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Impact on the physical and sensory properties of salt-and fat-reduced traditional Irish breakfast sausages on various age cohorts acceptance

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Abstract

The properties of varying salt and fat levels in traditional breakfast sausages were investigated. Sausages were produced with fat levels of: 30%, 20% and 15%. Fat was replaced with pea extract. Salt levels employed were: 2.5%, 1.1% and 0.0%. A reduced sodium salt which contains 45% less sodium than standard salt was used. Sensory analysis was conducted on consumers (n=228): 18-40 yrs., 41-64 yrs. and 65-85 yrs. The 18-40 yr. olds preferred sausages containing 20% fat, 41-64 yr. olds preferred sausages with 15% fat, 65+ age group preferred sausages containing 30% fat. The 18-40 yr. olds preferred high salt samples, 41-64 yr. olds displayed no salt preference, while the 65+ age group preferred high salt sausages. Sausage formulation choice was found to be driven by texture for the younger age cohort, flavour for the middle age cohort and visual aspects from the oldest age cohort. There is a need to understand how meat products might be reformulated different age palates.

Keywords: Cardiovascular Disease; Fat Reduction; Salt Reduction; Sensory; Elderly.

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1. Introduction

Due to the increasing number of elderly consumers in Europe, knowledge pertaining to their health and nutritional status should be complemented by studies focused on food preferences. Nutritional status and health of older adults has a direct impact on their social and economic interactions. Health concerns associated with processed meat products has become topical in recent years. Traditional Irish meat products such as breakfast sausages are familiar to all Irish age groups. While such products are useful in that they offer a protein source through the utilisation of meat off-cuts and trimmings, such products are typically comprised of high percentages of fat (Keenan, Resconi, Kerry, & Hamill, 2014) and salt (Fellendorf, O'Sullivan, & Kerry, 2015) and thus raise concern in relation to associated health risks through consumption. According to IUNA (2011), 39% of the Irish population aged between 18-64 years of age consume sausages and 31% of those 65 years old and over consume sausages. Taste (41%) was the most important factor for Irish consumers purchasing a product, followed by health and nutrition (36%).

The WHO (2012) recommends that adults should consume less than 2000mg of sodium, or 5g/d of salt. The Food Standards Agency Salt Targets 2017 are 1.3g of salt or 450mg of sodium in sausages. Previous researchers have successfully reduced salt in processed meats without compromising on sensory quality (Tobin et al., 2013; Fellendorf et al., 2015; Fellendorf, O'Sullivan & Kerry, 2017; Fellendorf, Kerry, Hamill & O'Sullivan, 2018; Delgado-Pando et al., 2018). Reductions in salt may be of huge benefit to the elderly. In a trial involving men and women aged 60–78 years of age, a decrease in daily salt intake from 10g to 5g for one month was linked to an average fall in SBP (systolic blood pressure) of 7mmHg and that these effects, which were seen in normotensive and hypertensive subjects, resulted in a 36% reduction rate in stroke risk over a five-year period in this age group (Cappuccio, Cook, Atkinson, & Strazzullo, 1997). The demand for low salt food products has

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resulted in reduced salt content meat products being available commercially. A variety of approaches to replace or substitute sodium chloride are available for meat processing, which includes using; transglutaminase (TG), potassium chloride (KCl), dietary fibre, and caseinate as a salt replacer (Colmenero, Ayo, & Carballo, 2005). Processed meats generally have the highest fat content (approximately 25%) of all meat categories (Chan, Brown, Church, & Buss, 1996). Fat is incorporated into processed meat products, as fat possesses unique and important sensory characteristics as its presence in products affects mouth-feel, juiciness and taste. Fat also plays an important structural role in meat products (Cáceres, García, & Selgas, 2008). However, fat in processed meats poses a threat to public health as it may increase the risk of diseases like CVD, obesity and cancer. This is mostly due to its high saturated fat content (WHO, 2008). Loss of sensory perception of fat increases with age (Schiffman, Graham, Sattely-Miller, & Warwick, 1998). This may further increase the danger of over consumption of high-fat foods by the elderly to compensate for their lower capacity to perceive fat in foods. Strategies for reducing fat in processed food products have been devised. Fat substitutes like rice starch, (Limberger et al., 2011), milk-co-precipitate, (Eswarapragada, Reddy, & Prabhakar, 2010), soy protein isolate, (Chin, Keeton, Miller, Longnecker, & Lamkey, 2000), pea flour, starch and fibre (Pietrasik & Janz, 2010) have been employed for use in processed meats.

Increased quantities of fibre in foods have been proven to reduce the risk of colon cancer, cardiovascular diseases, obesity, and several other disorders (Cummings, Bingham, Heaton, & Eastwood, 1992; & Johnson & Southgate, 1994). The hulls of yellow peas are comprised of approximately 82% fibre making them an excellent fibre source for incorporation into food products (Sosulski & Wu). In metabolically unhealthy humans, 12g/d of pea fibre intake for 28 days reduced fasting insulin concentrations and improved postprandial glucose responses (Marinangeli & Jones 2011). Pea fibre has also been proven to be beneficial from a function

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ability (Grigelmo-Miguelet al. 1999) and nutritional point of view (Rossellet al. 2001). In a study examining the effect pea fibre had on beef burgers it was found that the water-holding capacity of raw beef burger was significantly higher due to the addition of pea fibre. The use of pea fibre in the beef burger reduced the cook loss and in turn it decreased the shrinkage. Thus the production cost is reduced without degradation of sensory properties. Many dietary fibres have been used in meat products, not only to determine their possible beneficial effects on health, but also as potential fat substitutes (Chang & Carpenter, 1997; & Mansour & Khalil, 1997).

Processed meats are especially desirable to elderly consumers as they generally tend to be traditional product-types, possess high fat and salt levels which satisfy sensory desirability by overcoming perceptional decline and are protein dense. Despite all that has been described above, little or no research has been conducted into examining the sensory impacts that fat and salt reduction in breakfast sausages would have on different age cohorts of consumers.

Consequently, the objective of this study was to investigate age related sensory perception as a result of substituting fat and salt with pea extract and a reduced sodium salt, by examining the sensory perception of sausages based on varying age cohorts. It was envisaged that this research may provide an insight into sensory decline with age, and provide suggestions as to more healthful substitutes for the traditional breakfast sausage. The scientific objective of this research focused on establishing a profile of formulations which are accepted based on differing age cohorts with the aim of identifying perceived differences as aging occurs.

2. Materials and Methods

2.1 Reagents and chemicals

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Sulphuric acid, hydrogen peroxide, boric acid, hydrochloric acid, sodium hydroxide and silver nitrate were supplied by Sigma-Aldrich Ireland Ltd., Vale Road, Arklow, Wicklow, Ireland.

