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Effects of organic tomato pulp powder and nitrite level on the physicochemical, textural and sensory properties of pork luncheon roll

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ABSTRACT

Nine treatments of pork luncheon roll produced with three sodium nitrite levels (0, 0.05 and 0.1%) and three tomato pulp powder (TPP) levels (0, 1.5 and 3%) were assessed at three storage times (2, 7 and 14 d). The effects of enrichment with TPP on composition (protein, fat, moisture and ash), pH, colour (CIE L*, a*, b*), nitrosomyoglobin (NOMb) content, lipid oxidation (TBARS), residual nitrite content, total viable count (TVC) texture profile analysis (TPA) and sensory analysis of cooked pork luncheon roll were investigated. Decreasing the level of nitrite increased ($p < 0.001$) the pH, the NOMb value ($p < 0.001$), lipid oxidation ($p < 0.001$) and the residual nitrite content ($p < 0.001$) and affected the colour of the cooked product. The reduction in nitrites had no effect on the composition and texture of the pork luncheon rolls. Adding TPP reduced ($p < 0.001$) the pH and increased ($p < 0.001$) the colour parameters a* and b* of both the raw luncheon roll formulation and the cooked luncheon roll product. TPP, particularly at 3% had a detrimental effect on the texture of pork luncheon rolls by decreasing hardness ($p < 0.001$), gumminess ($p < 0.001$) and chewiness ($p < 0.001$) and increasing cohesiveness ($p < 0.001$). The TBA value increased ($p < 0.01$) with the three main factors (nitrite, TPP, day) but was in all cases well below the 2 mg MDA/kg threshold. TVCs for all treatments and storage days were below the TVC limit for this type of cooked product. The pork luncheon roll formulated with 50 mg nitrite and 1.5% TPP had similar or enhanced sensory attributes compared to the luncheon roll containing no TPP and a nitrite level of 100 mg/kg of product.

1. Introduction

Consumers are demanding meat products that are safe, nutritious, convenient, healthy, and innovative and have good organoleptic qualities. This stimulates interest in the manufacturing of cooked pork products using new techniques, formulations, reduced additives (nitrite, salt, phosphates) and use of natural ingredients all of which lead to potential beneficial health effects (Desmond, 2006; Hayes, Desmond, Troy, Buckley, & Mehra, 2006; Viuda-Martos, Fernández-Lopez, Sayas-Barbera, Navarro, & Pérez-Álvarez, 2009).

Nitrite is widely used as a curing agent in meat products and is responsible for the development of cured colour (Wirth, 1986), serves as an antioxidant to protect product flavour (Morrissey & Tichivangana, 1985) and plays an important role in controlling the growth of *Clostridium botulinum* (Cassens, 1995; Shahidi & Pegg, 1992).

However, dietary nitrites from processed meat may react with certain amines in food to produce N-nitroso compounds, such as nitrosamines, which are known carcinogens (Cassens, 1995; Cassens, 1997). Even if the normally controlled use of nitrite in processed meats represents no toxicity risk, the issue of ingested nitrite arose in the 1970s. Due to this potential health risk associated with nitrites, there is a considerable interest worldwide in the development of food colourants and nitrite alternatives from natural sources which are considered healthier. The importance of natural food compounds is increasing due to the more extensive use of natural food colourants in food following the EU directive in favour of natural rather than synthetic compounds (Vági et al., 2007). Organic TPP which is a known waste by-product from the tomato processing industry is rich in carotenoids (particularly lycopene, β-carotene, phytoene and lutein), flavonoids, vitamins E and C, and fibre. Recent studies have indicated the potential health benefits of a diet rich in tomatoes and tomato products (Kavanaugh, Trumbo, & Ellwood, 2007; Rao, 2006; Rao & Rao, 2007).

Several studies have reported the use of tomato products in a variety of meat products such as frankfurters and beef patties (Candogan, 2002; Sánchez-Escalante, Torrescano, Djenane, Beltran, & Roncales, 2003), low-fat cooked sausages (Yılmaz et al., 2002), minced meat (Østerlie & Lerfall, 2005) and a dry fermented sausage enriched in lycopene. Testing a natural ingredient such as TPP for use in meat products to replace conventional nitrites seems appropriate owing to the increasing sensitivity of consumers to nitrites. Deda, Bloukas, and Fista (2007) also reported on the possibility to reduce the added nitrite in frankfurters using tomato paste. Tomato powder can be used to reduce the residual nitrite level in frankfurters and can also act as a natural colourant (Eyiler

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& Oztan, 2009). Although several studies have been carried out on meat products formulated with added tomato products there is a lack of research in pork luncheon roll products containing TPP and nitrite reduction.

The objective of this study was to evaluate the effects of TPP and nitrite level on the physiochemical, textural and sensory attributes of pork luncheon rolls over a refrigerated storage period of 14 days.

2. Material and methods

2.1. Production of luncheon rolls

Nine different treatments of pork luncheon rolls were prepared and analysed with three nitrite levels (0, 0.05 and 0.1%), three TPP levels (0, 1.5 and 3%) and three storage times (2, 7 and 14 d) (Table 1). Each treatment was replicated three times; hence 27 luncheon rolls were produced.

Fresh lean pork shoulder and pork back fat (Granby Meats, Dublin, Ireland) were minced separately (Model No 22P-1, McDonnells Ltd., 19/20 Blackhall St., Dublin 7) through a 5 mm plate, vacuum packed and stored at 4 °C over night. All formulations contained crushed ice/water, soya protein (500E), seasoning (PD295), superfine rusk and potato starch (Blakes Ingredients, Dublin 12, Ireland). Treatments 4 to 9 contained sodium nitrite while treatments 2, 3, 5, 6, 8 and 9 contained organic TPP (Naturex, Avignon, France).

