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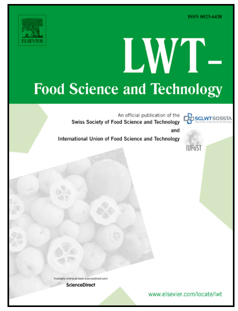


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**Interaction of salt content and processing conditions drives the quality response in streaky rashers**

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**Abstract**

Response surface methodology was utilised to explore the relationship between processing conditions, including cooking temperature and drying time, and ingredients in reduced-salt streaky rasher formulations. The goal of this project was to assess the impact of reducing salt content on physicochemical and sensory properties. Salt levels above 2.44 g/100 g did not affect cooking loss. Cooking temperature (240°C) was negatively correlated with lightness and redness, n-3 fatty acids, and sensory acceptance, and positively correlated with hardness and monounsaturated fatty acids. Salt content was highly correlated with perceived saltiness and both were identified as negative attributes by the sensory panel. Results indicate that optimised reduced-salt streaky rashers with acceptable technological and sensory performance could be achieved under the following conditions: 2 g/100 g salt, 94 min of drying and grilling at 190°C.

**Keywords:** Salt reduction, bacon, response surface methodology, sensory, multiple factor analysis

## 1. Introduction

Bacon, originally developed as a method for pork preservation, has become an economically important portion from the pig carcass (Sheard, 2010; Soladoye, Shand, Aalhus, Gariépy, & Juárez, 2015). While in countries like the United Kingdom and Ireland, the most popular bacon product is back bacon (from cured pork loin), elsewhere in Europe and North America, streaky rashers (from cured pork belly) are the most widely available (Sheard, 2010).

The overconsumption of meat products have been related to several diseases, including cardiovascular disease (CVD), obesity, type 2 diabetes and cancers of multiple organs (Klurfeld, 2015). Excessive salt content and some saturated fatty acids have been tagged as the unhealthy components of meat products. Sodium—with salt being the main dietary source of this mineral—increases blood pressure, and a reduction in the diet of hypertensive people leads to blood pressure reduction and thus, less risk of CVD (Cook, Appel, & Whelton, 2016; Mozaffarian et al., 2014). On the basis of this evidence, numerous countries, under the World Health Organisation policies, have adopted strategies for dietary salt reduction (Trieu et al., 2015). The Food Standards Agency from UK (FSA) and the Food Safety Authority of Ireland (FSAI) have agreed guidelines for the meat industry in order to reduce the salt content of different meat products. The agreed targets for bacon products are 2.88 g salt /100 g product.

The primary approach for developing reduced-salt meat products is based on salt substitution and/or inclusion of flavour enhancers (Desmond, 2006). Nonetheless, the increasing market shift towards clean label food products makes necessary the search for novel salt alternatives. We can define strategies aligned with this goal based on approaches such as use of herbs and spices, flavourings from plant origin, varying fat levels, and the application of high pressure, among others (Fellendorf, O'Sullivan, & Kerry, 2017; Saricoban, Yilmaz, & Karakaya, 2009; Viuda-Martos, Ruiz-Navajas, Fernandez-Lopez, & Perez-Alvarez, 2011; Yang et al., 2015).

All of these strategies can be easily applied to comminuted meat products, but not all are technically feasible in whole-muscle cured products.

Processing variables, such as cooking and drying conditions, can affect the physicochemical properties, fatty acid composition and sensory acceptance of meat products (Alfaia, Lopes, & Prates, 2013; Gou, Comaposada, & Arnau, 2003; Sánchez del Pulgar, Gázquez, & Ruiz-Carrascal, 2012). Response Surface Methodology (RSM) has been widely used by meat scientists as an effective tool to examine the interactions of processing conditions and formulation levels to determine quality, and can also permit optimisation through maximising and minimising specified technological outcomes (Lowder et al., 2013; Resconi et al., 2015; Saricoban et al., 2009).

In this study we aimed to deepen the understanding of the relationship between processing conditions (drying time and cooking temperature) and quality in streaky bacon rashers, and evaluate if processing conditions can be defined which permit salt levels to be reduced to meet or better the aforementioned guidelines without affecting the physicochemical and sensory characteristics.

## 2. Materials and Methods

### 2.1. Experimental design

A split-plot D-optimal point exchange RSM experiment was designed using Design Expert v10 (Stat Ease Inc., USA) generating a total of 14 runs (Table 1). Three numerical factors were included in the design: salt content (g/100 g), drying time (min) and cooking temperature (ºC). Minimum and maximum levels were: 2 to 2.88 for salt, 60 to 120 min for drying time and two discrete values for cooking temperature 190°C and 240°C, as intermediate values proved not to be meaningful in previous experiments. Two additional model groups were included generating 5 additional model points. The whole experiment was replicated twice and the means for each run were used for the statistical study.

## 2.2. Streaky rashers processing

Fourteen pork bellies were purchased from a meat supplier (Rosderra Irish Meats, Edenderry, Ireland) and transported to the meat processing facility at Teagasc Food Research Centre Ashtown. Three different brines were prepared with varying levels of salt (Table 1) and 150 ppm of sodium nitrite. Maximum salt level of 2.88 g/100 g was selected as in line with the recommendations from both The Food Standards Agency from UK and the Food Safety Authority in Ireland for this type of products. Each belly was cut in half and was randomly assigned to a different formulation; hence, each of the fourteen runs was repeated. The half-bellies were pumped to 113 % of their green weight using a 20-needle brine injector (Inject-O-MAT type PSM-21, Dorit Maschinen, Handels AG, Switzerland). The injected bellies were weighed, vacuum packed and left to mature at 0-4 °C for 48 h. After the maturing stage the bellies were dried at 55 ºC for the respective time according to each formulation (Table 1). The bellies were cooled, weighed again, and chilled up to -5 °C when they were sliced (3mm). The streaky rashers were cooked on an electric grill (Velox Grill CG-3.71, Velox Ltd., Wantage, UK) for 2 min each side at the designated temperature (Table 1), left to cool down and weighed again. The cooked slices were then vacuum packed and stored at 2±1 °C for future analysis.