2.2 Sample Preparation

Fresh boneless pork and pork back fat were purchased from local meat processors (Ballyburden Meats Ltd, Ballincollig, Cork, Ireland). All meat purchased had full traceability. The meat and fat were cut, weighed and placed into vacuum packs and vacuum packaged. They were then and stored in the freezer (-18°C) until required. Prior to use meat and fat were thawed slightly at refrigerated temperature (4°C) before being minced through a 10mm plate (TALSABELL S. A.,Pol. Ind. V. Salud, 8. Valencia, Spain). Independent batches of pork and pork fat was used each time. The ingredients were weighed according to the formulations in Table 1. The reduced sodium salt, and pea extract were purchased from All in All Ingredients Ltd., Unit 33 Lavery Avenue, Parkwest, Dublin 12, Ireland. The reduced sodium salt was measured by the manufacturer 'All in All Ingredients' to determine that the salt contained 45% less sodium than standard salts. The reduced sodium salt featured the following composition. Sodium: 22.0 ± 0.6, chloride: 34.0 ± 0.9, sulphate: 23.0 ± 0.7, potassium: 9.0 ± 0.3, magnesium: 2.0 ± 0.1, trace elements 0.3± 0.1 & free and bound moisture: 10.0 ± 1.5. The seasoning utilised is a 0% salt spice blend: which is described as having yeast extract, carmine, sodium ascorbate and sodium metabisulphate. The seasoning was supplied by All in All ingredients also. The seasoning comprised of the pork, seasoning (0% sodium), salt, pea starch, the reduced sodium salt and a third of the required water were fed into a bowel chopper and mixed at high speed for 45 s. Having formed the base emulsion, the required fat was then added to the bowel chopper (Maschinenfabrik Seydelmann KG, Aalen (Wurtt), Burgstallstrabe, Germany) and the mix was chopped for a further 45s at high

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speed. The remaining water was added and the batter mixed for a further 30s. at high speed. Finally, the pin-head rusk was added to the batter and mixed again for 30s at low speed. The sausage mix was then loaded into the sausage filler, (Mainca, Mod EB 12/25 MAINCA, Maquinaria Industria Carnica Equipamientos Carnicos, S.L. Granollers, Barcelona, Spain) from where it was fed into collagen casings. The sausages were the sealed in plastic bags and refrigerated (4°C) overnight to allow product equilibration. Nine treatment batches were manufactured three individual times.

2.3 Cooking

Oven cooking of the sausages was chosen as the cooking method as it provided consistent results and was easily replicated. Each sausage sample was wrapped in aluminium foil (tin-foil), labelled and dry cooked at 150°C in a Zanussi convection oven (C. Batassi, Conegliano, Italy) and cooked to an internal temperature of 73°C, as monitored using a calibrated temperature probe (Testo 110, Lenzkirch. Germany).

2.4 Sensory Analysis

2.4.1 Recruitment

Panellists of varying age cohorts were recruited for this study. Panellists were chosen in compliance with the following criteria; community dwelling, healthy, did not have a food allergy, did not have any difficulties swallowing, and were regular consumers of breakfast sausages. Trial subjects were recruited from University College Cork and from active retirement groups based around the Cork region to allow for an older consuming demographic within the study. The assessor cohorts were derived from various socio-economic backgrounds and were gender balanced.

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2.4.2 Sensory Evaluation

Sensory analysis was carried out on untrained assessors (n=228). The ages ranged from 18-85 yrs. of age. The sample size of the three age cohorts were 18-40 yrs. (n=81), 41-64 yrs. (n=84) and 65-85 yrs. (n=63). Consumers evaluated both hedonic (n=4), first and then intensity (n=7) attributes at the same session, but separated by an interval to allow training and descriptor explanation with reference to a provided table of description. The definitions presented to each panellist are outlined in Table 2. Nine products were evaluated per session and two sessions were carried out per consumer. Each panellist rated the sensory qualities of the samples according to AMSA (2015). The following hedonic (liking) attributes were examined always first; texture, flavour and acceptability. Hedonic attributes were rated whereby 0=extremely dislike 8=extremely like. The following intensity attributes were then measured after a short training session whereby descriptors were presented along with a table of description (Table 2): Spiciness, coarseness, toughness, juiciness, meat flavour, off flavour and saltiness. Intensity was rated whereby 0=none 8=extreme. The samples were presented to the assessors on a white polystyrene plate. Each sample was presented randomly, with corresponding codes on the plate. The panellists were asked to rinse their mouths with water in-between each sample in accordance with the methods of (Tobin et al., 2012b). The experiment was conducted in panel booths, which conformed to international standards (ISO, 2007).

2.5 Proximate Compositional Analysis

2.5.1 Protein Content

The Kjeldahl method, was used to determine the protein in the cooked breakfast sausage samples (Suhre, Corrao, Glover, & Malanoski, 1982), and percentage protein was calculated using a nitrogen conversion factor of 6.25. This method was in accordance with the work

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outlined by (Tobin et al., 2013). The results recorded represent the average of six measurements (three independent batches x two samples).

2.5.2 Ash Content

Ash content of the sausages were measured using a muffle furnace (Nabertherm GmbH, Lilienthal, Germany). The muffle furnace was preheated to 525°C. A 5g blended sample was weighted into a porcelain dish and placed in the muffle furnace for 6 hr, until the colour of the samples went white. The samples were placed in a desiccator to cool. The dishes were weighted and the ash content was calculated. The results recorded represent the average of six measurements (three independent batches x two samples).

2.5.3 Moisture and Fat Content

A 2.0g of sausage sample was homogenised using a Büchi Mixer B-400 (Büchi Labortechnik AG, Meierseggstrasse 40, Postfach, CH-9230 Flawil 1, Switzerland). The sample was transferred into a moisture proof bag, to insure that the least amount of moisture as possible was lost. The moisture content was then determined using the CEM SMART system and the fat was determined using the SMART Trac system (CEM GmnH, Kamp – Lintfort, Germany). The results recorded represent the average of six measurements (three independent batches x two samples).

2.5.4 Carbohydrates

Total carbohydrates were determined by difference: A hundred grams minus the addition of protein, fat, water and ash in grams, expressed as a percentage. The results recorded represent the average of six measurements (three independent batches x two samples).

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2.6 Physical Analysis

2.6.1 Texture Analysis

After cooking, sausage samples were cooled to room temperature (approximately 20°C) to determine textural properties. Texture was measured using a texture profile analyser; (Texture Analyser 16 TA-XT2I Stable Micro Systems, Surrey, UK) following the guidelines of AMSA 2015 procedures. Cylindrical slices (10mm x 10mm) were taken from each sausage. Each slice underwent a two cycle compression test using a 25kg load cell. The samples were compressed to 40% of their original height with a 35mm diameter probe (SMSP/35 compression plate) and a cross head speed of 1.5mm/s.

Textural factors were measured using descriptors highlighted by Bourne, (1978). They included springiness (mm): the samples' ability to recover its original shape after the initial compression and the deforming force were removed, cohesiveness (dimensionless): extent to which the sample could be deformed prior to rupture, measured by the areas under the compression portion instead of using the total area under positive force, hardness (N): maximum force required for the initial compression of the sample and resilience (dimensionless): the ratio between the negative force input to positive force input during the first compression. The results recorded represent the average of six measurements (three independent batches x two samples).

