PE4.19 Characteristics of low-fat frankfurters with addition of alginate/glyceride functional mixture
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***Abstract* - This study evaluates the physicochemical and sensory properties of low-fat frankfurters prepared with added functional mixture alginate/glyceride (AG/GL-LF), comparing to conventional production with standard fat level of approximately 22% and with soy protein isolates (SPI) and functional mixture alginate/glyceride (AG/GL) addition. Results reveal that lightness (L*) and redness (a*) were not affected with far reduction ($p \geq 0.05$), but the low fat content led to lower yellowness (b*) of the products ($p < 0.05$). AG/GL-LF frankfurters presented higher shear values ($p \geq 0.05$) than SPI and AG/GL samples, and also higher firmness that AG/GL ($p < 0.001$) and SPI ($p \geq 0.05$) samples. Low-fat frankfurter scored higher for color, taste, juiciness and tenderness, and for overall acceptability.**

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***Index Terms* — frankfurters, low-fat, alginate/glyceride, physicochemical characteristics, sensory properties**

I. INTRODUCTION

In recent years there has been a dramatic changes in consumers eating habits. Consumers have become increasingly more health conscious, and because of that the trend is toward foods with decreased levels of fat, salt, cholesterol and overall caloric content. Due to concerns about diseases related to high-fat diets, many consumers now desire low-fat or no-fat versions of their traditional foods [1]. In order to meet consumers interest and market demands meat industry have made attempts to reduce fat in processed meat products and is offering variety of low-fat meat choices [2] [3]. Knowing that the fat content plays a major role in meat product characteristics (flavour, juiciness and texture), that it is essential to processing properties (texture, handling, bite, heat transfer etc.) [3], and is vital to formation of stable emulsion (reological and structural properties) fat reduction is not simple [4] [5]. Low-fat or reduced-fat processed meat products must be equal in quality to traditional high-fat products in order to be successfully marketed [6].

An alternative in low-fat meat products production is use of functional ingredients that mimic the properties of fat in emulsified cooked meat products [5].

These alternatives include the use of non-meat ingredients that could help to convey desirable texture and sensory properties and, more important, enhance water-holding capacity [5]. In this regard, addition of functional mixture with carbohydrates into processed meats has been shown to stabilize emulsions and increase water and fat retention [6] and have been successful in improving cooking yield, reducing formulation cost and enhancing texture [7]. Carrageenans are often utilised as fat replacers in modifying both texture and sensory attributes of meat products [8]. Lin and Mei [6] reported that incorporation of alginate, carrageenan, and soy protein isolate into reduced meat batters improved the emulsion stability and water-holding capacity. Soy protein isolate in commonly used in meat industry as a binder to reduce water loss, increase yield and viscosity, and to stabilize emulsions [6]. Since, soy can be recognized as potential allergen, in some meat products soy can be replaced with alginate/glyceride mix.

Alginates are commercially extracted from brown seaweed (*Phaeophyceae*), and are utilized in the food industries because of their gelling, viscosifying and stabilising properties. Alginates are linear polysaccharides composed of (1–4) linked b-D-mannuronic acid (M) and a-Lguluronic acid (G). Functional properties of the alginates, i.e. solubility, interaction with metal ions, gel properties and viscosity vary according to season, age of population, species and geographic location [9].

However, alginate/glyceride mix influence on the quality attributes of processed meat products have not been examined. Therefore, the objective of this study was to evaluate the influence of fat reduction with inclusion of alginate/glyceride mix, on physicochemical and sensory properties of frankfurters.