Half the pork meat, half the pork fat, the soya protein, sodium nitrite (treatments 4 to 9 inclusive) and salt and were placed in a bowl chopper (CR.22 model, Mainca, Berkshire, England) for 90 s at a bowl speed of 20 rpm and a knife speed of 1200 rpm during which time half the iced water was added to control any temperature rise in the batter. The remaining pork meat and fat were then added along with the superfine rusk, potato starch, TPP (1:4, powder: water for treatments 2, 3, 5, 6, 8 and 9) and the remainder of the water. The formulation was then chopped for 30 s at a bowl speed of 10 rpm and a knife speed of 1200 rpm followed by chopping for a further 90 s at a knife speed of 20 rpm and a bowl speed of 1200 rpm. Stuffing was carried out in 145 mm diameter cellulose casings (Broderick Brothers, Dublin, Ireland) to approximately 1.8 kg using a hydraulic piston-type sausage stuffer (Mainca, Berkshire, England) and tied using a clipper (Tipper Tie, Glinde, Germany). On the day of manufacturing colour and pH were analysed on the raw luncheon roll formulations. The luncheon rolls were placed in refrigerated storage at 4 °C over night then cooked to an internal temperature of 75 °C (Jugema 2500, Jugema P.P.U.H., Sroda Wlkp, Poland) followed by showering in cool water for 10 min. Once cooled the luncheon rolls were placed in refrigerated storage at 4 °C over night. The cooked luncheon rolls were then sliced to 3 mm thickness and vacuum-packed. The entire experiment was replicated three times. All cooked sliced luncheon rolls were stored for 21 days at 4 °C and quality parameters were analysed at days 2, 7 and 14 of storage.

Table 1
Formulation of pork of luncheon rolls showing nine different treatments.

Ingredient (%)[a]	Treatment (T)								
	T1	T2	T3	T4	T5	T6	T7	T8	T9
Lean pork	36.68	35.18	33.68	36.63	35.13	33.63	36.58	35.08	33.58
Nitrite	0.00	0.00	0.00	0.05	0.05	0.05	0.10	0.10	0.10
Tomato pulp powder (TPP)	0.00	1.50	3.00	0.00	1.50	3.00	0.00	1.50	3.00

[a] Other ingredients were consistent across treatments: pork fat, 21.16 g; 500E soya protein 2.0 g; seasoning (PD295), 2.5 g: iced water, 25.5 g; superfine rusk, 5.0 g; potato starch, 5.0 g; water, 1.79 g; salt, 0.38 g.

2.2. Sample preparation for compositional analysis

On days 2, 7 and 14, samples were homogenised using a Robot Coupe Blender (R101, Robot Coupe SA, Vincennes Cedex, France) prior to analysis. Each sample was analysed in duplicate. Results are expressed on a fresh (before drying) weight basis.

2.2.1. Protein determination

Protein analysis was performed by LECO Organic Nitrogen Determinator (Model No. FP-428, LECO Corporation, St. Joseph, MI 49086-23, USA). A system blank check was performed and repeated if necessary until the percentage nitrogen was $\leq$0.003%.

2.2.2. Fat and moisture analysis

The fat and moisture content of the luncheon roll samples were determined using the Smart Trac5 rapid moisture/fat analyser (CEM Corporation, NC, USA) following manufacturer instructions.

2.2.3. Ash determination

Ash content was determined by a standard method (ISO 936).

2.2.4. Energy values

Total calories (kcal) were calculated in relation to 100 g samples using the Atwater values for fat (9 kcal/g), protein (4.02 kcal/g) and carbohydrate (3.87 kcal/g).

2.3. pH measurement

A 2 g sample was homogenised (Ultra-Turrax T25, Janke&Kunkel, Staufen, Germany) with 20 ml of distilled water. The pH was measured using a pH-meter model 420A (Orion Research Inc., Boston, MA, USA). The pH of the raw formulations on day 0 and the pH of the cooked luncheon roll were analysed on all storage days.

2.4. Colour measurements

Surface colour measurements were performed using a HunterLab Colourimeter (Ultra scan XE, Hunter Associates Laboratory Inc., Reston, VA, USA). The UltraScan XE was standardised using a black light trap and a white tile, as per the manufacturer's specifications. The illuminant D65, 10° with 8° viewing angle and a 10 mm port size was used. Colour was measured on the raw formulation using cling film to cover the samples (day 0) and on the cooked sliced (3 mm) and vacuum packed luncheon rolls (days 2, 7, 14) in triplicate. The sample holder with a black background was used to hold the samples in place and ensure consistent measurements for the thin slices. Lightness (L^*), redness (a^*) and yellowness (b^*) values were recorded (CIE LAB colour system) in triplicate. Saturation $[(a^{*2} + b^{*2})^{1/2}]$ and hue angle $[\tan^{-1}(b^*/a^*)]$ were also calculated.

2.5. Determination of nitrosomyoglobin (NOMb) content

NOMb content and total pigment in the luncheon rolls on days 2, 7 and 14 were determined using the method of Hornsey (1956). Nitroso-pigments analysis and total pigments analysis were performed to calculate the content of nitrosomyoglobin. Each sample was analysed in duplicate.

2.5.1. Nitroso-pigment analysis

Samples (5 g) were weighed in plastic tubes surrounded by silver foil to prevent pigment deterioration. Acetone (20 ml) and 1.5 ml of distilled water were added and the mixture was homogenised (Ultra-Turrax T25, Janke & Kunkel, Staufen, Germany) for 30 s at 12,000 rpm and filtered through Whatman 42 filter paper. The absorbance (540 nm) was measured immediately after filtration. The amount