2.6.2 Colour

Surface colour was measured on the cooked sausages. The sausages were brought to room temperature (approximately 20°C) before analysis. The sausages were cut down the middle before being analysed through colorimetry (Minolta Camera Co. Ltd., Osaka, Japan). Lightness (CIE), redness (a ± red-green) and yellowness (b ± yellow-blue) were measured. A CIE 19312º standard observer was used. The colorimeter features an 11mm – diameter aperture and D65 illuminant, calibrated by the CIE Lab colour space system using a white tile

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(C: y= 93.6, x= 0.3130, y = 0.3193). A Minolta calibration plate was used to calibrate the instrument. Colour was measured by following the guidelines for colour measurements presented by the AMSA (2012). Duplicate colour measurements were recorded on two samples from each experimental batch.

2.6.3 Cooking Loss

Sausage sample weights were recorded both before and after cooking. The differences in weights were recorded. Each sample was wrapped in aluminium foil before cooking. Before weighing, each sample was blotted with a paper towel to remove excess moisture. Cooking loss was determined as the difference between cooked and raw weights expressed as a percentage of the raw weight. The results recorded represent the average of six measurements (three independent batches x two samples).

2.7 Chemical analysis

2.7.1 Salt

The salt concentrations were measured in accordance with that reported Fox (1963). The samples were homogenised thoroughly. A 2g of sample of sausage meat was added to 100ml of dilute nitric acid solution (1.5ml conc. Nitric acid/L).

Samples were placed in a water bath at 60°C for 15mins. The sample was then titrated with 0.1M $AgNO_3$ to +255mV using a potentiometer equipped with silver and reference electrodes. During titration, a magnetic stirrer was used to assist solution mixing. A bank titration was also carried out. By means of the ratio to chloride, sodium chloride concentrations were calculated. The results recorded represent the average of six measurements (three independent batches x two samples).

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2.8 Statistical Analysis

Data obtained from the sensory trials were analysed using ANOVA – Partial Least Squares Regression (APLSR) to process the mean data accumulated from the test subjects. Data was processed using Unscrambler software version 10.3. (CAMO ASA, Trondheim, Norway). The X-matrix was designed as different age categories. The Y – matrix involved the sensory, variables of the design. The fixed effects were age cohorts and the random effects were sensory results and sausage samples. Principal components i.e. PC 1 versus PC 2 are presented (Fig. 1). Regression coefficients were analysed by Jack – knifing (Table 4) to derive significant indicators for the relationships determined in the quantitative APLSR, which is based on cross validation and stability plots.

A mixed model ANOVA was conducted in SPSS. The age*treatment interaction was measured. The fixed effects included treatments and panellist's ages. The batches, panellists and sessions were included as random effects. All datasets were subjected to descriptive analysis and tests for normality (Shapiro-Wilk test), Independence and Equality of Variances (Levene's test) were performed. The assumptions of the relevant statistical tests were satisfied in all cases. Tukeys HSD post hoc test was used to determine significant differences within the groups. The results can be viewed in Table 3. Proximate (Table 5) and physical (Table 6) data are presented as the mean values ± standard error of the mean (SEM). One-way ANOVA was used to examine the data from proximate and physical analysis. Tukey's post-hoc test was used to adjust for multiple comparisons between treatment means using. All statistical analysis was carried out using the SPSS 11.0 software package for Windows (SPSS, Chicago, IL, USA).

3. Results and discussion

3.1 Fat and Pea extract

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The interactions between sensory results on treatment, age, session, batch and panellists is illustrated in Table 3. As expected age and panellists both caused significant effects on the sensory analysis results. The results of the breakfast sausage consumer sensory evaluation (n=228) can be viewed in Table 4. The sensory data figures are presented in the PCA plot in Fig. 1. From this plot it can be seen that the 18-40 yr. olds focused on texture attributes such as coarseness, texture and toughness. The 41-65 yr. olds were associated predominantly with flavour attributes such as flavour, meat flavour and spiciness. The 65+ age cohort were more focused on the visual presentation of the sausages. They focused more on colour than the other age cohorts.

Table 4 presents the 18-40 year old age group as accepting the samples containing 20% fat; (F20,S0,RNa1.13) ($P \leq 0.01$), (F20,S1,RNa0) ($P \leq 0.001$) and (F20,S0,RNa1) ($P \leq 0.001$). There were trends towards negative correlations for the acceptability of the 15% fat sausages. This age group statistically ($P \leq 0.01$) did not accept the lower fat sample; (F15,S0,RNa1) for meat flavour. The 41-64 year old age group accepted the sausages containing 15% fat; (F15,S0,RNa1.13) ($P \leq 0.001$), (F15,S1.13,RNa0) ($P \leq 0.05$) and (F15,S0,RNa1) ($P \leq 0.01$).

Panellists aged between 18-40 years of age preferred sausages formulated with 20% ((F20,S0,RNa1.13) ($P \leq 0.01$), (F20,S1,RNa0) ($P \leq 0.001$) and (F20,S0,RNa1) ($P \leq 0.001$) over those formulated with 15% fat and which were deemed to be unacceptable by this age cohort on the basis of meat flavour. However, panellists aged between 41-64 years of age had a greater acceptance for sausages containing 15% fat ((F15,S0,RNa1.13) ($P \leq 0.001$), (F15,S1.13,RNa0) ($P \leq 0.05$) and (F15,S0,RNa1) ($P \leq 0.01$)) as can be seen in Table 4.

Panellists in the 65+ age category only had a trend towards acceptance for the control sample (F30,S2.5,RNa0). This had the highest fat in all of the sausage formulations. Similar results were observed in the research of Schiffman et al. (1998), who also found elderly require a higher amount of fat to detect its presence. It was found that fat detection thresholds ranged

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from 5.3% (vol/vol) in young adults to 15.8% (vol/vol) in elderly (Schiffman, et al., 1998). Panellists in the 65+ age group disliked the reduced fat sample (F20,S0,RNa1) ($P \leq 0.001$). This was due to a dislike for the products texture ($P \leq 0.001$). In a study carried out by Rolls et al., (1997) it was found that elderly consumers rated the sensory properties of fat, such as taste and texture as major determinants when consuming foods. However, this finding does not agree with the results of (Warwick & Schiffman, 1990) who found that fat content did not influence the elderly's perception of foods. In this study the 18-40 year olds preferred the 20% sausages, the 41-64 year olds preferred the 15% fat sausages and the 65+ age group preferred the 30% fat sausage.

The control sample (F30,S2.5,RNa0) was linked with saltiness ($P \leq 0.001$), spiciness ($P \leq 0.01$) and meat flavour ($P \leq 0.01$) by the 65+ age group. High fat is hypothesised to enhance meaty flavour (Keeton, 1994). The reduced fat samples (F15,S0,RNa1), (F15,S1.13,RNa0), (F20,S0,RNa1.13) and (F20,S1.13,RNa0) were not perceived as having a coarse texture by the 65+ age cohort, whereas the control sample was associated with a coarse texture. This result was unexpected as fat is thought to induce a lubricated texture to meats and meat products. Previous research has shown a decrease in textural acuity in those over the age of 65 (Conroy, O'Sullivan, Hamill, & Kerry, 2017).