II. MATERIALS AND METHODS

Experimental design

Three different frankfurter formulations were prepared in a processing plant: with addition of soy protein isolate (SPI), with alginate/glyceride mix (AL/GL), and low-fat frankfurter with alginate/glyceride mix (AG/GL-LF). Partially thawed pork (I category – sample AG/GL-LF; III category – samples SPI and AG/GL) and beef meat was trimmed of heavy connective tissue and external fat, and placed in a cutter and homogenised. Than common ingredients (water/ice, additives and seasonings) were added and mixed with chopped meat. Soy protein isolate was added in concentration of 4% (SPI), alginate/glyceride mix in concentrations of 0.7% (AG/GL) and 0.3% (AG/GL-LF). Pork fat was added with continuous chopping until the emulsion was prepared. After that, the batter was stuffed into 23 mm diameter polyamide casings and heat processed to an internal temperature of 72ºC. The frankfurters were cooled with cold water, first to internal temperature of 25ºC, than finally to 4ºC and stored (4ºC) until analysis.

Proximate analysis

Fat, protein (Kjeldahl N x 6.25), ash and moisture contents of frankfurter samples were determined according to the official methods: ISO 1444 [10], ISO 937 [11], ISO 936 [12] and ISO 1442 [13], respectively. Proximate composition analysis of sausages was determined in triplicate.

INSTRUMENTAL MEASUREMENT OF TEXTURE

Warner–Bratzler shear test - samples were uniaxially shear-compressed with a Warner–Bratzler blade, adapted to Universal Testing Machine (Instron International LTD, High Wycombe, UK, model 4301), at a constant cross-head speed rate of 100 mm/min, using 0.25kN load cell. The parameter recorded was the maximum shear force (N) that is the highest peak of the curve, which is the maximum resistance of the sample to shearing. Firmness of the cooked sausages was determined using a texture analyser (Instron 4301) equipped with a plunger of “five needles” at a crosshead speed of 100 mm/min, using 0.25kN load cell. Compression force was taken as the maximum recorded force on the output, for 1cm thick sample, expressed as Newton (N).

Each sample was assessed 10 times and the average was expressed as Newton (N).

A. Colour measurement

Colour measurements were performed with a Minolta Chromo Meter CR – 400 (Minolta Co., Ltd., Osaka, Japan), according to the standard conditions of the Commission International de I’Eclairage (CIE). The samples were sliced with a thickness of 2.5 cm and the values were measured three times on the surface of the slices immediately after cutting. Results were expressed as L^* (lightness), a^* (redness) and b^* (yellowness).

SENSORY EVALUATION

A five-member training panel was used to evaluate the sensory characteristics of frankfurters. Sausage samples were heated by placing in boiling water for 5 min and then sliced into pieces, and served warm to the panellists. The panellists evaluated each characteristic of the sample using a 5-point hedonic scale, where one (1) was dislike extremely, and five (5) was like extremely. They were asked to express their opinion of the product regarding its appearance, colour, taste, juiciness, and tenderness.

Statistical analysis. All data are presented as means ± standard deviation. The results were evaluated statistically using the analysis of variance and Duncan's multiple range test in the Statistical Analysis System [14].

III. RESULTS AND DISCUSSION

Proximate composition of different frankfurter formulation is shown in Table 1. Differences in protein content between SPI and AG/GL can be attributed to addition of soy protein isolates, and highest protein content (14.11%) in AG/GL-LF samples can be explained with better raw material composition (I category pork meat). Proximate composition indicates that the fat level of the reduced-fat product was about 3% with fat being replaced with water (water content was 76.58%). Fat content in sample AG/GL-LF was reduce for 87% from the commercial one. According to Lin and Mei [6] alginates demonstrate superior water holding capacity at higher cooking temperatures because of more heat-stable gel, comparing to soy protein isolate. The ash content of frankfurters increased with addition of alginate/glyceride mix.

