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Acceptable inclusion levels for selected red and brown Irish seaweed species in pork sausages. (#477)

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Introduction

Interest in food products that can promote health and well-being has increased within the food industry and amongst consumers. Such foods are generically termed 'functional foods' where health benefits exist beyond basic nutrition. Seaweeds have been consumed as food and utilised as traditional drugs in Asian countries. Recently, seaweeds have gained significance in Western countries as a functional food or as ingredients for use in the development of functional food products. Seaweeds contain bioactive compounds and nutritional properties such as high levels of quality protein, minerals, vitamins, dietary fibre, polyphenols, carotenoids and tocopherols. They are also low in fat, and selected species contain high levels of n-3 polyunsaturated fatty acids. Bioactivities and health benefits associated with compounds present in seaweed include antioxidant, anti-inflammatory, anti-coagulation and antibiotic properties. In addition to enhancing healthiness, seaweeds can also impact the physicochemical and sensory properties of meat products.

The objective of this study was to investigate the effect of commercially available red (*Porphyra umbilicalis*-(Nori), *Palmaria palmata*-Dulse (PP)) and brown (*Himanthalia elongata*-Sea spaghetti (SS), *Alaria esculenta*-Irish wakame (IW)) seaweed species on the physicochemical and sensory properties of pork sausages. Acceptable inclusion levels from a quality and sensory perspective will be determined.

Methods

Seaweeds (1%, 2.5% and 5%) were incorporated into pork sausage formulations (45% pork oyster, 20% pork fat, 20% water, 12.5% rusk and 2.5% seasoning). Proximate composition (protein, moisture, ash and fat), colour (CIE L*a*b), texture profile analysis (TPA), water holding capacity (WHC), cook loss and sensory properties (10 cm hedonic scale) were assessed. Statistical analysis was carried out using the IBM SPSS statistics 25 for windows (SPSS, Chicago, IL, USA) software package. One-way ANOVA was used to examine all experimental data measurements. Tukey's post-hoc test was used to adjust for multiple comparison between treatment means.

Results

Protein (13.1 – 15.6%), moisture (52.8 – 55.7%) and fat (10.8 – 12.6%) contents of fresh pork sausages were not influenced ($p>0.05$) by seaweed type or addition level. However, the ash content of pork sausages containing PP, SS and IW at 2.5% & 5% and Nori at 5%, was higher ($p<0.05$) than the control samples.

The surface lightness (L*) values of fresh sausages containing PP and IW at 2.5% & 5%, Nori at 1% - 5% and SS at 5% and were lower ($p<0.05$) than the control samples (Table 1). Surface redness (a*) values decreased ($p<0.05$) in all seaweed-containing sausage samples, relative to the control, with the exception of Nori at 1%. The addition of IW at levels of 2.5% and 5% increased the greenness (-a* values) of sausages. Yellowness (b*) values decreased ($p < 0.05$) in sausages containing PP and IW at levels of 2.5% & 5% and Nori at 1% - 5%. Colour changes in pork sausages were attributed to various pigments present in seaweeds such as phycobiliproteins, carotenoids and chlorophyll.

Texture profile analysis (TPA) results indicated that hardness and gumminess increased ($p<0.05$) in sausages containing Nori and IW at 5% (Table 1). Springiness values for sausages containing PP at 2.5% and 5% decreased ($p<0.05$) compared to controls. No differences ($p>0.05$) were observed in relation to sausage cohesiveness values. However, the addition of Nori at 5% increased ($p<0.05$) the chewiness of sausage samples. Red and brown seaweed species contain dietary fibres such as galactans, agar and carrageenan, alginate, fucans and laminarans which have gelling and thickening properties and can influence the texture of pork sausages. Sausages containing Nori at 5% and SS at 2.5% displayed higher ($p<0.05$) WHC, however cook loss was unaffected by the addition of seaweeds into sausage formulations. Sensory analysis indicated that inclusion of Nori and IW at 5% negatively influenced the appearance of cooked pork sausages (Tables 2 & 3). Sausage odour scores also decreased ($p<0.05$) in cooked sausages containing PP, SS and IW at a 5% inclusion level. In general, juiciness and texture descriptors were not significantly affected by the addition of seaweed species. However, the addition of PP at 2.5% and 5% and SS at 5% decreased ($p<0.05$) flavour scores of cooked pork sausages. Overall sensory acceptability decreased ($p<0.05$) in cooked sausages containing PP at 2.5% and 5% and SS and IW at 5% (Table 2 & 3).

Conclusion

Addition of seaweeds (PP, Nori, SS, and IW) did not exert significant effects on the proximate composition of fresh pork sausages. However, addition of seaweeds (Nori, SS and IW) at a 5% inclusion level and PP at 2.5% and 5% negatively influenced the colour, instrumental textural properties and sensory attributes of pork sausages. This study demonstrated that, in pork sausages, a maximum acceptable inclusion level for PP is 1% and 2.5% for the other seaweed species examined. Future research will focus on enhancing

Notes

the healthiness of processed pork products such as sausages, utilising seaweed species at the acceptable inclusion levels determined in the present study.