## 2.3. Physicochemical properties

Samples were homogenised in a Robot Coupe (R101, Robot Coupe SA, France). Fat and moisture were determined using the Smart System 5 microwave and NMR Smart Trac rapid Fat Analyser (CEM Corporation USA) using AOAC Official Methods 985.14 & 985.26.

Protein concentration was determined using a LECO FP328 (LECO Corp., MI, USA) according to AOAC method 992.15,1990. Salt was determined by titrating chloride anions in ashed (by furnace) samples with silver nitrite using the Mohr method (Vogel, 1961). pH was measured in the brines, green muscle, dried muscle and cooked samples. All these analyses were performed in at least duplicates. Cook loss was calculated from the initial and final weight before and after cooking of at least six slices per formulation. Shear force (N) was assessed on streaky bacon cooked rashers using an Instron Universal Testing Machine with a Warner-Bratzler shear force cell at a crosshead speed of 5 cm/min. Colour was analysed using a Ultrascan XE spectrophotometer (CIE L*a*b system) on the lean part of the rasher.

### 2.4. Fatty acid analysis

Fat was extracted from samples and methyl esters of fatty acids were prepared by base-catalysed trans-esterification methodology (Christie & Han, 2012). The fatty acid methyl esters were analysed using gas chromatography with flame ionization detector (GC-FID) in accordance with a UKAS accredited methodology (Cam Nut003) as in Kirk and Sawyer (1991). Samples were analysed in duplicate and results were expressed as percentage of total fat.

### 2.5. Sensory analysis

The sensory acceptance test was conducted using untrained panellists (n = 24, 14 females) in the age range of 21–65 following the same approach as in Delgado-Pando et al. (2018). The twenty four panellists (14 female) were asked to evaluate on a 9-point hedonic scale the following attributes: liking of appearance, texture, flavour and overall acceptability. The assessors then participated in a ranking descriptive analysis (RDA) using a list of sensory attributes (crunchiness, saltiness and meaty flavour) measured on an intensity line scale

(Richter, de Almeida, Prudencio, & de Toledo Benassi, 2010). Due to the great amount of samples to test and to avoid sensory fatigue, the sensory analysis was split in four different sessions according to a balanced incomplete block design. Each panellist assessed each sample twice, in both the hedonic and RDA tests.

### 2.6. Statistical Analysis

Statistical analysis of physicochemical and sensory properties was performed using Design Expert software. Pearson correlations were calculated using "Hmisc" package in R studio (Harrell & Dupont, 2016; R, Core Team 2015). Sensory and instrumental data were also analysed using FactomineR and factoextra packages (Kassambara & Mundt, 2017; Le, Josse, & Husson, 2008) by means of a multiple factor analysis.

## 3. Results and Discussion

### 3.1. Physicochemical properties

Variations in the levels of cooking temperature, drying time and salt content affected the physicochemical properties of the streaky rashers.

As expected, cooking temperature significantly affected moisture, protein and fat content (Table 2). Moisture ranged between 19.6-33.5 g/100 g, protein between 25.6-39.2 g/100 g and fat between 30.0-45.8 g/100 g. In the case of moisture, the higher the temperature the lower the water retained in the sample. However, a significant interaction between salt and drying time was also observed. The maximum content of moisture appeared at the longest drying time (120 min) and from salt content ≥2.5 g/100 g (Fig. 1a,b). Salt impact on moisture content was more significant at higher drying times, the more salt the higher the moisture after cooking. During the drying process first stage, water losses are expected to be rapid, because of the evaporation from the surface, but as time passes the resistance to moisture movement becomes higher. According to Gou et al. (2003) the binding strength between water and the meat matrix increases as the moisture decreases. The same authors also concluded that the effect of salt on moisture increased with drying time during the process of dry-cured pork ham; the higher the salt content the higher the moisture. In the case of the protein content the model was not significant (Table 2) and only the cooking temperature had a significant increasing impact (Fig. 1c). Fat content was also significantly affected by cooking temperature, but in an opposite way (Table 2); it was lower with increasing cooking temperature. On the other hand, drying time was a significant factor too, the higher the drying time the lower the fat content after cooking (Fig 1d,e). Moisture reduction and protein concentration was reported on different pork roast with increasing end-point temperature (Heymann, Hedrick, Karrasch, Eggeman, & Ellersieck, 1990). Fat and moisture had a significant and negative correlation with protein, -0.53 and -0.68 respectively. Moisture and fat were released as a result of drying and cooking, increasingly affecting the protein concentration.

Streaky rashers had a mean salt content of 4.62 g/100 g, with 3.56 g/100 g the lowest and 6.37 g/100 g the maximum. As expected, the higher the initial salt concentration the higher its final salt concentration after cooking. The drying time also affected the final salt concentration as can be seen in the contour figure (Fig 1e,f); the maximum appeared after 90 min of drying but significantly varied depending on the initial salt level and cooking temperature. Generally, as the drying time increased the effect of the cooking temperature increased, final salt content was higher at 240 ºC than at 190 ºC (Fig 1e,f).