Colour which was rated 'extremely dislike' to 'extremely like' was perceived very differently among the three age groups. The 18-40 age cohort did not like the colour of the samples containing 20% fat: (F20,S0,RNa1.13) ($P \leq 0.01$), (F20,S1,RNa0) ($P \leq 0.001$) and (F20,S0,RNa1) ($P \leq 0.001$). They had a preference for one of the samples containing 15% fat; (F15,S0,RNa1) ($P \leq 0.001$). The 41-65 age group disliked the samples containing 15% fat for colour: (F15,S0,RNa1.13) ($P \leq 0.001$), (F15,S0,RNa1) ($P \leq 0.01$) and (F15,S1.13,RNa0) ($P \leq 0.01$). These results disagree with those of Chan & Kane-Martinelli., (1997) who examined the effect of food colouring on perceived flavour intensity and acceptability ratings

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in samples of chicken bouillon and chocolate pudding. These foods were presented with no colour added, with the normal level of food colouring, or with twice the normal level of colour added. The results indicated that younger adults (20 to 35 years of age) were more affected by the presence of food colouring than the older adults (60 to 90 years of age). The younger age group's judgment of the overall flavour intensity of the chicken bouillon was influenced by the quantity of colouring added to the sample (Chan & Kane-Martinelli, 1997). The senior citizen age cohort: the 65+ age group favoured the colour of all samples particularly sample (F20,S1.13,RNa0) ($P \leq 0.05$). However, this was not the case for the control sample. In this study the younger adults (18-40) inversely associated colour with acceptability.

Pea extract was only absent from the control group. There are no indications that this affected the acceptability of the sausages for the 18-40 or the 41-64 age groups. Similar results can be observed in the work of Pietrasik & Janz, where consumer acceptance of low fat bolognas, extended with pea starch and fibre fractions was equivalent to the higher fat formulations (Pietrasik & Janz, 2010). It did however have an effect on the acceptability of the sausage for the 65+ age group. This age group positively ($P \leq 0.05$) correlated only the control sample for acceptability. The rest of the samples were not perceived as acceptable. This finding contradicts the work of Kälviäinen, Roininen, & Tuorila (2003), where it was found, that provided the ease of eating criterion is fulfilled, the elderly were more diverse in their texture likes than the young. Food neophobia is defined as the reluctance to try new or novel foods is often associated with the elderly (Otis, 1984). The elderly have established their patterns of eating over many years, and they dislike change, for security is achieved through the maintenance of rigidly led attitudes and rituals in which food acceptances play a large part (Horwath, 1991). Many studies suggest that a compensatory strategy by changing food texture is needed for the elderly (Ship, Duffy, Jones, & Langmore, 1996; & Forde &

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Delahunty, 2004). However, as this paper suggests, factors such as sensory changes due to aging and food neophobia should be taken into consideration when developing such compensatory strategies.

3.2 Salt and the reduced sodium salt

From the data in Table 4, it is apparent that the 18-40 year old age group liked the control sample (F30,S2.5,RNa0) for spiciness ($P \leq 0.01$), flavour ($P \leq 0.001$), juiciness ($P \leq 0.05$) and meat flavour ($P \leq 0.001$). Salt is proven to be a flavour enhancer as suggested by Breslin, & Beauchamp (1995). This age group did not accept the higher level of reduced sodium salt (1.13%) as they negatively correlated sample (F15,S0,RNa1.13) for spiciness ($P \leq 0.001$), flavour ($P \leq 0.05$) and juiciness ($P \leq 0.05$). They did however positively correlate this sample for meat flavour ($P \leq 0.01$). Knaapila et al., (2016) found that regular users of a flavour rated its odour as more pleasant and familiar than did non-users. The 18-40 year age group favoured the flavour of the 0% reduced sodium salt sample. They associated sample (F15,S1.13,RNa0) with a positive flavour ($P \leq 0.001$). They did not perceive this sample as being spicy ($P \leq 0.001$) or having a meat flavour ($P \leq 0.001$).

There were no significant differences observed in the 41-65 age group in respect to the addition of the reduced sodium salt, with the exception of sample (F20,S0,RNa1) which was statistically positively associated with spiciness ($P \leq 0.05$). The 65+ age category associated the control sample containing 2.5% salt and the 0% reduced sodium salt sample with spiciness ($P \leq 0.001$), flavour ($P \leq 0.01$) and meat flavour ($P \leq 0.01$). The control sample was this age cohort's preferred sample. They did not associate any other samples with flavour. The findings of the current study are consistent with those of Laureati, Pagliarini, Calcinoni, & Bidoglio,. (2006a) who found that elderly tend to confine food preference evolution to childhood, a life stage where people form their food preferences when (n=48) institutionalised elderly aged between 57 and 98 were analysed. It was also found that

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simple-cooking, tradition and sensory aspects were the most important factors influencing elderly's preference for traditional foods. (Horwath, 1991) stated that the eating habits of elderly people are extremely difficult to change.

There are many studies examining the age related differences of varying NaCl levels in foods; Drewnowski, Henderson, Driscoll, & Rolls,. (1996) found that older subjects preferred less salty soups than did young adults. Jos Mojet, Heidema, & Christ-Hazelhof (2003) found that the perception of salt diminishes with age in varying solutions of NaCl dissolved in water. Murphy & Withee,. (1986) demonstrated a preference for high concentrations of NaCl in vegetable juices compared to the younger subjects examined. Younger subjects outperformed the elderly in an intensity discrimination of NaCl dissolved in tomato soup (Stevens, Cain, Demarque, & Ruthruff,. 1991).An increase preference for stronger flavours in elderly subjects compared to younger age groups was found by Schiffman & Warwick (1993) whereby elderly subjects in a retirement home using flavour enhanced foods and unenhanced foods was analysed. It was found that the subjects ate more of the enhanced foods and less of the unenhanced foods. Schiffman,. (1998) also reported that the addition of MSG in foods improved food intake of hospital patients (n=43).The elderly age cohort (65+) did not like the flavour of the low salt sausages; (F15,S0,RNa1) ($P \leq 0.001$), (F20,S0,RNa1.13) ($P \leq 0.01$) & (F20,S0,RNa1) ($P \leq 0.05$). This age cohort correlated the low salt sausages with a low intensity of saltiness on the intensity scale. Whereas, they associated the control sample intensity attributes such as spiciness and meat flavour. The elderly age cohort also rated the 0% salt samples as having an unpleasant texture. These results agree with work previously carried out by Tobin et al., (2013) who found lowering salt levels increase the coarse mouth feel of sausages to consumers. A number of studies have linked reducing salt with an undesired texture in a range of pork meat products such as frankfurters (Mcgough, Sato, Rankin, & Sindelar, 2012) and salami (Zanardi, Ghidini, Conter, & Ianieri, 2010).

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3.3 Proximate Compositional Analysis

Proximate Compositional Analysis is presented in Table 5. Protein content differed within the samples. The control sample (F30,S2.5,RNa0) featured a statistically ($P \leq 0.05$) lower protein content than the other samples. This sample was the only sample that did not have pea extract included in its formulation. Thus, it can be concluded pea extract influences the protein content of sausages, when added at a level of 0.5%. All of the other samples protein levels did not differ statistically, except for sample (F20,S0,RNa1). Meat protein content was held constant in all of the samples, indicating that the slight increase in overall protein content in all the samples (except the control sample) was a function of proteins present in the pea extract. Similar results were found in the work of Pietrasik & Janz,. (2010) who found that pea and wheat flours raised the protein levels of low fat bologna sausages.

