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Rice starch and fructo-oligosaccharides as substitutes for phosphate and dextrose in whole muscle cooked hams: Sensory analysis and consumer preferences

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A B S T R A C T

Sensory characteristics and visual acceptability of cooked hams with rice starch (RS) and fructo-oligosaccharides (FOS) as substitutes for, respectively, sodium tripolyphosphate (STPP) and dextrose (Dex), were evaluated. Replacement of STPP with RS is associated with hams being less juicy, salty and springy, but more adhesive and could negatively affect appearance; but replacement of Dex by FOS had minimal sensory influence. The relative importance of product appearance, pack labels and price information cues in simulated purchasing decisions was also investigated. Consumer purchase choices were more influenced by product appearance than by pack labels referring to additives or price. Including labelling information regarding reduction or exclusion of phosphates may be more important than labels regarding a reduction in salt. For the Irish consumers studied here, the use of phosphates in cooked hams sounds artificial, unhealthy and unknown, whereas dietary fibre was perceived as healthy, natural and improving of the eating quality.

1. Introduction

Many European consumers perceive processed meats as unhealthy and as containing high levels of harmful chemicals, fat and salt (Haugaard, Hansen, Jensen, & Grunert, 2014). Furthermore, excess consumption of processed meat is associated with increased risk of developing coronary heart diseases and diabetes (Micha, Michas, & Mozaffarian, 2012). However, at the same time, many of these products are traditional and are regularly consumed as part of the typical diets of European consumers. Therefore, novel approaches to develop healthier versions of processed meat products, taking into consideration nutritional advice and legislation, are needed. Possible approaches include reducing and/or replacing artificial additives with clean label ingredients, or the inclusion of new healthy ingredients. Phosphate reduction and addition of fibre are two approaches that have potential to improve the perception and health profile of meat products. Research has shown that dietary fibre can be successfully added to meat products to improve their healthiness (Fernández-Ginés, Fernández-López, Sayas-Barberá, & Pérez-Alvarez, 2005) and some products were/are available in the market generally (Jiménez-Colmenero, Reig, & Toldrá, 2006). If added in sufficient quantities, a health claim, such as "contains dietary fibre" could be included on the label (Regulation (EC) No 1924/2006).

Modification of traditional formulations to improve their health profile could, however, negatively impact technological and sensory characteristics of the traditional product. While instrumental, chemical and microbiological studies are useful to characterize the safety and can help to predict the organoleptic characteristics of the novel products, only sensory analysis can predict their sensory acceptability to consumers. For example, cooked hams prepared with two salt replacers (Ocean's Flavor: OF45, OF60) were found to have acceptable instrumental and safety characteristics, but had a low acceptability in flavour and aftertaste due to bitterness and further flavour optimization would be required before product launch (Pietrasik & Gaudette, 2014).

In a previous study aimed at improving the health profile of

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Table 1
Definitions of the descriptors used in the sensory analysis of the cooked ham.

Descriptor	Definition
Tenderness	Force required during the first bite between molars to deform the sample (0 = very hard to 10 = very tender).
Juiciness	Amount of perceived juice released from the product during mastication (0 = dry to 10 = very juicy).
Springiness	Degree and rapidity of recovery from a deforming force (compression by molar teeth, 0 = non-elastic to 10 = extremely springy).
Adhesiveness	Force required to remove material that adheres to the mouth (0 = non-adhesive to 10 = very adhesive)
Salty taste	Intensity of the taste characterised by sodium chloride (0 = non-salty to 10 = very salty)
Ham flavour	Intensity of the typical ham flavour (0 = non-flavour to 10 = very intense flavour)

traditional cooked ham, rice starch (RS) and fibre (fructo-oligosaccharides, FOS) were proposed as substitutes for phosphates (STPP) and sugar (dextrose, Dex) (Resconi et al., 2015) to assess the potential of cooked ham containing FOS as a source of fibre. Instrumental and chemical analysis demonstrated that the healthier products had acceptable technological characteristics but differed from the conventional product in certain aspects. Since STPP substitution with RS affected water retention and instrumental texture (Resconi et al., 2015), the sensorially perceived juiciness and texture of a ham with total or partial substitution of phosphates could also change with respect to a traditional cooked ham formulation (with 0.3% added phosphates). RS inclusion could further affect the acceptability of the appearance since starch gel pockets were visible in the hams (Resconi et al., 2015). It is also important to establish consumer attitudes and acceptance of modifications to traditional products for example, addition of fibre in cooked ham products. Previous studies suggest that consumers readily accept bioactive compounds in dairy products (Tobin, O'Sullivan, Hamill, & Kerry, 2014), such as yoghurt with added oligosaccharides/fibre or omega-3 fatty acids. However, is still uncertain if consumers accept similar compounds in traditional meat based products.

