CANADIAN MEAT SCIENCE ASSOCIATION

Quality and bacteriology of moisture-enhanced and conventional pork products available at retail markets in Western Canada

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Introduction

Injecting pork with brine solutions containing polyphosphates and salt is widely used in meat industry in order to provide consumers with convenient products that have improved juiciness and tenderness. These products may also tolerate some cooking abuse.
There is, however, a risk of introducing bacteria into the deep tissue, when the meat surface is violated, which has been shown for blade tenderised beef and needle-injected pork. Re-circulation of injection brine is known to increase bacterial contamination of injection solutions and, thus, carries a further risk of introducing spoilage bacteria and pathogens into injected meat products. Limited information is available about the bacterial contamination of needle-injected, moisture-enhanced pork products.
The present study, therefore, was conducted to determine the quality and bacteriology of needle-injected, moisture-enhanced pork chops available at retail markets and to compare enhanced with non-injected, conventional pork.

Material and Methods

A total of 2 x 30 packages of moisture-enhanced (M; sodium-tripolyphosphate, salt, lemon juice) and conventional (C) bone-less pork chops, packaged on sampling day or the day before, were purchased from four stores of one Canadian retailer on five sampling dates. Purchased meat was transported in a cooler to the Lacombe Research Centre and was kept refrigerated (2°C) for two days.
Meat was analysed for pH, expressible juice, cook loss, meat colour, shear force, and moisture, fat, and protein content according to standard methods. Chops were subjectively evaluated for surface colour, surface discoloration, and retail appearance on five-point (1 = extremely pale, 0 % discoloration; 5 = extremely dark, completely discoloured) and seven-point (1 = extremely undesirably; 7 = extremely desirable) descriptive scales, respectively. Semi-trained panellists rated chops, cooked to an internal temperature of 71°C for tenderness, juiciness, and pork and other flavour intensity using a nine-point descriptive scale (9 = extremely tender, juicy, etc.; 1 = extremely tough, dry, etc.). Overall palatability was rated using seven-point hedonic scale (7 = extremely desirable; 1 = extremely undesirable). Total aerobic bacteria, total psychrotrophs, lactic acid bacteria, *Pseudomonas* spp., *Brochothrix thermosphacta*, and *Enterobacteriaceae* were enumerated in raw meat using selective media. Potential pathogenic bacteria and *Listeria* spp. were determined by genotypic methods and most probable numbers were calculated.

Results

As expected, injection of pork with brine consisting of sodium-tripolyphosphate, salt and lemon juice increased meat pH and water content, while protein content was reduced (Table 1). The higher moisture content in enhanced chops can be explained by a higher water holding capacity due to shift in meat pH from iso-electric point and/or increase in ionic strength by polyphosphates and salt, respectively. Accordingly, moisture-enhanced meat had less expressible juice than conventional pork. The positive effects on water holding capacity were well reflected in taste panel scores for juiciness, which were higher for enhanced than conventional chops.

Needle-injected pork was also found to be more tender and had lower shear force values than conventional meat, which is in agreement with previous brine injection studies. Improved tenderness was most probably the result of disruption of myofibrillar meat matrix by injection needles and high ionic strength in injection brines. According to juiciness and tenderness, enhanced pork was higher in taste panel scores for overall palatability. The use of lemon juice in injection brines, however, decreased pork flavour intensity in grilled enhanced chops. This may have contributed to a lower overall palatability than expected based on tenderness and

juiciness ratings, as some panellists found the lemon flavour to be inappropriate.

Moisture-enhanced pork chops were darker (L*-value), less red (hue) and had a lower saturation index (chroma) than conventional chops (Figure 2). Changes in meat colour due to injection of brine solutions have also been previously reported, and darker meat can be explained by a stronger binding of water molecules in the meat matrix and less light scattering on free water molecules at increased pH values.

Enhanced chops also had a higher surface discolouration and, thus, were rated lower for retail appearance, most probably due to the appearance of grey or dark surface areas along the path of the injection needles, which might have been caused by disruption of myofibrillar muscle structure due to high salt concentration around the injection sites, and changes in meat pH. Greater surface discolouration might have negative effects on purchase intent as colour is the first quality criteria for consumers when selecting meat.