As expected the fat level in the control sample (F30,S2.5,RNa0) was statistically ($P \leq 0.05$) different to the rest of the samples. This sample contained 30% fat. The samples containing 15% fat were all categorised as being statistically the same. So too were the samples containing 20% fat. Salt levels varied statistically ($P \leq 0.05$) between the 2.5%, 1.13% 1% and the 0% salt formulations. Ash levels were also statistically ($P \leq 0.05$) higher in the control sample (F30,S2.5,RNa0). This was expected as the salt levels were also higher in this sample.

3.4 Physical analysis

The physical analysis of the cooked breakfast sausages are presented in Table 6. High values of cooking loss were noted in samples higher in fat. Significant differences were observed between samples in the three fat levels; 30%, 20% and 15%. Similar results have been noted in previous studies & (Hughes, Cofradesb, & Troy, 1997; Choi et al., 2009; & Tobin et al., 2013), whereby the higher the fat content, the greater the cooking loss in processed pork meat products. Cooking loss has being found to decrease with increasing amounts of starch (Pietrasik & Janz, 2010). Salt content is known to affect cooking loss. Ruusunen, Särkkä-

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Tirkkonen, & Puolanne,. (2001) reported that cooked ham with added salt levels below 1.4% had higher cook losses compared to hams with salt levels greater than 1.7% The control sample featured the most salt (2.5%). This sample had statistically ($P \leq 0.05$) reduced cook loss compared to the other samples. Fat was found to have more of an influence on cook loss than salt in this study.

The colour of the sausages varied. Hunter Lab values indicated the L value was statistically ($P \leq 0.05$) different in the control sample. Thus, the control featured a statistically lighter value than the other samples. The 15% fat samples containing the reduced sodium salt at 1.13% and 1% were not statistically different from each other in terms of colour. The L values (lightness) of the final products were directly proportional to the fat content. The high fat products (30%) were lighter than the low fat ones (15% & 20%). This result was predicted as the increase in the quantity of the white fat does contribute to the increase in L value while a reduction in fat level generally favours the appearance of darker colourings (higher redness values and lower lightness values). When the fat content is reduced in processed meat products they become darker (Hughes, Cofrades, & Troy, 1997), (Morin, Temelli, & McMullen, 2004) & (Pietrasik, 1999). However, Ahmed, Miller, Lyon, Vaughters, & Reagan,. (1990) suggested that lightness values in fresh pork sausage are unaffected by simultaneous reduction in fat content and increase in water content because visual appearance is sustained. There were no significant differences observed between treatments for the a and the b Hunter values in this study.

Texture profile analysis of the samples as measured by a texture analyser illustrates a range of correlations throughout the products. The lower fat sausages were found to be harder than the control sausage; samples (F15,S0,RNa1.13) (F15,S1.13,RNa0) and (F15,S0,RNa1) did not differ statistically ($P \leq 0.05$). Sample (F20,S0,RNa1) was also statistically the same. This may be due to the lack of salt in the sample. Samples (F20,S1.13,RNa1) and (F20,S1,RNa0)

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were also statistically the same ($P \leq 0.05$) for hardness. Many researchers have found low-fat pork products to be tougher than higher-fat ones (Bloukas, Paneras, & Fournitzis, 1997) & (Barbut & Mittal, 1996).Varying levels of the reduced sodium salt concentrations had no difference on hardness.

The control sample was statistically ($P \leq 0.05$) different in resilience compared to the other samples. Samples (F15,S0,RNa1.13), (F15,S1.13,RNa0), (F20,S0,RNa1.13), (F20,S1.13,RNa1) and (F20,S1,RNa0) all had statistically ($P \leq 0.05$) similar results for resilience and protein. Fat may also contribute to resilience; Samples (F15,S0,RNa1.13), (F15,S1.13,RNa0) and (F15,S1,RNa0) also were statistically the same for resilience, protein and fat. A similar result was also noted in samples (F15,S0,RNa1) and (F15,S1,RNa0). In meat products, fat contributes to the flavour, texture, mouth feel and overall sensation of lubricity of the product. Fat reduction can therefore statistically affect the toughness of meat products (Barbut & Mittal, 1996).

Protein influences the springiness of meat products (Youssef & Barbut, 2011). This was also found in this study. The control sample had the lowest protein content (12.5 ± 0.02) and this sample was statistically ($P \leq 0.05$) different in terms of springiness. Samples (F15,S0,RNa1.13), (F20,S0,RNa1.13), (F20,S1.13,RNa1) and (F20,S1,RNa0) all were statistically ($P \leq 0.05$) the same in terms of springiness. They also were statistically ($P \leq 0.05$) the same in terms of protein content. The same was observed for samples (F15,S1.13,RNa0), (F15,S0,RNa1) and (F15,S0,RNa1).

Fat has also been demonstrated to influence the springiness of sausages. The decreased springiness is proportional to the reduction in fat and these differences were significant ($P \leq 0.05$) between the batches. The control sample (F30,S2.5,RNa0) had a statistically ($P \leq 0.05$) higher fat content than the other samples. This in turn influenced the springiness of the sample. Samples (F15,S0,RNa1.13), (F15,S1.13,RNa0), (F15,S0,RNa1) and

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(F15,S1,RNa0) all were statistically ($P \leq 0.05$) the same for springiness and fat content. The same trend is observed in samples (F20,S0,RNa1.13) & (F20,S1.13,RNa1) where they were statistically the same for springiness and fat. Similar studies have demonstrated that fat influences springiness in sausages (Mendoza, García, Casas, & Selgas, 2001) & (Keeton, 1994), however in contrast there are some studies to suggest that fat has no significant effect on springiness (Pietrasik, 1999) & (Hughes et al., 1997). The increase in springiness may also be due to a reduction in the moisture content. Springiness is directly proportional to moisture contents in the samples. Springiness was found to increase when moisture was reduced in scalded sausages (Pietrasik, 1999).

The highest cohesiveness values were associated with the control sample (F30,S2.5,RNa0). This sample featured the highest fat and salt content, both of which have been demonstrated to increase cohesiveness. Salt was statistically ($P \leq 0.05$) the same for samples (F15,S0,RNa1.13), (F15,S0,RNa1) and (F20,S0,RNa1). Cohesiveness was also statistically ($P \leq 0.05$) the same for these samples. Fat content also influenced cohesiveness as can be seen in sample (F20,S0,RNa1.13) and sample (F20,S1.13,RNa1). In this study cohesiveness was statistically ($P \leq 0.05$) higher in the 30% fat sample compared to the rest of the samples. Opposite results have been observed by (Pietrasik, 1999) whereby cohesiveness tended to decrease as fat content was increased from 15% to 25% in sausages. The 30% fat sample was the only sample not to have pea extract this may be a contributing factor to the differences in cohesiveness also.

4. Conclusions

This research demonstrates various preferences for varying salt and fat formulations from three different age categories. Texture attributes influenced the younger age categories choice in sausage formulation, flavour and its associated attributes influenced the 41-64 year olds choice of sausage formulation, whereas visual aspects such as colour were the main driving

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force influencing the >65 yr. olds choice. This study provides evidence that salt concentrations in sausages, and possibly other processed meats, may be reduced without having an impact on the sensory aspects perceived by consumers of certain age cohorts. Reducing the levels of fat by adding pea extract caused varying results between all three age cohorts, especially with respect to product flavour and texture. Pea extract may be used in further reformulations of food products to increase protein content. This research suggests that those aged 41-64 are more accepting of novel formulations. This information can be used to develop tailor made food products with our 'future' elderly consumer in mind. This research demonstrates different preferences and dislikes for various attributes presented by the reformulation of a traditional meat product based on the age of panellists consuming them.