Table 1. Proximate analysis (%) of frankfurters (SPI: normal fat with added soy protein isolate; AL/GL: normal fat with added alginate/glyceride mix; AG/GL-LF: low-fat with added alginate/glyceride mix)

Samples	Moisture	Protein	Fat	Ash
SPI	58.34	13.13	22.73	2.63
AG/GL	60.35	11.87	22.44	2.71
AG/GL-LF	76.58	14.11	2.93	3.01

Table 2 shows the CIE *L*, a*, b** colour values of frankfurters. The addition of alginate/glycerine mix did not significantly effect the colour of frankfurters, comparing to soy protein isolate addition. Also fat reduction did not significantly changed lightness (*L**) and redness (*a**) of the products. The lightness value decrease, and redness values increase in the low-fat frankfurter, but the changes were not significant. AG/GL-LF frankfurters had slightly higher *a** values ($p \geq 0.05$) what may have some connection with meat content and raw meat quality. Yellowness significantly decreased with fat reduction and lowest value was noted in the AG/GL-LF product. According to Ayo et al. [15] number of authors have reported that when fat content was reduced *L** and *b** values decreased and *a** values increased, Crehan et al. [16] reported significant affect of fat content on cooked frankfurters colour. Lin and Huang [17] reported that frankfurters with highest fat content had highest *L** and *b** values and lowest *a** values. Also in number of occasions no differences in colour values were observed as a result of fat reduction [15].

Table 2. Colour parameters of frankfurters samples (SPI, AG/GL, AG/GL-LF)

Samples	*L**	*a**	*b**
SPI	66.34±0.62 [a]	14.34±0.23 [a]	17.27±0.76 [a]
AG/GL	67.07±1.17 [a]	14.51±1.43 [a]	17.91±0.74 [a]
AG/GL-LF	66.74±1.43 [a]	15.54±0.26 [a]	14.10±0.46 [b]

Means (± standard deviation) within the same column bearing unlike letters are significantly different ($p<0.001$);

The texture attributes of analysed frankfurters are shown in Table 3. No significant difference between frankfurter samples on maximum force was found using Warner-Bratzler shear test. Cofrades et al. [18] suggest that shear test may not be sufficiently sensitive to distinguish between fat levels in frankfurters, and not be useful in the texture assessment of this type of meat products. Firmness of the low fat frankfurters (AG/GL-LF) was higher than firmness of AG/GL ($p<0.001$) and SPI ($p \geq 0.05$) samples.

Table 3. Textural attributes (N) of frankfurters samples (SPI, AG/GL, AG/GL-LF)

Samples	Shear value	Firmness
SPI	12.40 ± 0.88 [a]	5.45 ± 0.53 [ab]
AG/GL	12.55 ± 4.04 [a]	5.03 ± 0.51 [b]
AG/GL-LF	13.23 ± 4.86 [a]	5.97 ± 1.02 [a]

Means (± standard deviation) within the same column bearing unlike letters are significantly different ($p<0.001$);

Table 4 shows the sensory scores of frankfurters containing soy protein isolates and alginate/glyceride mix. Although panellists found that the appearance of the AG/GL-LF samples was different from the expected, other sensory characteristics (colour, taste, juiciness and tenderness) of low-fat frankfurters were evaluated with highest marks, comparing to other two examined group of samples. The overall acceptability scores ranged from 3.66 to 4.39, with maximum acceptability obtained for low-fat frankfurter. Several studies have shown that the addition of starch and polysaccharides in ground muscle-based food products can lead to an acceptable product [1].

Table 4. Sensory score* of frankfurters samples (SPI, AG/GL, AG/GL-LF)

Samples	Appearance	Colour	Taste	Juiciness, and tenderness	Overall acceptability
SPI	4.5 ± 0 [a]	4.3±0.25 [a]	3.9 ±	4.0 ± 0 [b]	4.25
AG/GL	4.3±0.24 [a]	3.5 ± 0 [b]	3.3 ±0.2	3.1 ± 0.2 [c]	3.66
AG/GL-LF	4.0 ± 0 [b]	4.4 ± 0.2 [a]	4.4 ±	4.4 ± 0.2 [a]	4.39

*On a 5-point hedonic scale: 1-the least, 5-the most.
Means (± standard deviation) within the same column bearing unlike letters are significantly different ($p<0.05$);

IV. CONCLUSION

Incorporation of alginate/glyceride functional mix to frankfurters did not significantly affected colour parameters or texture properties. Low fat frankfurters with addition of alginate/glyceride mix had the best score for colour, taste, juiciness and tenderness, and also for the overall acceptability.

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