There were no differences between enhanced and conventional chops in total aerobic (M: 5.63 CFU×g^{-1}, C: 5.97 CFU×g^{-1}) and psychrotrophic bacteria (M: 5.64 CFU×g^{-1}, C: 5.86 CFU×g^{-1}). Lactic acid bacteria dominated bacterial flora, which is typical for previously vacuum packaged meat. Significantly higher numbers (>1 log CFU×g^{-1}) of the spoilage organisms *Enterobacteriaceae*, *Pseudomonas* spp., and *Brochothrix thermosphacta* were isolated from enhanced chops than from conventional chops (Figure 3).

Moisture-enhanced pork chops had a higher incidence of *Listeria* spp. and of the potential pathogenic bacteria *Listeria monocytogenes* and enterohaemorrhagic *E. coli* (Figure 4 and Table 3). Most probable numbers for *Salmonella* spp. were higher in injected pork than in conventional chops but incidence of *Salmonella* spp. was not different.
Higher bacterial load and increased incidence of potential pathogenic bacteria in enhanced meat could be the result of an introduction of surface bacteria into the interior tissue due to needle injection process. It is also likely that the re-circulation led to increased numbers of spoilage organisms in injection brine, as was found in a previous study. It is also worth mentioning that there were differences in the incidence of potential pathogens between stores and sampling dates. This clearly indicates that appropriate in-store handling of meat products is crucial for food-safety, especially when further processed fresh meat products are concerned.

Conclusions

The present investigation showed that eating quality of pork can be markedly improved by the injection of brine containing polyphosphate, salt, and lemon juice. Adverse effects on meat colour, however, can negatively affect the purchase intent of consumers. Further research is needed to minimize colour variation in enhanced meat so that eating quality can be improved without impairing meat colour.

Needle-injection of brine may cause an increase in the number of spoilage organisms and the incidence of food-borne pathogens in pork. The immediate industry need, therefore, would seem to be implementation of HACCP procedures for moisture-enhanced products, including regulations for in-store handling for retailers.

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Table 1: Physico-chemical and meat quality traits

				P-Value	
	C	M	SEM	P_{Meat}	$P_{Store*Day}$
pH	5.86	6.14	0.04	.000	.387
Expressible juice [mg·g^{-1}]	81.2	58.8	5.78	.010	.091
Cook loss [mg·g^{-1}]	270	251	6.70	.059	.001
Max. shear force [kg]	4.88	4.32	0.13	.005	.176
Moisture [mg·g^{-1}]	725	750	1.33	.000	.002
Crude protein [mg·g^{-1}]	253	226	1.35	.000	.095
Crude fat [mg·g^{-1}]	20.1	16.4	1.37	.062	.003