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Table 1: Sausage formulation table

Sample	RNS (%)	Fat (%)	Pork (%)	Water (%)	Rusk (%)	NaCl (%)	Pea Extract (%)	Seasoning (%)
F30,S2.5,RNa0	0	30	35	17.5	12.50	2.50	0	2.50
F15,S0,RNa1.13	1.13	15	35	33.37	12.50	0	0.5	2.50
F15,S1.13,RNa0	0	15	35	33.37	12.50	1.13	0.5	2.50
F15,S0,RNa1	1	15	35	33.5	12.50	0	0.5	2.50
F15,S1,RNa0	0	15	35	33.5	12.50	1	0.5	2.50
F20,S0,RNa1.13	1.13	20	35	28.37	12.50	0	0.5	2.50
F20,S1.13,RNa0	0	20	35	28.37	12.50	1.13	0.5	2.50
F20,S0,RNa1	1	20	35	28.5	12.50	0	0.5	2.50
F20,S1,RNa0	0	20	35	28.5	12.50	1	0.5	2.50

F: % of Fat, S: % of NaCl, RNa: % Reduced Na salt

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Table 2: Intensity sensory attributes

Descriptor	Explanation	Reference
Spiciness	Heat/chili like sensation	Chili flavoured crisps/snacks
Coarseness	Consistency not uniform – oat like texture	Pin head rusk/rolled oats
Toughness	Rubbery/tough texture	Similar texture to squid
Juiciness	Moist perception in mouth	Biting into an orange
Meat Flavour	Taste sensation typically associated with meat (Umami)	Meat broth like flavour
Off Flavour	Unpleasant rancid taste sensation	Oxidised meat flavour
Saltiness	Perception typically associated with NaCl	Table salt

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Table 3: Significance of relationships between sensory descriptors, fixed (treatment, age and treatment*age interaction) and random factors (session, batch and panellist)

Sensory	Texture	Saltiness	Spiciness	Flavour	Colour	Acceptability	Coarseness	Toughness	Juiciness	Meat flavour	Off flavour
Treatment	0.155 ns	0.663 ns	0.061 ns	0.650 ns	0.565 ns	0.091 ns	0.252 ns	0.001 **	0.546 ns	0.879 ns	0.149
Age	0.004 **	0.000 ***	0.000 ***	0.194 ns	0.000 ***	0.000 ***	0.001 ***	0.003 **	0.076 ns	0.000 ***	0.004
Age * Treatment	0.933 ns	0.340 ns	0.233 ns	0.763 ns	0.232 ns	0.502 ns	0.563 ns	0.961 ns	0.671 ns	0.593 ns	0.994
Session	0.000 ***	0.000 ***	0.000 ***	0.933 ns	0.000 ***	0.000 ***	0.000 ***	0.000 **	0.000 ***	0.000 ***	0
Batch	0.746 ns	0.047 ns	0.249 ns	0.492 ns	0.534 ns	0.850 ns	0.847 ns	0.600 ns	0.937 ns	0.598 ns	0.999
Panellist	0.000 ***	0.000 ***	0.000 ***	0.075 ns	0.000 ***	0.000 ***	0.000 ***	0.000 **	0.000 ***	0.000 ***	0

Significance of regression coefficients; ns = non-significant, * = ($P \leq 0.05$), ** = ($P \leq 0.01$), *** = ($P \leq 0.001$)

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Table 4: *P* values of estimated regression coefficients (ANOVA values) for the relationships terms of sensory terms and sausage formulations (Table