Cooking loss ranged from 50.1-59.3 % and was affected by the three studied parameters. A high salt level and drying time and lower cooking temperature exerted the minimum losses. Even though salt was the main parameter influencing cooking loss, between 2.44-2.88 g/100 g the impact was minimal (Fig 2). Within this salt range, the effect of drying time became more important and below that the cooking temperature showed a bigger effect. In agreement with the results of moisture composition, the longer the drying time the lower the cook loss as water got more bound to the meat matrix. Cooking loss was significantly correlated with final protein content (0.71) and negatively with moisture (-0.74). From these results and Fig. 2 we could infer that an initial salt level above 2.44 g/100 g was enough to maintain the cooking loss values irrespective of the drying and cooking conditions under study. In sausages, it has been reported a salt level at around 1.5 g/100 g as the minimum to prevent negative functional properties (Aaslyng, Vestergaard, & Koch, 2014; Ruusunen et al., 2005). Several authors have reported increases in cooking loss when reducing the salt content in different meat products (Puolanne, Ruusunen, & Vainionpää, 2001; Ruusunen et al., 2005; Tobin, O'Sullivan, Hamill, & Kerry, 2013).

The texture of the cooked streaky rashers was measured by means of shear force (N/g). This parameter was primarily affected by cooking temperature and initial salt content, whereas drying time effect was not significant (Table 2). Important differences appeared when varying these parameters, the lowest shear force (8.77 N/g) was recorded in the sample with highest salt level and lowest cooking temperature and drying time, while the maximum (22.59 N/g) appeared at the lowest salt content and highest cooking temperature and drying time. As mentioned earlier, salt is related to the water holding capacity (WHC) of meat as the chloride ions are thought to be responsible for the swelling of the myosin shaft and thus increasing its WHC; on the other hand, the sarcomere length of the meat is known to decrease with increasing cooking temperature (Ertbjerg & Puolanne, 2017). Reductions in WHC and sarcomere length (low salt and high temperature), along with the protein denaturation, are then related to an increase in the hardness (as measured by shear force) of the meat.

The response surface models for the colour parameters were not significant, although the effect of cooking temperature was significant for lightness and redness (Table 2). The streaky rashers appeared darker and less red with increasing cooking temperature. The effect of cooking conditions on colour is complex because of the biochemical changes in the muscle pigments (myoglobin and haemoglobin) but also the Maillard reactions occurring at temperatures above 140 ºC. As the temperature increases the meat gets drier, the myoglobin degrades and gives more greyish-brown pigments and Maillard reactions will be more numerous giving a darker and less red colour. Accordingly, lightness and redness values of streaky rashers were significantly and negatively correlated (-0.84, -0.53) with the protein content. Similarly, Sánchez del Pulgar et al. (2012) and Oz and Celik (2015) found decreasing L* and a* values with increasing cooking temperature in pork chops and goose meat, respectively.

**3.2. Fatty acid composition**

Fatty acid composition of cooked streaky rashers was analysed, average results were calculated as a percentage of total fat and the response surface models were calculated (Table 3). The main components of the lipid profile of the streaky rashers observed were oleic acid (31.5-36.6 %), palmitic acid (23.1-25.0%), linoleic acid (12.9-17.6%) and stearic acid (11.2-13.1%), in accordance with existing literature of fat from pork traits (Douny et al., 2015; Li et al., 2016). The processing conditions significantly affected the concentration of some of the fatty acids (Table 3). None of the individual saturated fatty acids (SFA) was significantly affected by any of the studied parameters, and thus the surface response models for total or individual SFA were not significant. Variation in SFA within the different rashers was low (36.6-39.5 %) with palmitic and stearic acids accounting for almost 95 % of the total SFA. Similarly, no differences in fatty acid composition were observed when comparing grilling, microwaving and boiling in beef muscle (Alfaia et al., 2013). However, Li et al. (2016)

observed higher quantities of SFA in stewed pork bellies when compared with pre-fried and stewed ones.

Total monounsaturated fatty acids (MUFA) concentration ranged between 34.7 %- 40.0 % and were mainly oleic (>90%) and palmitoleic acids (>5%). Oleic acid and total MUFA significantly increased with cooking temperature (Table 3). In pork patties, MUFA significantly increased when pan-fried as compared to an electric grill (Salcedo-Sandoval, Cofrades, Ruiz-Capillas, & Jiménez-Colmenero, 2014) but this could be attributed to the transference of MUFA from the frying oil to the piece of meat. Heymann et al. (1990) observed an increase of oleic and palmitoleic acids with increasing endpoint temperatures in different pork roasts.

Total content of polyunsaturated fatty acids ranged from 14.0 %-20.8 %, where linoleic acid accounted for more than 85 %. Surprisingly, the response surface models for PUFA were not significant and only a trend (p=0.08) was observed where the PUFA content decreased with increasing cooking temperature. Douny et al. (2015) found that the PUFA fraction of pork meat was affected by the cooking type, being higher when cooked in a pan as opposed to oven cooking. Conversely, Turp (2016) found no significant differences in fatty acid composition between oven, grill and pan cooked Turkish beef meatballs. n-3 fatty acids concentration ranged from 1.4 %-2.2 % and were significantly affected by the cooking temperature, the higher the temperature the lower the n-3 concentration (Table 3). Alpha linolenic acid accounted for more than 80 % of the total observed n-3 while eicosatrienoic acid (ETA) around 10 %. This fatty acid, ETA, was the only one significantly affected by the drying time, and with a significant interaction of salt and cooking temperature. Low salt content and high drying time at 190 ºC gave the highest values. After linolenic acid, ETA is the main source of n-3 fatty acids in pork fat, has been shown to promote eicosanoid precursors of long chain n-3 fatty acids and has also exhibited a photo-protective effect in human skin (Dugan et al., 2015). The results demonstrate that through altering the processing conditions, it is possible to achieve higher quantities of n-3 fatty acids, specifically ETA, and hence improve the healthier lipid fraction of the rashers.