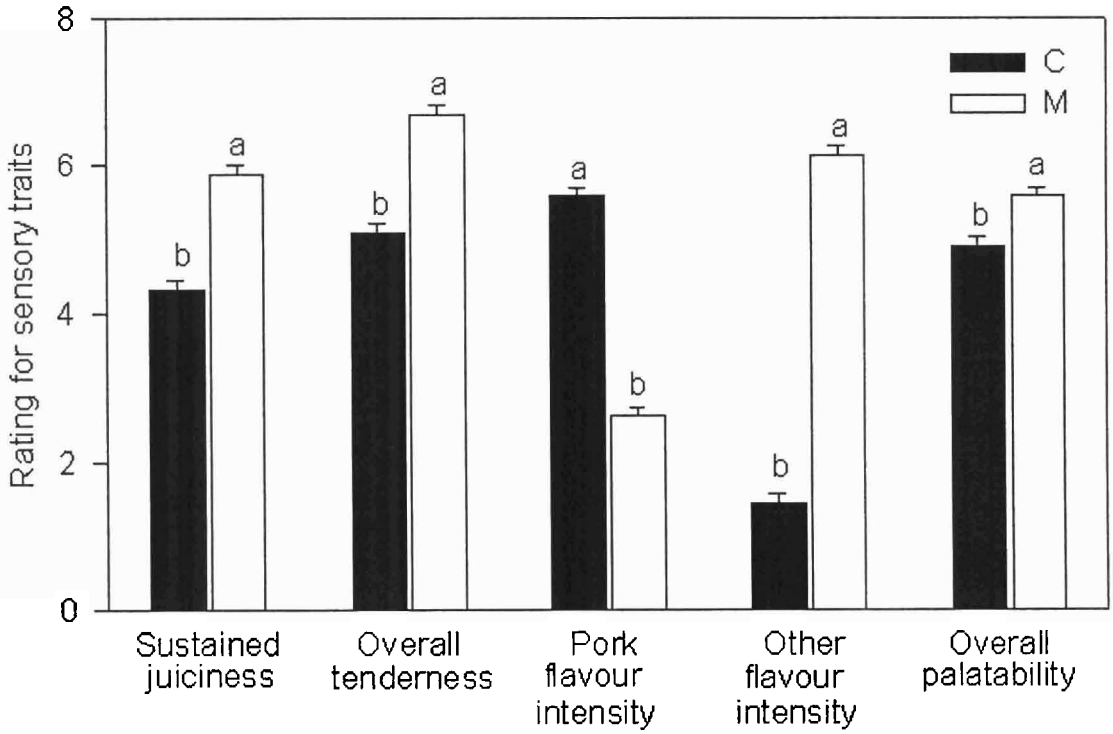
C = Conventional pork, M = Moisture-enhanced pork, SEM = maximum standard error, P_{Meat}=P-Value for meat source, $P_{Store*Day}$=P-Value for interaction store and sampling day

Table 2: Incidence of pathogenic bacteria and *Listeria* spp. in raw meat (positive samples out of total samples)

	Store 1		Store 2		Store 3		Store 4		Meat	
	C	M	C	M	C	M	C	M	C	M
Listeria monocytogenes	1/7	5/7	3/8	4/8	3/8	3/8	2/7	3/7	9/30	15/30
Salmonella spp.	1/7	1/7	0/8	0/8	1/8	1/8	0/7	0/7	2/30	2/30
Enterohaemorr. *E. coli*	2/7	0/7	1/8	3/8	1/8	4/8	1/7	4/7	5/30	11/30
Listeria spp.	2/7	0/7	4/8	8/8	0/8	2/8	1/7	3/7	7/30	13/30

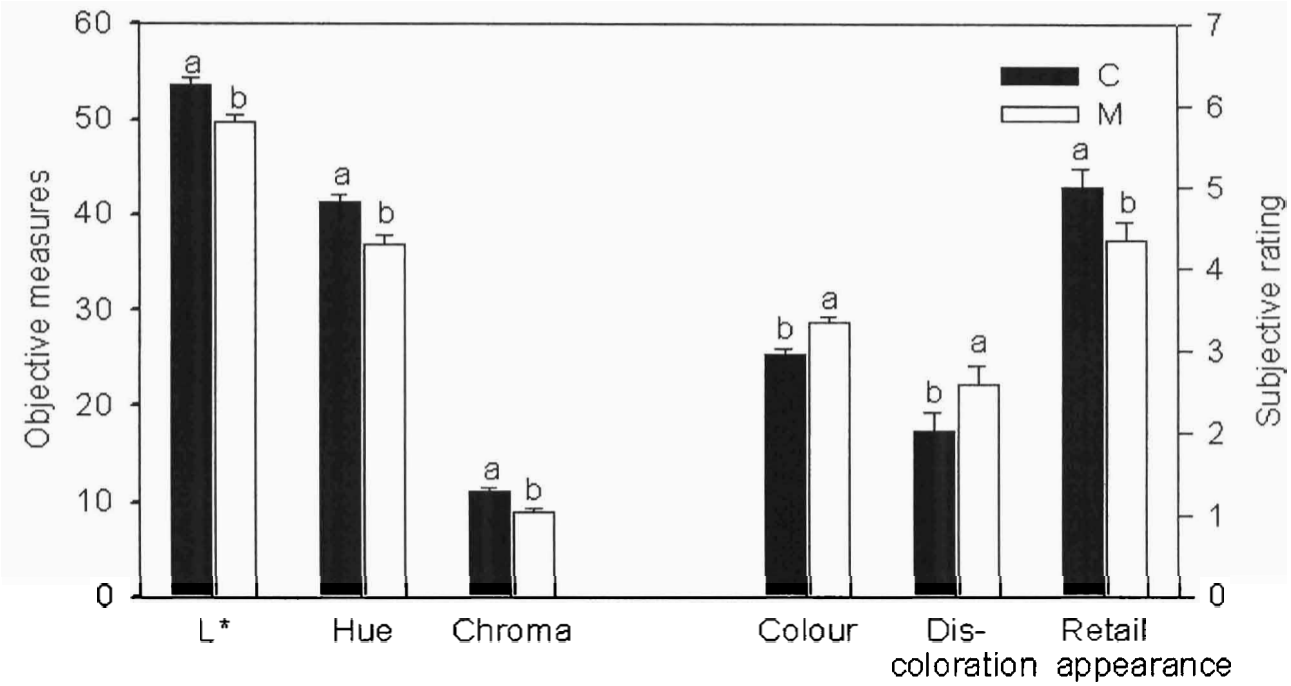
C = Conventional pork, M = Moisture-enhanced pork