Age (yrs.)	Formulation	Hedonic Attributes				Intensity Attributes						
		Texture	Flavour	Acceptability	Colour	Spiciness	Coarseness	Toughness	Juiciness	Meat Flavour	Off Flavour	Saltiness
18-40	F30%, S2.5% RNa0%	0.0167 *	0.00031 ***	0.1692 ns	0.54574 ns	9.88E-10 ***	0.05095 *	0.31053 ns	0.04874 *	0.00033 ***	0.29445 ns	0.56148 ns
	F15%, S0% RNa1.13%	-0.4085 ns	-0.01965 *	-0.80823 ns	0.27775 ns	-0.00015 ***	-0.2979 ns	-0.43632 ns	-0.68597 *	0.01042 **	0.66283 ns	-0.88148 ns
	F15%, S1%, RNa0%	-0.10738 ns	-0.80909 ns	-0.12525 ns	0.15832 ns	-0.8234 ns	-0.25476 ns	-0.43632 ns	-0.68597 ns	-0.84273 ns	-0.268267 ns	-0.26322 ns
	F15%,S0%, RNa1%	-0.07344 ns	-0.5055 ns	-0.00247 **	0.00049 ***	-0.2195 ns	-0.2092 ns	-0.62441 ns	-0.31124 ns	-0.4256 ns	-0.33735 ns	-0.1647 ns
	F15%, S1.13%, RNa0%	-0.23777 ns	0.004783 ***	-0.691231 ns	0.11247 ns	-8.20E-07 ***	-0.12835 ns	-0.490719 ns	-0.02457 ns	-7.91E-08 ***	-0.58746 ns	-0.86039 ns
	F20%, S0% RNa1.13%	0.06321 ns	0.5727 ns	0.0043 **	-0.00215 **	0.33682 ns	0.12612 ns	0.5748 ns	0.3221 ns	0.54646 ns	0.26502 ns	0.24042 ns
	F20%, S1%, RNa0%	0.03564 *	0.59476 ns	0.000127 ***	-0.000422 ***	0.46736 ns	0.17677 ns	0.55785 ns	0.38108 ns	0.65041 ns	0.2890 ns	0.12079 ns
	F20%,S0%, RNa1%	0.0373 *	0.6397 ns	0.00106 ***	-0.00049 ***	0.65964 ns	0.15136 ns	0.54834 ns	0.42553 ns	0.78607 ns	0.315131 ns	0.13307 ns
	F20%, S1.13%, RNa0%	0.91758 ns	0.32336 ns	0.72461 ns	-0.45501 ns	0.21198 ns	0.97989 ns	0.9596 ns	0.26638 ns	0.2027 ns	0.8677 ns	0.57115 ns
41-65	F30%, S2.5% RNa0%	0.46924 ns	0.3727 ns	0.27368 ns	-0.1154 ns	0.12442 ns	0.56988 ns	0.78316 ns	0.28020 ns	0.21810 ns	0.51268 ns	0.40233 ns
	F15%, S0% RNa1.13%	0.07409 ns	0.4774 ns	0.00032 ***	-1.50E-06 ***	0.11627 ns	0.1817 ns	0.6158 ns	0.27242 ns	0.34681 ns	0.28409 ns	0.20514 ns
	F15%, S1%, RNa0%	0.82714 ns	0.20766 ns	0.93396 ns	-0.50119 ns	0.09873 ns	0.69694 ns	0.75291 ns	0.22950 ns	0.13573 ns	0.92144 ns	0.8155 ns
	F15%,S0%, RNa1%	0.0845 ns	0.4326 ns	0.01354 **	-0.00376 **	0.1102 ns	0.38228 ns	0.69447 ns	0.2073 ns	0.25845 ns	0.42820 ns	0.14659 ns
	F15%, S1.13%, RNa0%	0.19205 ns	0.41486 ns	0.029041 *	-0.00723 **	0.12818 ns	0.400296 ns	0.72459 ns	0.18573 ns	0.27238 ns	0.45165 ns	0.18635 ns
	F20%, S0% RNa1.13%	0.65612 ns	0.78773 ns	0.651712 ns	-0.687 ns	0.90138 ns	0.72724 ns	0.73161 ns	0.74769 ns	0.90535 ns	0.68328 ns	0.5991 ns
	F20%, S1%, RNa0%	0.61006 ns	0.5845 ns	0.71796 ns	-0.94009 ns	0.41124 ns	0.60515 ns	0.57832 ns	0.6636 ns	0.41803 ns	0.66281 ns	0.77234 ns
	F20%,S0%, RNa1%	0.68769 ns	0.22422 ns	0.35634 ns	-0.08664 ns	0.02144 *	0.90023 ns	0.97065 ns	0.13907 ns	0.0647 ns	0.71754 ns	0.31706 ns
	F20%, S1.13%, RNa0%	0.21089 ns	0.46139 ns	0.27773 ns	0.64706 ns	0.09182 ns	0.10698 ns	0.34268 ns	0.55881 ns	0.13807 ns	0.18466 ns	0.51969 ns
65+	F30%, S2.5% RNa0%	0.11575 ns	0.01972 **	0.39158 ns	-0.73198 ns	0.00036 ***	0.15225 ns	0.3265 ns	0.11512 ns	0.00829 **	0.38581 ns	0.66207 ns
	F15%, S0% RNa1.13%	-0.75669 ns	-0.33435 ns	-0.53192 ns	0.22299 ns	-0.22638 ns	-0.84924 ns	-0.91031 ns	-0.19676 ns	-0.25355 ns	-0.73385 ns	-0.53993 ns
	F15%, S1%, RNa0%	-0.50712 ns	-0.42847 ns	-0.36381 ns	0.18934 ns	-0.21697 ns	-0.53043 ns	-0.74651 ns	-0.29194 ns	-0.35097 ns	-0.51284 ns	-0.47958 ns
	F15%,S0%, RNa1%	-0.06648 ns	-0.00321 ***	-0.224 ns	0.70133 ns	-0.00043 ***	-0.0549 *	-0.32800 ns	-0.07817 ns	-0.00107 ***	-0.25629 ns	-0.5614 ns
	F15%, S1.13%, RNa0%	-0.02847 *	-0.04195 *	-0.09249 ns	0.75073 ns	0.00012 ***	-0.05055 *	-0.32174 ns	-0.17944 ns	0.00579 **	-0.20994 ns	-0.3239 ns
	F20%, S0% RNa1.13%	-0.05300 *	-0.00467 **	-0.13338 ns	0.92921 ns	-0.00021 ***	-0.04256 *	-0.3238 ns	-0.10749 ns	-0.00261 **	0.23665 ns	-0.48956 ns
	F20%, S1%, RNa0%	-0.83869 ns	-0.12804 ns	-0.86047 ns	0.35164 ns	-0.018 *	-0.70643 ns	-0.77475 ns	-0.07841 ns	-0.07681 ns	-0.9598 ns	-0.70876 ns
	F20%,S0%, RNa1%	-0.03684 *	-0.01942 *	-0.05451 *	0.821491 ns	-4.21E-05 ***	-0.00035 ***	- 0.27284 ns	-0.15234 ns	-6.16E-05 ***	-0.19077 ns	-0.44219 ns
	F20%, S1.13%, RNa0%	-0.10527 ns	- 0.002297 **	-0.2428 ns	0.7947 ns	-0.00058 ***	-0.03375 *	-0.30372 ns	-0.11755 ns	-0.00047 ***	-0.26457 ns	-0.58713 ns

2) as derived by Jack – knife uncertainty testing for sausages

The sign dictates whether the correlation is positively or negatively correlated significance of regression coefficients; ^{ns} = non-significant,

* = ($P \leq 0.05$), ** = ($P \leq 0.01$), *** = ($P \leq 0.001$). ºF: % of fat, S: % of NaCl, RNa: % of Reduced Na salt

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Table 5: Proximate compositional analysis values for cooked breakfast sausages of varying fat and salt content, whereby the percentage mean is presented ± the standard deviation

Sample	Protein (%)	Fat (%)	Moisture (%)	Ash (%)	Salt (%)	Carbohydrate (%)
F30,S2.5,RNa 0	12.5 ± 0.02^{a}	28.5± 0.04^{c}	43.7 ± 0.24^{a}	3.3 ± 0.07^{e}	1.0 ± 0.00^{d}	12.1 ± 0.35^{f}
F15,S0,RNa1.13	19.7 ± 0.18^{b}	16.5 ± 0.03^{a}	52.2 ± 0.02^{d}	1.6 ± 0.02^{ab}	0.5 ± 0.00^{c}	9.9 ± 0.13^{de}
F15,S1.13,RNa0	19.9 ± 0.04^{b}	16.3 ± 0.20^{a}	51.6 ± 0.03^{d}	2.4 ± 0.07^{d}	0.1 ± 0.00^{a}	9.8 ± 0.08^{de}
F15,S0,RNa1	19.7 ± 0.02^{b}	16.3 ± 0.04^{a}	51.7 ± 0.02^{d}	1.5 ± 0.04^{a}	0.5 ± 0.00^{c}	10.8 ± 0.09^{ef}
F15,S1,RNa0	20.1 ± 0.04^{bc}	16.4 ± 0.19^{a}	51.9 ± 0.01^{d}	2.5 ± 0.04^{d}	0.4 ± 0.00^{b}	9.2 ± 0.14^{cd}
F20,S0,RNa1.13	19.9 ± 0.06^{b}	25.7 ± 0.01^{b}	45.5 ± 0.02^{bc}	2.4 ± 0.01^{d}	0.5 ± 0.00^{c}	6.6 ± 0.08^{a}
F20,S1.13, RNa1	19.7 ± 0.01^{b}	25.6 ± 0.04^{b}	44.9 ± 0.24^{b}	1.9 ± 0.01^{c}	0.1 ± 0.00^{a}	8.0 ± 0.27^{bc}
F20,S0,RNa1	20.5 ± 0.01^{c}	25.7 ± 0.06^{b}	45.3 ± 0.20^{bc}	1.8 ± 0.01^{bc}	0.5 ± 0.00^{c}	6.7 ± 0.25^{a}
F20, S1,RNa0	20.0 ± 0.02^{b}	25.6 ± 0.05^{b}	45.9 ± 0.15^{c}	1.6 ± 0.01^{ab}	0.4 ± 0.00^{b}	7.0 ± 0.05^{ab}

^{abcde} Mean values (± SEM) in the same column that do not share a common superscript are significantly different, $P \leq 0.05$.