Discrepancies in the effect of cooking on the fatty acid fraction can be attributed to the type of cooking, total heating time, different cut and animal species (Alfaia et al., 2013). In general, the cooking temperature was the main factor affecting some of the lipids from the streaky rashers, with salt having no significant effect and the drying time only on ETA. This temperature effect could be partially attributed to the fat concentration and retention of specific fatty acids.

**3.4. Sensory Analysis**

Response Surface models were tested for the seven sensory attributes (liking of appearance, texture, and flavour, overall acceptability, crunchiness, saltiness and meaty flavour) but only three of them had any significant term (Table 4). Streaky rashers with the highest salt content were preferred in flavour when lower drying times were applied and for rashers with the lowest salt content medium drying times (~90 min) were scored the highest in flavour (Fig. 3). As expected, the cooking temperature significantly affected the crunchiness of the samples, the higher the temperature the higher the score for this attribute. In general, panellists were able to perceive the differences in saltiness according to the formulation as in the model we can see the significance of this factor (Fig 3).

In order to delve into the correlation between the sensory characteristics and the physicochemical properties, a multiple factor analysis (MFA) was performed. MFA helps to analyse several data sets measured on the same observations. In our case, we structured our data set into one supplementary and three active groups: formulation (salt content, drying time and cooking temperature) as supplementary, hedonic characteristics (liking of appearance, texture, flavour and overall acceptability), intensity characteristics (crunchiness, saltiness and meaty flavour) and instrumental properties (cook loss, shear force and colour). Most of the variables were highly correlated to the first dimension irrespective of the active group they belong to (Fig. 4). Nonetheless, whereas hedonic and instrumental colour attributes were positively correlated, cook loss crunchiness and shear force do correlate with first dimension negatively. Saltiness intensity and liking of flavour were more correlated with the second dimension, although in an opposing way. Attending to the supplementary group, we can clearly observe that both drying time and salt content are associated with perceived saltiness and that cooking temperature relates to an increase of cook loss, shear force and perceived crunchiness. With regards to the individual plot (Fig. 5) we can see that is not the high salt samples but some of the medium and low salt the ones that are correlated with positive liking attributes. In addition, with the exception of sample S8, samples cooked at 190°C were positively correlated with the first dimension and thus with positive hedonic scores and higher instrumental colour. As mentioned earlier, temperature plays a role in the Maillard reactions, generating some desirable flavour compounds, but high temperatures can also degrade the proteins into peptides and amino acids contributing to sour, umami and bitter taste and also undesirable burnt off-flavours (Alfaia et al., 2013; Hilmes & Fischer, 1997).

**3.5. Optimisation of responses using RSM**

Using the optimisation module of the RSM software and with the selection criteria of minimising salt content, shear force and cooking loss, and maximising the flavour preference, the optimised sample will be that with 2 g/100 g initial salt level, 94 min of drying time and grilled at 190 °C. This solution generated the highest desirability value (0.648). The optimised sample was manufactured and assessed for the physicochemical characteristics, obtaining a salt content of 3.9 g/100 g, a shear force of 16.1 N/g and a cooking loss of

52.8 %. Compared to the predicted values the differences were: +0.4 in salt and shear force values and +1.5 in cook loss.

## 4. Conclusions

This study confirmed the relevance of the processing conditions on the physicochemical and sensory properties of streaky rashers. Despite the importance of salt level in manufacturing streaky rashers—and any other meat products—this level should be re-evaluated as our results showed that lower salt concentrations are preferred and technically feasible. When evaluating a product that needs to be cooked before consumption, the cooking temperature, frequently neglected, should be taken into consideration. In our case, the use of lower temperatures increased the sensory acceptance, the tenderness and the PUFA levels of the streaky rashers irrespective of the salt level. Cooking temperature also doubled the initial salt content and should be a piece of information to consider disseminating when labelling the product. The use of RSM proved to be a helpful tool in evaluating the optimal processing conditions of streaky rashers.

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**Figure Captions**

Figure 1. Response surface model for moisture (g/100 g) (a, b), fat (g/100 g) (c), protein (g/100 g) (d) and final salt content (g/100 g) (e, f) in streaky rashers. The remaining factors were fixed as follows: a) cooking temperature 190°C, b) cooking temperature 240°C, c) cooking temperature 190°C, d) salt 2.44 g/100 g and drying time 90min, e) cooking temperature 190°C, and f) cooking temperature 240°C.

Figure 2. Response surface model for cooking loss (%) in streaky rashers. Left: cooking temperature fixed at 190°C, right: salt content fixed at 2 g/100 g.

Figure 3. Response surface model for sensory properties in streaky rashers. Left: liking of flavour score (cooking temperature fixed at 190 °C), right: perceived saltiness intensity (cooking temperature fixed at 190 °C)

Figure 4. Multiple Factor Analysis (MFA) variable plot. Active groups: instrumental colour, cooking loss and shear force; hedonic sensory attributes (liking of flavour, liking of texture, liking of appearance and overall acceptability); intensity sensory attributes (meaty flavour, saltiness and crunchiness). Supplementary group: salt content, cooking temperature, drying time.