Notes

Treatment	Descriptors					
	Appearance	Odour	Texture	Juiciness	Flavour	Overall Acceptability
Control	7.08^{a}	7.31^{a}	6.07^{a}	6.35^{a}	7.14^{a}	7.36^{a}
Nori 1%	7.01^{a}	6.87^{a}	5.71^{a}	5.57^{a}	7.08^{a}	6.98^{a}
Nori 2.5%	6.23^{ab}	6.87^{a}	5.35^{a}	5.61^{a}	6.82^{a}	6.23^{ab}
Nori 5%	4.60^{b}	6.02^{ab}	5.44^{a}	5.18^{a}	6.58^{a}	6.18^{ab}
PP 1%	6.96^{a}	7.23^{a}	5.84^{a}	5.62^{a}	5.83^{ab}	5.91^{abc}
PP 2.5%	6.03^{ab}	6.05^{ab}	5.29^{a}	5.15^{a}	4.34^{bc}	4.78^{bc}
PP 5%	5.44^{ab}	4.79^{b}	5.01^{a}	4.97^{a}	3.23^{c}	4.17^{c}

^{abc} Within each descriptor, mean values in the same column bearing different superscripts are significantly different ($p < 0.05$).

Table 2. Sensory (hedonic) scores of sausages containing red seaweed species.

	Appearance	Odour	Texture	Juiciness	Flavour	Overall Acceptability
Control	6.51^{ab}	6.48^{a}	5.40^{ab}	5.73^{ab}	6.31^{abc}	6.26^{ab}
SS 1%	7.18^{b}	6.89^{a}	6.53^{a}	6.88^{a}	7.39^{a}	7.27^{a}
SS 2.5%	6.63^{ab}	5.23^{ab}	5.71^{ab}	5.37^{ab}	5.04^{bcd}	5.23^{bc}
SS 5%	5.78^{ab}	4.12^{b}	5.07^{ab}	4.42^{b}	3.14^{d}	3.81^{c}
IW 1%	6.37^{ab}	6.82^{a}	5.76^{ab}	5.46^{ab}	6.68^{ab}	6.26^{ab}
IW 2.5%	5.24^{a}	5.38^{ab}	5.65^{ab}	5.53^{ab}	5.32^{bc}	5.55^{abc}
IW 5%	3.19^{c}	4.42^{b}	4.37^{b}	4.29^{b}	4.38^{cd}	4.12^{c}

^{abcd} Within each descriptor, mean values in the same column bearing different superscripts are significantly different ($p < 0.05$).

Table 3. Sensory (hedonic) scores of sausages containing brown seaweed species.

Parameter	Control	PP (%)			Nori (%)			SS (%)			IW (%)		
		1	2.5	5	1	2.5	5	1	2.5	5	1	2.5	5
Colour													
CIE L*	70.45^{a}	67.78^{ab}	62.21^{bcd}	59.13^{def}	61.09^{cde}	56.05^{ef}	48.96^{g}	66.54^{abc}	64.90^{abcd}	61.73^{cde}	66.15^{abc}	59.71^{de}	53.29^{h}
CIE +a*/-a*	6.25^{a}	3.94^{de}	3.04^{ef}	2.54^{ef}	5.29^{abcd}	4.19^{cde}	2.70^{ef}	4.29^{bcde}	2.97^{ef}	1.42^{f}	2.05^{f}	-0.65^{g}	-2.01^{g}
CIE b*	13.87^{a}	11.62^{abcd}	9.44^{de}	8.03^{ef}	10.34^{cde}	8.22^{ef}	6.19^{f}	13.35^{ab}	13.16^{ab}	12.77^{abc}	12.39^{abc}	10.90^{bcd}	9.55^{de}
TPA													
Hardness (N)	42.81^{abc}	50.07^{cd}	41.18^{abc}	34.20^{ab}	46.20^{bc}	48.29^{bc}	68.60^{e}	35.67^{abc}	45.23^{abc}	46.62^{bc}	41.49^{abc}	44.95^{abc}	64.13^{d}
Springiness (mm)	0.86^{abcde}	0.82^{defg}	0.78^{fg}	0.76^{g}	0.87^{abcde}	0.83^{cdefg}	0.88^{abcde}	0.89^{abcd}	0.90^{abc}	0.84^{bcdef}	0.89^{abcde}	0.85^{abcdef}	0.81^{efg}
Cohesiveness	0.66^{abc}	0.62^{a}	0.64^{abc}	0.65^{abc}	0.67^{abc}	0.68^{abc}	0.62^{ab}	0.69^{abc}	0.67^{abc}	0.70^{abc}	0.67^{abc}	0.66^{abc}	0.62^{ab}
Gumminess (N)	28.28^{abc}	30.90^{bcd}	26.16^{abc}	22.15^{ab}	30.93^{bcd}	32.84^{cd}	42.59^{e}	24.46^{abc}	30.26^{bcd}	32.76^{cd}	27.84^{abc}	29.84^{abc}	39.50^{d}
Chewiness (N x mm)	24.41^{abcd}	25.11^{abcd}	20.58^{abc}	16.91^{a}	27.10^{bcd}	27.20^{bcd}	37.42^{e}	21.80^{abc}	27.32^{bcd}	27.76^{cd}	24.89^{abcd}	25.38^{abcd}	32.13^{d}
WHC %	63.73^{abc}	55.05^{a}	60.66^{ab}	64.98^{bcd}	69.30^{bcde}	66.14^{bcde}	73.36^{de}	69.25^{bcde}	74.95^{e}	70.96^{cde}	71.18^{cde}	67.47^{bcde}	70.20^{c}
Cook loss %	29.45^{abc}	33.23^{c}	31.04^{abc}	27.38^{abc}	28.29^{abc}	26.14^{ab}	25.76^{ab}	30.27^{abc}	28.57^{abc}	25.05^{a}	31.98^{bc}	30.52^{abc}	29.97^{a}

^{abcdefg} Within each parameter, mean values in the same row bearing different superscripts are significantly different ($p < 0.05$).

Table 1. Physicochemical properties of sausages containing red and brown seaweed species.

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