Caceres, & Selgas, 2007) and the mixture of orange fiber and soybean concentrate protein (Cengiz & Gokoglu, 2005) were extensively investigated by international researchers as fat-replacers in sausage with different fat contents. Some critical physicochemical properties of products in the presence of fat substitutes prepared by polysaccharides, including pH, color, protein content, TBARS (thiobarbituric acid-reactive substances) values, emulsifying stability, water holding capacity etc., were measured and compared with those of unmodified samples. Although some properties have been changed somehow after the employment of fat substitute, polysaccharides or fibers act as the fat substitute of different sausages.

Traditional Chinese Cantonese-style sausage is a part of the daily diet in rural areas of southern China along with some metropolitan areas due to their distinctive sensory properties (Tan, Liao, Jhan, & Liu, 2007). This kind of sausage belonging to semi-dry fermented sausages manufactured by several processing technologies such as smoking, addition of sugar and spices is generally categorized into two groups: sausages with high fat content (28%) and with low fat content (18%). (Du & Ahn, 2001; Huang, Tsai, & Chen, 2011).

MBG is an ionic polysaccharide gum extracted from an herb named *Mesona Blumes*, a plant native to the southern China. Compared with other commercial gums, it presents low-viscosity with a pronounced shear-thinning characteristic (Feng, Gu, & Jin, 2007). In addition, due to the ability of MBG to interact with non-waxy starch, Feng, Gu, Jin, and Zhuang (2010a) studied the effect of *Mesona Blumes* gum (MBG) on the formation of cereal starch (wheat and rice) gels. The results indicated that MBG-wheat starch and MBG-rice starch gel exhibited typical viscoelastic properties. Subsequently, Feng, Gu, Jin, and Zhuang (2010b) extensively studied the rheological properties of rice starch–*MBG* mixtures. It was concluded that rice starch-MBG mixtures with *MBG* concentration of 0.1–0.5% displayed the rheological behavior of solid-like gels and the dynamic rheological data showed that the mixtures displayed strong gel-like behavior. Therefore, it was speculated that the mixture of MBG and wheat or rice starches was potentially utilized as a fat substitute and binder for meats, such as traditional Chinese sausages (Feng, Gu, Jin, & Zhuang, 2008). Hence, the aim of this research is to extensively evaluate the effect of MBG/rice starch gels on substituting the fat part of sausage with a low fat content. The knowledge achieved from this study could benefit the development of unique meat products with low fat content.

2. Materials and methods

2.1. Materials

MBG was prepared following the protocol developed by our previous study (Feng et al., 2007). Rice starch was generously donated by Jiangsu Baobao Group Ltd. Co (Jiangsu, China). Fresh pork hind leg meat and carcass backfat were purchased from the local market (Wuxi, China) and were stored in a refrigerator. Casing cellulose (No. 25) was manufactured by Devro-Teepak of Jilemnice of Czech (Prague, Czech). Cryovac barrier bags (type CN530 180 mm × 270 mm; water vapor transmission rate: 38 °C, 90% RH, 20 g/24 h/m^2/1 atm; oxygen transmission rate: 23 °C, 0% RH, 20 cm^3/24 h/m^2/1 atm) containing LLDPE and PVDC oxygen barrier layer of three co-extruded layers were kindly donated by Wuxi Wuqiao meat plant (Wuxi, China). Glucose and salt were purchased from the local market (Wuxi, China).

2.2. Experimental methods

2.2.1. Preparation of MBG/rice starch mixed gels

MBG/rice starch mixed gels were prepared carefully following the developed protocol by our group (Feng et al., 2008). 0, 0.1, 0.35, 0.5% (w/w) MBG and 6% (w/w) rice starch had been stirred homogeneously at 250 rpm for 30 min and then heated at 95 °C, respectively. After gelatinization, the pastes were poured into a sterilized container for cooling at 4 °C.

As mentioned in Introduction section, two groups of Chinese Cantonese-style sausage are generally classified in terms of fat content: sausages with non-fat substituted groups such as high fat content (28%, S28) and low fat content (18%, S18), sausages with fat-substituted groups (18% fat content) such as M0R6, M0.1R6,M0.35R6 and M0.5R6.

2.2.2. Preparation of sausage

The toilet of raw meat was removed from the lean pork ham. Skeletal muscle of lean meat and carcass backfat were separately crashed by the meat grinder (TJ12H, Shanghai Kailong Hotel Equipment & Supplies Co., Ltd., Shanghai, China) with a sieve plate containing well-distributed holes of 9.5 mm in diameter. Afterwards, fat contents of samples were analyzed by using a published method (Choi, Kim, Eun, & Chin, 2003).

According to the compositions of sausage (Table 1), the grinded skeletal muscle of lean meat was quantitatively added into the cut mixer (RPJ-2, Shanghai Kailong Hotel Equipment & Supplies Co. Ltd., Shanghai, China). Then, salt (1.80 wt.%), sodium tripolyphosphate (0.20 wt.%), sodium nitride (0.012 wt.%) and isoascorbic acid (0.05 wt.%) were introduced into the cut mixer in order at 1500 rpm for 40s. Subsequently, glucose powder was added into the mixture at 1500 rpm for 120 s, following the addition of the crashed carcass backfat and MBG/rice starch gel. After being homogenized at 3000 rpm for 40s, the mixture was stored at 4 °C for 30 min. The meat mixture was carefully filled into the cellulose casing with No. 25 (diameter of the product 25 mm) (Devro AE21, Devro-Teepak, Jilemnice, Czechoslovakia). Later the filled Chinese Cantonese-style sausage was divided into 10 cm sections and

Table 1
Low-fat Chinese sausage formula with MBG/rice starch mixed gels.

Component (% total weight [a])	S28[b]	S18[b]	MBG/rice starch18
Skeletal muscle of lean meat	70 (350 g)	85 (425)	85 (425)
Carcass backfat	30 (150 g)	15 (75)	15 (75)
Salt	1.80 (9)	1.80 (9)	1.80 (9)
Glucose	5 (25)	5 (25)	5 (25)
Sodium tripolyphosphate	0.2 (1)	0.2 (1)	0.2 (1)
$NaNO_2$	0.012 (0.06)	0.012 (0.06)	0.012 (0.06)
Isoascorbate	0.05 (0.25)	0.05 (0.25)	0.05 (0.25)
Chinese spice (white pepper powder, five spice powder, Cinnamon Powder)	0.60 (each piece 0.2%) (3)	0.60 (3)	0.60 (3)
Monosodium glutamate	1.0 (5)	1.0 (5)	1.0 (5)
MBG/rice starch gel	–	–	15 (75)
Ice/water	25 (125)	25 (125)	10 (50)
Sum	668.31 g	668.31 g	668.31 g
Each segment in sum 10 segments	66.831 g	66.831 g	66.831 g

[a] Based on the weight of raw meat.
[b] S28 = 28% fat, S18 = 18% fat, and MBG/rice starch18 = 18% fat.