Figure 5. Multiple Factor Analysis (MFA) individual plot.S1-S14 streaky rashers as formulated in Table 1. Salt levels as final salt content, High salt: >5 g/100g, Medium salt: 4-5 g/100g, Low Salt: <4 g/100g

Table 1. Processing conditions according to response surface split-plot D-optimal design

| Sample | NaCl (g/100 g) | Drying Temp. (°C) | Cooking Temp. (°C) |
|---|---|---|---|
| S1 | 2 | 60 | 190 |
| S2 | 2.44 | 90 | 190 |
| S3 | 2.88 | 60 | 190 |
| S4 | 2.88 | 120 | 190 |
| S5 | 2.88 | 120 | 240 |
| S6 | 2.88 | 60 | 240 |
| S7 | 2 | 90 | 240 |
| S8 | 2 | 120 | 190 |
| S9 | 2.88 | 90 | 190 |
| S10 | 2.44 | 60 | 190 |
| S11 | 2.88 | 90 | 240 |
| S12 | 2 | 120 | 240 |
| S13 | 2.44 | 60 | 240 |
| S14 | 2 | 60 | 240 |

Table 2. Response surface models split-plot design for composition, cook loss, texture and instrumental colour in streaky bacon

| | Moisture | Protein | Fat | Salt | Cook Loss | Shear Force | L* | a* | b* |
|---|---|---|---|---|---|---|---|---|---|
| Model | Quadratic | Linear | 2FI | Quadratic | Quadratic | 2FI | Linear | Linear | Linear |
| p whole-plot | 0.026 | <0.001 | 0.002 | 0.371 | 0.011 | 0.010 | 0.004 | 0.050 | 0.178 |
| p subplot | 0.007 | 0.590 | 0.052 | 0.010 | 0.034 | 0.034 | 0.9372 | 0.8136 | 0.372 |
| $R^2$ | 0.98 | 0.80 | 0.87 | 0.97 | 0.93 | 0.85 | 0.60 | 0.36 | 0.32 |
| *Coefficients:* | | | | | | | | | |
| CT | -2.01* | 4.04** | -3.29** | 0.26ns | 1.43** | 2.25** | -1.65** | -0.23* | -0.35ns |
| S | 0.96* | -0.72ns | 0.51ns | 0.61** | -2.02** | -3.01** | 0.18ns | 0.06ns | 0.37ns |
| DT | 3.34** | 0.38ns | -3.27** | 0.07ns | -1.13* | 0.80ns | 0.02ns | -0.05ns | 0.16ns |
| S x DT | 1.56* | | 1.03ns | -0.06ns | -0.75ns | -0.96ns | | | |
| S x CT | 0.41ns | | -0.98ns | 0.12ns | -0.61ns | -0.47ns | | | |
| DT x CT | -0.51ns | | 0.06ns | 0.28* | -0.26ns | -1.14ns | | | |
| $S^2$ | -2.88* | | | 0.31ns | 2.20* | | | | |
| $DT^2$ | -0.57ns | | | -0.53* | -0.30ns | | | | |

ns: p>0.05, *:p≤0.05, **:p≤0.01. 2FI: two level full factorial; CT: cooking temperature; S: salt; DT: drying time.

Table 3. Response surface models split-plot design for fatty acid composition of streaky bacon

| | SFA | MUFA | PUFA | OA | w3 | ETA w3 |
|---|---|---|---|---|---|---|
| Model | Linear | Linear | Linear | Linear | Linear | 2FI |
| p whole-plot | 0.468 | 0.034 | 0.080 | 0.047 | 0.038 | 0.315 |
| p subplot | 0.922 | 0.603 | 0.359 | 0.562 | 0.253 | 0.0161 |
| $R^2$ | 0.11 | 0.41 | 0.38 | 0.38 | 0.47 | 0.88 |
| *Coefficients:* | | | | | | |
| CT | 0.24 | 0.78** | -0.73* | 0.74** | -0.11** | -0.02 |
| S | 0.12 | 0.22 | -0.02 | 0.25 | <0.01 | 0.02 |
| DT | 0.01 | -0.32 | 0.68 | -0.35 | 0.10 | 0.03** |
| S x DT | | | | | | -0.04** |
| S x CT | | | | | | 0.03** |
| DT x CT | | | | | | <0.01 |

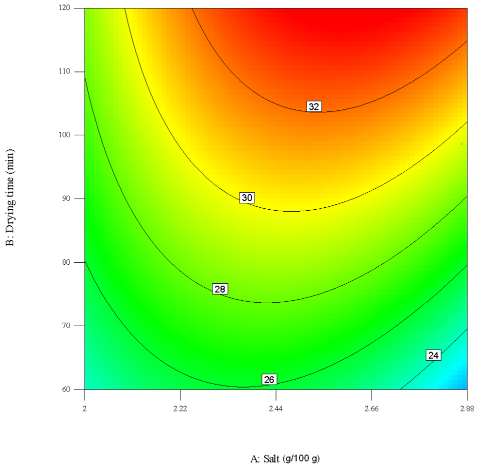
*:p≤0.1, **:p≤0.05.

SAF: saturated fatty acids; MUFA: monounsaturated fatty acids; PUFA: polyunsaturated fatty acids; OA: oleic acid; ETA: eicosatrienoic acid; 2FI: two level full factorial; CT: cooking temperature; S: salt; DT: drying time.