Figure 1: Sensory quality traits



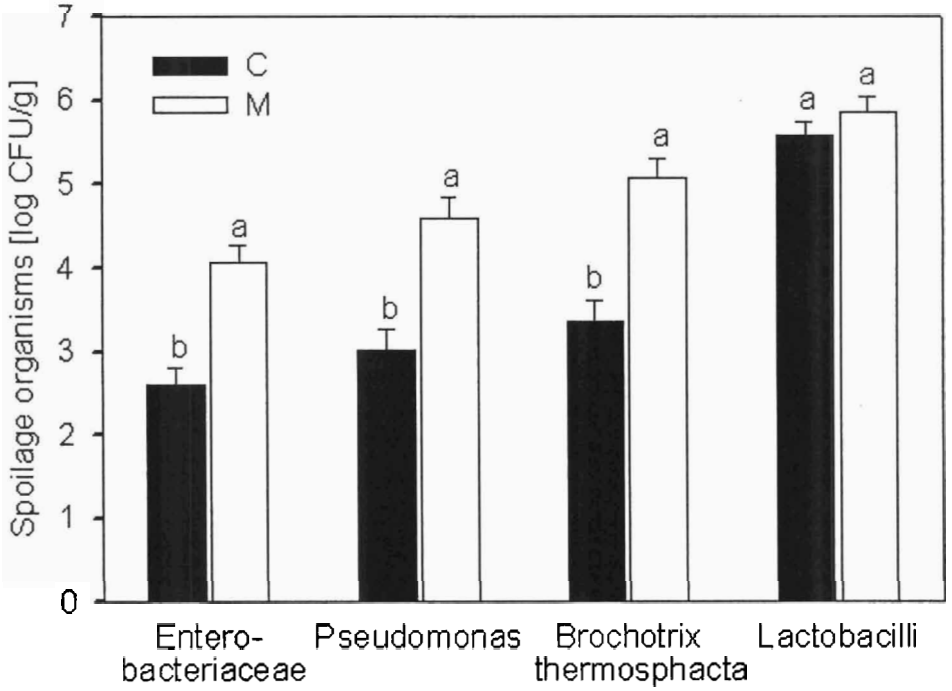
[a,b]Bars within an attribute labelled with different letters are significantly different (P<0.05)

Figure 2: Colour attributes and retail appearance



[a,b]Bars within an attribute labelled with different letters are significantly different (P<0.05)

Figure 3: Spoilage organisms enumerated in raw meat



[a,b]Bars within an attribute labelled with different letters are significantly different (P<0.05)

*Figure 4: Incidence and most probable numbers (**average** and range) of potential pathogenic bacteria in raw meat*