F: % of Fat, S: % of NaCl, RNa: % of Reduced Na salt

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Table 6: Physical analysis and cook loss values for breakfast sausages of varying fat and salt content whereby the percentage mean is presented ± the standard deviation

Sample	Colour				Texture Profile Analysis			
	L (n/a)	a	b	Cooking Loss (%)	Springiness (mm)	Cohesiveness (N)	Hardness (N)	Resilience (n/a)
F30,S2.5, RNa0	40.4 ± 0.03^{g}	4.4 ± 0.04$^{ns•}$	15.1 ± 0.12^{ns}	24.3 ± 0.04^{e}	0.8 ± 0.01^{a}	0.9 ± 0.37^{d}	13.1 ± 0.07^{a}	0.2 ± 0.00^{a}
F15,S0,RNa1.13	20.7 ± 0.07^{c}	3.0 ± 0.34^{ns}	12.9 ± 0.62^{ns}	16.4 ± 0.16^{b}	0.9 ± 0.01^{bcde}	0.7 ± 0.29^{bc}	23.4 ± 0.11^{d}	0.3 ± 0.00^{bcd}
F15,S1.13,RNa0	18.5 ± 0.06^{a}	3.8 ± 0.23^{ns}	15.1 ± 0.83^{ns}	16.7 ± 0.10^{bc}	1.0 ± 0.01^{de}	0.7 ± 0.29^{c}	23.6 ± 0.12^{d}	0.3 ± 0.00^{cde}
F15,S0,RNa1	21.4 ± 0.03^{c}	4.4 ± 0.04^{ns}	11.1 ± 0.12^{ns}	15.2 ± 0.12^{a}	1.0 ± 0.00^{e}	0.6 ± 0.24^{b}	23.1 ± 0.07^{d}	0.3 ± 0.0^{e}
F15,S1,RNa0	25.7 ± 0.03^{e}	2.7 ± 0.03^{ns}	13.1 ± 0.21^{ns}	15.2 ± 0.11^{a}	0.9 ± 0.02^{de}	0.6 ± 0.24^{b}	16.7 ± 0.13^{b}	0.3 ± 0.02^{ed}
F20,S0,RNa1.13	27.7 ± 0.09^{f}	4.5 ± 0.17^{ns}	14.8 ± 0.34^{ns}	20.5 ± 0.04^{d}	0.9 ± 0.01^{b}	0.4 ± 0.16^{a}	16.5 ± 0.13^{b}	0.3 ± 0.00^{bc}
F20,S1.13,RNa1	25.6 ± 0.12^{e}	4.1 ± 0.17^{ns}	13.9 ± 0.29^{ns}	19.7 ± 0.10^{d}	0.8 ± 0.01^{b}	0.5 ± 0.20^{a}	21.5 ± 0.13^{c}	0.3 ± 0.00^{bc}
F20,S0,RNa1	23.6 ± 0.12^{d}	2.9 ± 0.24^{ns}	11.7 ± 0.31^{ns}	17.5 ± 0.12^{c}	0.9 ± 0.01^{c}	0.6 ± 0.24^{b}	23.3 ± 0.15^{d}	0.3 ± 0.00^{b}
F20,S1,RNa0	19.5 ± 0.05^{b}	3.2 ± 0.22^{ns}	11.8 ± 0.24^{ns}	20.4 ± 0.16^{d}	0.9 ± 0.01^{bcd}	0.7 ± 0.29^{c}	21.2 ± 0.06^{c}	0.3 ± 0.00^{bc}

^{abcde} Mean values (± SEM) in the same column that do not share a common superscript are significantly different, $P \leq 0.05$.

^{ns} = non-significant

n/a = measurement is non applicable

F: % of Fat, S: % of NaCl, RNa: % of Reduced Na salt

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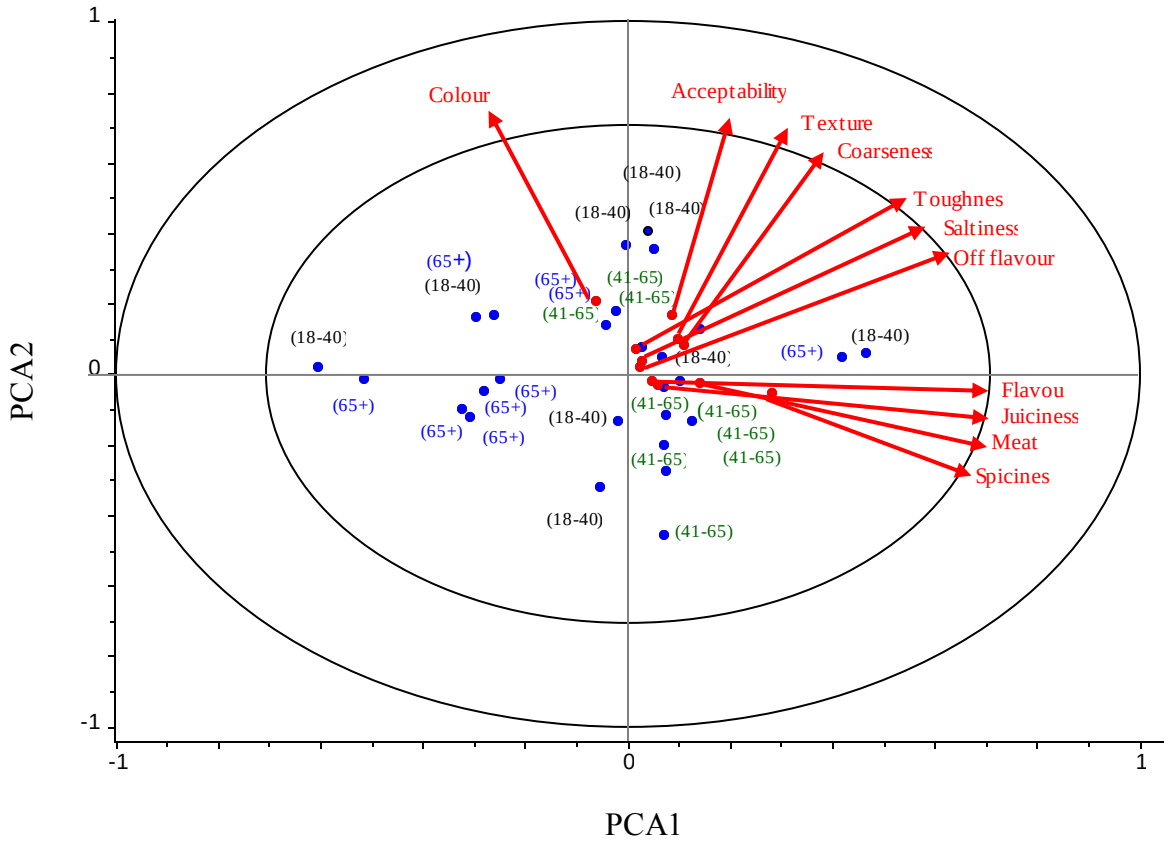

Figure 1. ANOVA – partial least squares regression (APLSR) correlation loading plot for each sensory descriptor and age category

This figure illustrates the loadings of the X and Y variables for the first two PCs.

Black: 18- 40 year olds, Green: 41-64 year olds Blue: 65+

= Sensory descriptors

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