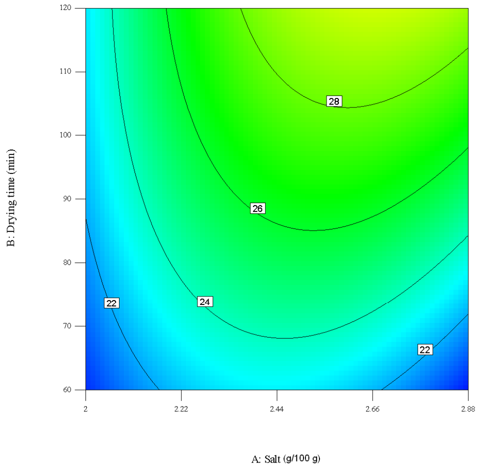
Table 4. Response surface model split-plot design for sensory attributes of streaky bacon

| | Liking appearance | Liking texture | Liking flavour | Overall acceptability | Crunchiness | Saltiness | Meaty flavour |
|---|---|---|---|---|---|---|---|
| Model | Linear | Linear | Quadratic | Linear | 2FI | 2FI | Linear |
| p whole-plot | 0.319 | 0.121 | 0.670 | 0.106 | 0.008 | 0.532 | 0.670 |
| p subplot | 0.530 | 0.384 | 0.025 | 0.562 | 0.059 | 0.018 | 0.130 |
| $R^2$ | 0.50 | 0.65 | 0.96 | 0.31 | 0.83 | 0.85 | 0.61 |
| *Coefficients:* | | | | | | | |
| CT | -2.08ns | -4.58ns | -1.05ns | -1.51ns | 3.41** | 1.15ns | -0.57ns |
| S | 1.21ns | 2.08ns | -1.17ns | -0.05ns | -0.94ns | 6.67** | 0.32ns |
| DT | -0.15ns | -0.32ns | -1.81* | -1.12ns | -3.49* | 3.69* | -1.20ns |
| S x DT | | | -2.87** | | 0.81ns | 1.69ns | |
| S x CT | | | 1.86* | | -1.57ns | -1.23ns | |
| DT x CT | | | 0.39ns | | -2.37ns | -1.52ns | |
| $S^2$ | | | 4.07* | | | | |
| $DT^2$ | | | -2.51* | | | | |

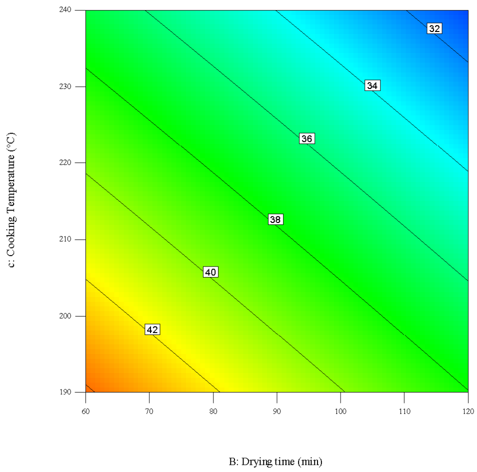
ns: p>0.05, *:p≤0.05, **:p≤0.01. 2FI: two level full factorial; S: salt; DT: drying time a)


B: Drying time (min)
A: Salt (g/100 g)
32
30
28
26
24

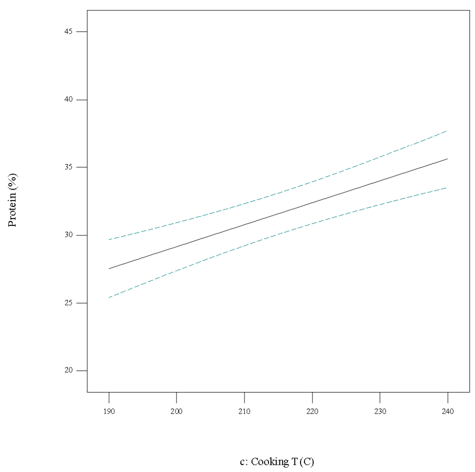
b)


B: Drying time (min)
A: Salt (g/100 g)
28
26
24
22
22

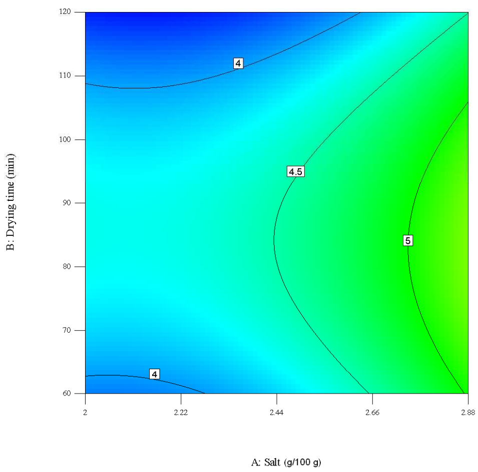
c)


c: Cooking Temperature (°C)
B: Drying time (min)

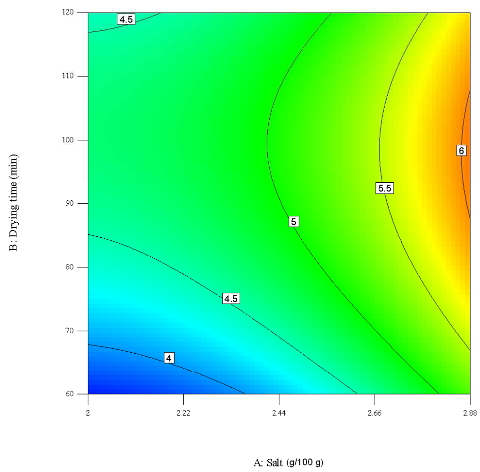
d)