In an initial study, the effect of different brine ingredient components (STPP, RS, FOS and Dex) on instrumental and chemical quality of cooked ham (Resconi et al., 2015) was investigated and now we aim to study their effects on sensory characteristics and visual acceptability. The second objective is to evaluate the relative importance of appearance, ingredient labels and price cues in simulated purchasing decisions. A questionnaire was also conducted to obtain the socio-demographic and consumption habits information of consumers and to describe their views and concerns related to cooked ham.

2. Materials and methods

2.1. Ham preparation

Hams were manufactured in the Meat Industry Development Unit (Teagasc, Food Research Centre, Ashtown, Ireland). Four ingredients, STPP ($Na_5P_3O_{10}$, Redbrook Ingredient Services Ltd., Ireland), RS (Remyline XS, Beneo, Belgium), Dex (Roquette Freres, Lestrem, France) and FOS (Beneo ORAFTI® Synergy1, Beneo, Belgium) were used for each formulation according to the experimental design. Pickling salt at 2.5% and sodium ascorbate at 0.05% w/w in injected muscle was also included in all the hams. Two pork muscles, *Biceps femoris* (BF) and *Semimembranosus* (SM) from female carcasses (Rosderra Irish Meats Group, Edenderry, Ireland) were pumped to 120%, using a 20-needle brine injector and then tumbled for 12 h (6 rpm: 30 min on/off). Tumbled muscles were netted, vacuum packed, heat shrink-wrapped and steam cooked at 85 °C, 85% RH, to a core temperature of 72 °C. After cooking, hams were chilled to 2–4 °C for 24 h, sliced at 2.5 mm thickness, vacuum packed and stored at 2–4 °C.

2.2. Sensory analysis (trained panelists)

2.2.1. Triangular test

For the triangular test, three pairs of cooked hams with different combination of the four ingredients (STPP, RS, Dex, FOS) from *B. femoris* and *Semimembranosus* muscles were compared:

- control *vs.* RS 0.30 (STPP 0%, RS 0.3%, Dex 0.2%, FOS 0%).
- control *vs.* RS 1.17 (STPP 0%, RS 1.17%, Dex 0.2%, FOS 0%).
- control *vs.* FOS (STPP 0.3%, RS 0%, Dex 0.2%, FOS 3%).

A triangular test for the 'no difference hypothesis' was performed according to the British Standard ISO 4120 (ISO, 2004). A 16 member panel, from a pool of screened assessors selected for their sensory performance (ISO-8586-1, 1993), evaluated two triads (one for each muscle) per pair comparison in individual booths under red light. Muscles from the left and the right side from the same animal were compared.

2.2.2. Descriptive test

A response surface methodology (RSM) based on d-optimal experiment was designed using Design Expert software (v. 7.6.1, Stat-Ease Inc.). This is described in detail in Resconi et al. (2015), where instrumental and chemical data is presented. Briefly, four

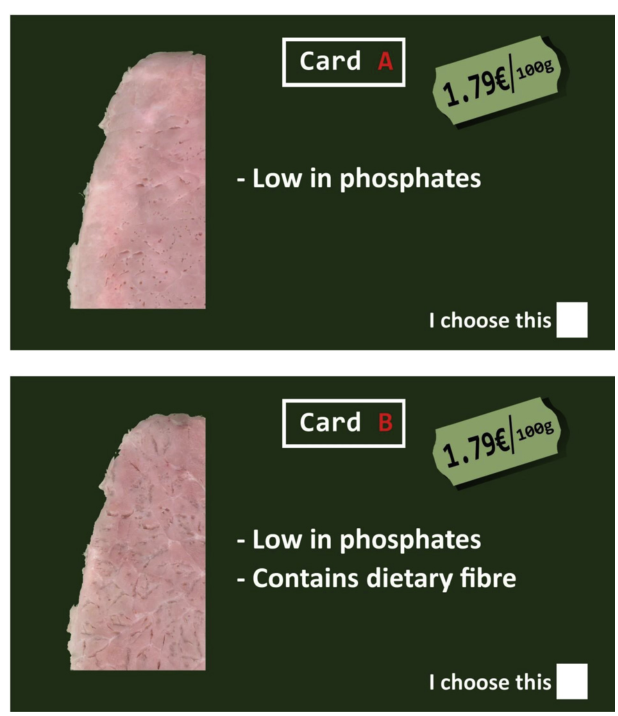

Fig. 1. Example of the pair comparison used in the choice based conjoint analysis. Card A shows an image with a ham without gel pockets (Image 1) and in the card B, the gel pockets are visible (Image 2).