IMPACT OF MINIMAL PROCESSING THROUGH THE COMBINED USE OF NATURAL INGREDIENTS AND HIGH PRESSURE PROCESSING ON COOKED HAM QUALITY CONTAINING LOW AND HIGH LEVELS OF NITRITE

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Background

Changes in consumer attitudes in recent years have led to demands for food of higher quality which is minimally processed, additive-free and shelf-stable. This has prompted the exploration of physical treatments other than traditional heat treatments as potential alternatives. High pressure technology provides opportunities to produce foods with high sensory and nutritional quality with extended shelf-life. The advantages of high pressure processing include; uniform product penetration, better retention of flavour, colour and nutritional value due to reduction or elimination of heat treatment to the product, reduction and/or elimination of microorganisms, degradative enzyme systems and lipid oxidation, energy efficiency, no requirement for chemical additives, modification of food components to create new functional properties and environmentally clean. Limited attention has been addressed to the use of high pressure on ham quality (Mandava et al., 1995) and there appears to be no documented reports on the effects of using high pressure combined with natural food extracts on cooked ham quality where nitrite levels have been manipulated.

Objective

The objectives of this study were to assess the combined impact of high pressure and the addition of natural food ingredients on cook-loss, colour, visual assessment, pH, lipid oxidation and microbiology of cooked cured hams containing low and high levels of nitrite.

Methods

Pork M. semimembranosus was obtained from a local pigmeat factory. Muscles were cured with input nitrite levels of 40 (low) and 150 (high) mg sodium nitrite/kg meat with brine injected at 25% (w/w) using a multi-hole hand injector pump. An input salt level of 2% (w/v) was used. Pre-screened food ingredients (blood plasma (BP), mustard (M), carmine (C) and tea catechins (TC)) were individually injected into low nitrite muscles via the brine at a concentration of 0.2%. Samples were tumbled and massaged at 10 rpm for 10 min in every 30 min at a temperature for a total of two hours. The meat was vacuum packed (269 g per bag) and held at 4°C for 48 hrs. Samples were placed in the pressure vessel which was filled with a mixture of water and a rust inhibitor and subjected to 150 MPa pressure for 5 min. Pressurisation was carried out at ambient temperature, approximately 20°C. After pressurising, samples were immediately removed and held at 4°C for 12 hours. Samples were cooked at 80°C to an internal meat temperature of 72°C. Cooked hams were cooled at 4°C for 6 hrs. Hams were sliced and overwrapped in oxygen permeable clingfilm or vacuum packaged and stored under refrigerated (4°C) display conditions for 10 or 17 days, respectively. All hams containing high and low nitrite levels described above were treated in the presence and absence of high pressure, while all hams containing food ingredients were subjected to high pressure. Ham slices from all treatments were assessed for cook-loss, colour (Hunter 'a' values), visual assessment, pH, lipid oxidation (2-thiobarbituric acid reactive substances test as outlined by Ke et al., 1977) and microbiological analysis. These quality assessments were evaluated during the retail display periods provided above.

Results and Discussion

High pressure did not enhance the colour or oxidative stability of either low or high nitrite ham slices. In general, colour and oxidative stability of low and high nitrite hams were greater than those hams which contained the added food ingredients, especially in vacuum packaged samples. High nitrite hams had better colour and oxidative stability compared to low nitrite hams. Ham slices displayed greater colour and oxidative stability in vacuum packs compared to aerobic packs. Sensory evaluation of ham slices showed that low and high nitrite ham slices were visually superior to those ham slices derived from hams which contained added food ingredients. Cook-loss and pH were unaffected by high pressure or the use of food ingredients. High pressure at 150 MPa and the use of food ingredients reduced total colony forming units/g meat for all treatments over the first 4 or 10 days of retail display compared to non-pressurised low nitrite hams for both overwrapped (Table 1) and vacuum (Table 2) packs, respectively. The combination of high pressure and high nitrite prevented ($p<0.01$) the growth of microorganisms in cooked hams compared to all other treatments over the entire storage period for both aerobic and vacuum packaging conditions. Total colony forming units/g meat were lower in vacuum packaged ham slices compared to overwrapped slices. The combined use of high pressure and injected food ingredients in this study failed to improve cooked ham quality, with the exception of total microbiological counts. This may be due to the level of pressure applied or the impact of the cooking procedure used. It is possible that higher pressures may be required in order to improve a wider range of cooked ham quality attributes and therefore, more research is required.

Conclusions

The combined effects of high pressure and injected food ingredients did not enhance colour, oxidative stability, visual impact, cook-loss or pH attributes of cooked ham slices held in both aerobic and vacuum packaging conditions. High pressure and injected ingredients did combine well to reduce total microbiological counts when compared to low nitrite ham slices. However, high pressure combined best of all with high nitrite levels in hams and prevented the growth of microorganisms in both aerobic and vacuum packaged meat slices over all retail display periods. It is possible that a pressure level of 150 MPa was not sufficient to enhance overall quality attributes of cooked cured ham slices and increased levels of pressure may be required to observe such benefits.

References

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Table 1. Effect of high pressure (150 MPa) and injected natural food ingredients on the total colony forming units/g meat as was detected in overwrapped ham slices.

Treatment / Day	Day 0 - cfu/g meat	Day 4 - cfu/g meat	Day 7 - cfu/g meat	Day 10 - cfu/g meat
Low Nitrite	*TFTC	2.1×10^1	3.0×10^1	2.6×10^5
High Nitrite	TFTC	TFTC	TFTC	3.3×10^2
Low Nitrite + Pressure	TFTC	TFTC	3.3×10^1	1.9×10^4
High Nitrite + Pressure	TFTC	TFTC	TFTC	TFTC
Low Nitrite + BP + Pressure	TFTC	TFTC	3.3×10^2	1.7×10^5
Low Nitrite + M + Pressure	TFTC	TFTC	1.4×10^1	3.3×10^5
Low Nitrite + C + Pressure	TFTC	TFTC	1.6×10^1	3.7×10^4
Low Nitrite + TC + Pressure	TFTC	TFTC	TFTC	3.3×10^4

* TFTC = Too Few To Count

Table 2. Effect of high pressure (150 MPa) and injected natural food ingredients on the total colony forming units/g meat as was detected in vacuum packaged ham slices.

Treatment / Day	Day 0 - cfu/g meat	Day 5 - cfu/g meat	Day 10 - cfu/g meat	Day 17 - cfu/g meat
Low Nitrite	*TFTC	TFTC	5.0×10^2	5.0×10^6
High Nitrite	TFTC	TFTC	TFTC	3.3×10^2
Low Nitrite + Pressure	TFTC	TFTC	1.9×10^1	2.0×10^4
High Nitrite + Pressure	TFTC	TFTC	TFTC	TFTC
Low Nitrite + BP + Pressure	TFTC	TFTC	TFTC	1.7×10^4
Low Nitrite + M + Pressure	TFTC	TFTC	TFTC	1.3×10^4
Low Nitrite + C + Pressure	TFTC	TFTC	TFTC	2.3×10^4
Low Nitrite + TC + Pressure	TFTC	TFTC	TFTC	1.3×10^3

* TFTC = Too Few To Count