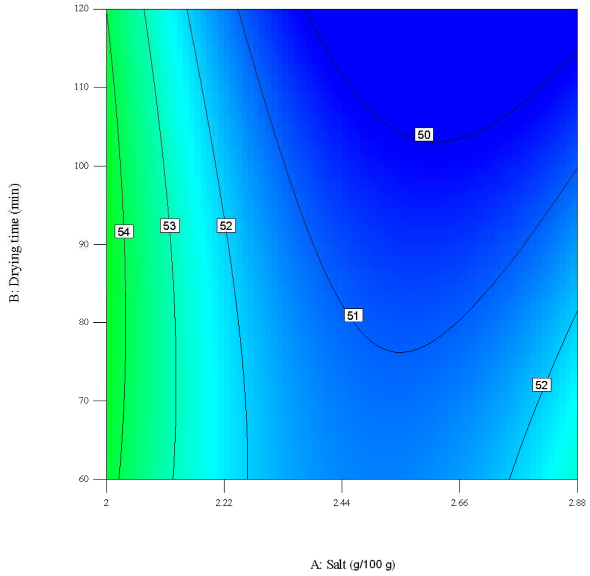

Protein (%)
c: Cooking T (C)

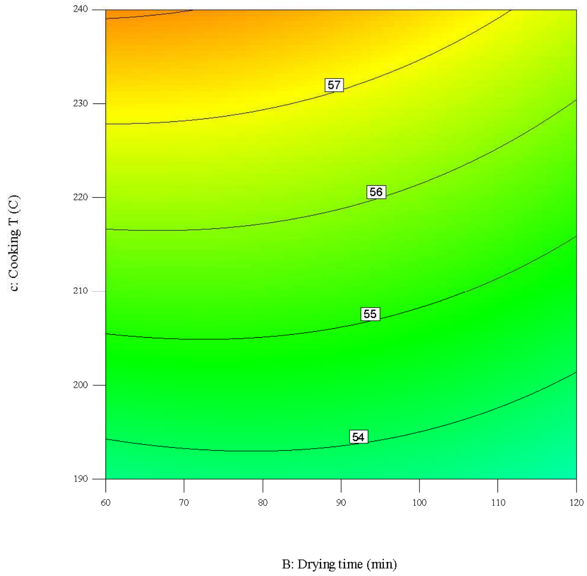
e)

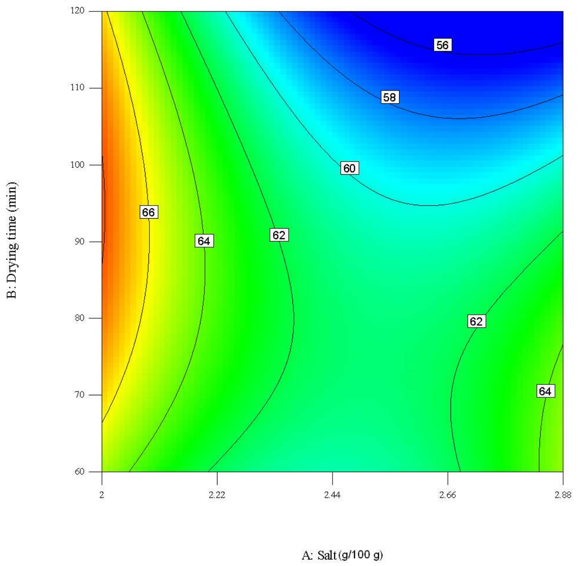

B: Drying time (min)
A: Salt (g/100 g)

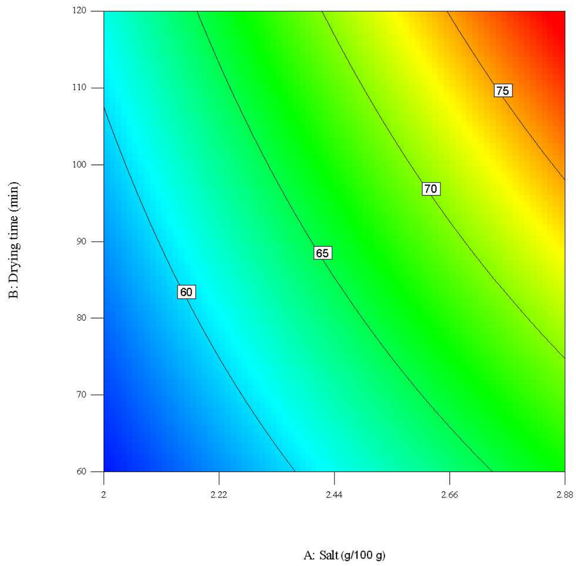
f)

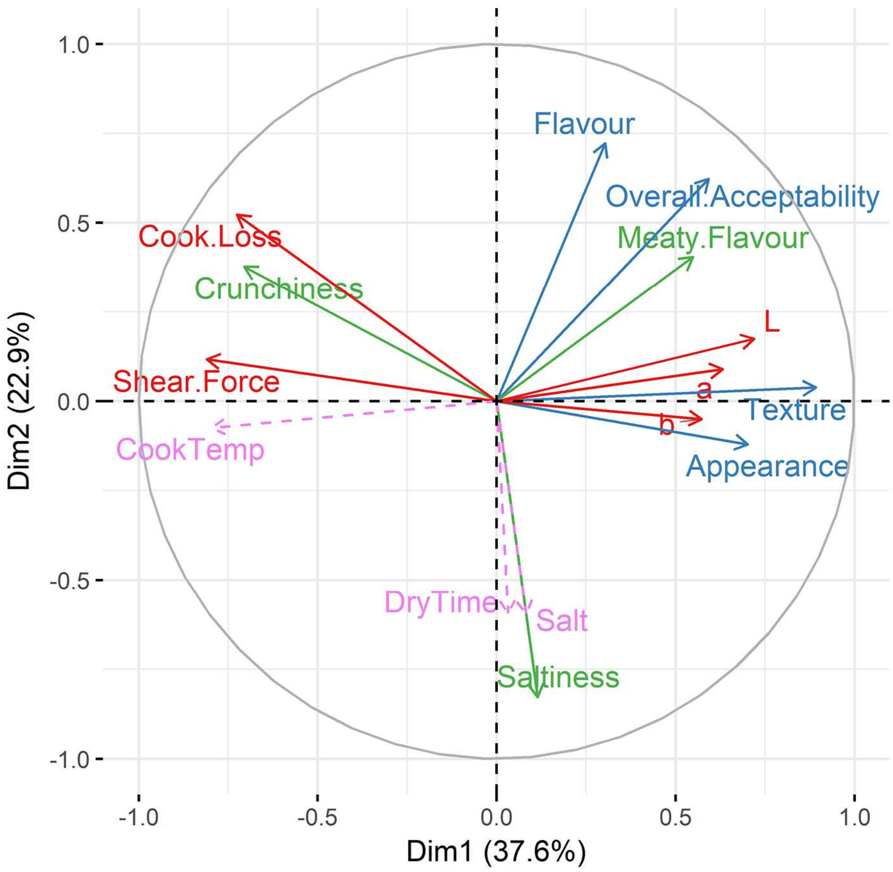

B: Drying time (min)
A: Salt (g/100 g)


B: Drying time (min)
A: Salt (g/100 g)
54
53
52
51
50
52

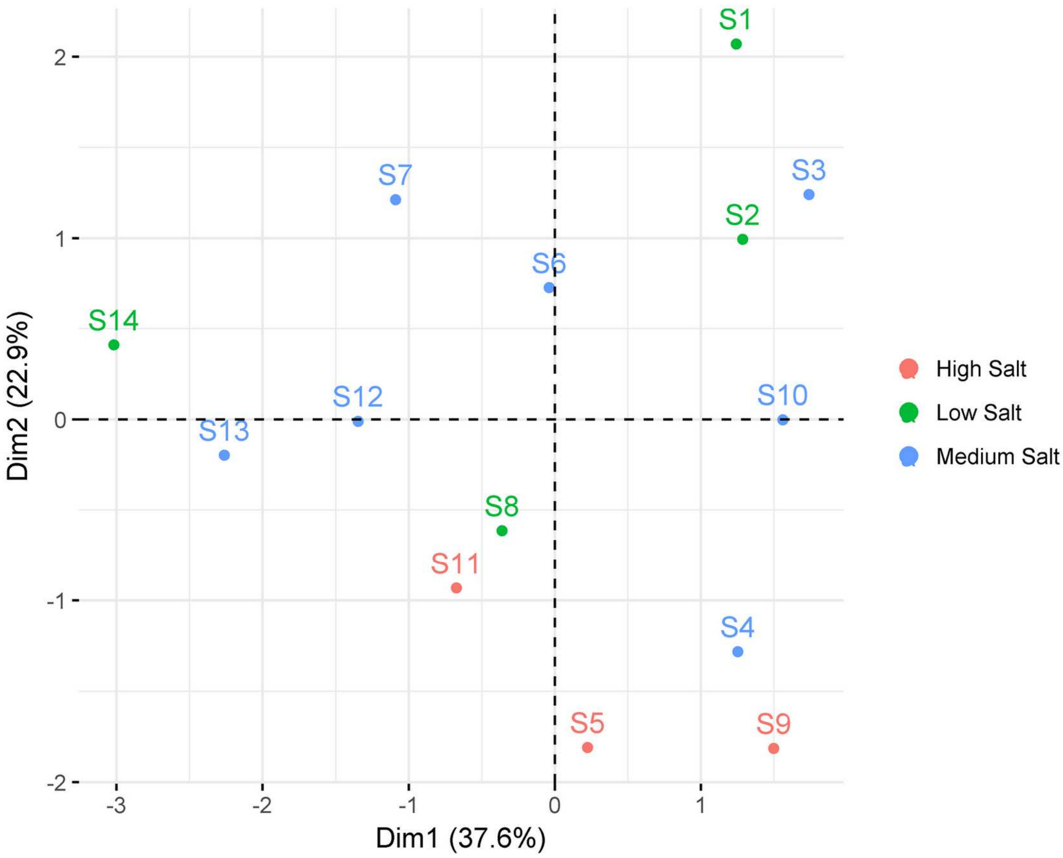

c: Cooking T (C)
B: Drying time (min)
57
56
55
54


120
110
100
90
80
70
60
B: Drying time (min)
56
58
60
66
64
62
62
64
2
2.22
2.44
2.66
2.88
A: Salt (g/100 g)


120
110
100
90
80
70
60
B: Drying time (min)
75
70
65
60
2
2.22
2.44
2.66
2.88
A: Salt (g/100 g)



1.0
0.5
0.0
-0.5
-1.0
-1.0
-0.5
0.0
0.5
1.0
Dim2 (22.9%)
Dim1 (37.6%)
Flavour
Overall.Acceptability
Meaty.Flavour
Cook.Loss
Crunchiness
L
a
Shear.Force
Texture
b
CookTemp
Appearance
DryTime
Salt
Saltiness



S1
S7
S3
S2
S6
S14
S12
S10
S13
S8
S11
S4
S5
S9
2
1
0
-1
-2
-3
-2
-1
0
1
Dim2 (22.9%)
Dim1 (37.6%)
High Salt
Low Salt
Medium Salt

- Interaction of salt and processing conditions impacts quality of streaky rashers
- Fatty acids are affected by processing conditions
- Cooking temperature is a main factor in the sensory acceptance of rashers
- RSM proved to be a useful tool for optimising reduced-salt streaky rashers