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Sodium and Saturated Fat Levels in Meat Products in the Netherlands: An Evaluation Based on Label Information

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Authors' contributions

This work was carried out in collaboration between all authors. Authors SJCMJ, KJJN, HV and AJCR designed the study and wrote the protocol. Authors SJCMJ, KJJN and AJCR managed and controlled the data. Authors SJCMJ and ED collected the data. Author SJCMJ performed the statistical analysis, managed the literature searches and wrote the first draft of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Aim: To collate and analyse label information on nutrients for meat products (used as sandwich fillings) in the Netherlands, using a standardised methodology established by the Global Food Monitoring Group. The objective was to compare levels of saturated fat (in g/100 grams) and sodium (in mg/100 grams) from 2011-2015 and to evaluate reformulation targets for sodium and saturated fat levels that were due to be met by January 1, 2015.
Study Design: Data collection study.

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Place and Duration: Data collection in two supermarkets in the Netherlands for one month.
Methodology: Data were collected by photographing the Nutrition Information Panels (NIPs), front-of-pack communications (Guideline Daily Amounts, health logos) and other back-of-pack information from product labels of processed foods in-store using smartphone technology. Photos were uploaded to a central database where data were entered and checked and cleaned manually. Levels of sodium and saturated fat were calculated and compared with data available from reformulation monitoring reports and with the reformulation targets of the meat sector.
Results: Data were collected for 911 processed meat products, with data available for 863 meat products after data cleaning, and 86% (n=745) displaying a NIP. Sodium levels in 2015 were similar compared to concentrations observed in previous years for all subcategories of meat products. For saturated fat, combined heated meat products' saturated fat content was 8 g/100g (SD=3) based on label information in 2015 compared with 10 g/100g (SD=3) based on the label and chemical analyses information of 2014: $P<0.001$. The percentages of products (2015) which complied with the reformulation targets ranged per product category from 14%-93% for sodium levels and 25%-88% for saturated fat levels. Only a small percentage of meats displayed a health logo (2%) or Guideline Daily Amounts (15%) on the label.
Conclusion: Based on the comparison we observed no progress with sodium reductions and little progress with saturated fat reductions in the Netherlands between 2011 and 2015 in processed meat products. In light of the Netherlands' reformulation covenant of 2014, focus on nutrient levels of meat products could contribute to help meet the national commitment to reduce sodium and saturated fat levels. This method of evaluation could also be used for other product categories to monitor progress and to ultimately decrease the burden of nutrition-associated diseases in the country.

Keywords: Label information; sodium; saturated fat; meat products; reformulation; Nutrition Information Panels (NIPs).

1. INTRODUCTION

Non-communicable diseases (NCD's), also known as chronic diseases, are globally the leading cause of premature death (63% in 2008 and 71% in 2018 of all reported deaths in the world and 89% in the Netherlands in 2014) [1-3]. NCD's are mostly attributable to poor lifestyle: over-nutrition, poor diet quality and physical inactivity being major causes [3-5]. Nowadays, the majority of the population is exposed to foods high in energy, saturated fat, added sugar and sodium [4]. The majority of food eaten in the Netherlands (and other developed countries) is processed or pre-prepared by the food industry [6]. This has led to an increased focus on the nutritional quality of processed foods [7]. To improve the tremendous burden of nutrition-related disease, the government and food industry are under increasing pressure to enhance the quality of the food supply [8].

Upon a request from the Dutch government to the food industry to come up with a single health logo, the Choices Programme was established in 2006, enabling consumers to make healthier food choices and stimulating product innovation [9]. In 2016 the programme was stopped, logos on packages are now being phased out. For a period of 10 years, products of participating food companies could carry a health logo if their products complied with nutrient criteria for sodium, trans-fat, saturated fat, caloric content and added sugars [10-12].

At the same time, the Dutch government (Ministry of Health, Welfare and Sports, VWS) has been urging the food industry to improve their products by lowering salt, saturated fat, total sugar and calories. In 2014, joint ambitions of the government and the private sector resulted in the 'agreement on improvements in product composition' (In Dutch: Akkoord Verbetering Productsamenstelling) [13], in which mandatory reformulation targets are defined to be reached before the end of 2020. For meat products, sodium levels have to be reduced by 10% for the product categories single heated (e.g. York ham, grilled bacon), combined heated (e.g. pâté, luncheon meat) and combined raw meat products (e.g. filet Americain, salami), and saturated fat levels had to be reduced by 5% for (a part of) the product category combined heated, by the beginning of 2015 (Appendix 1) [14].

The National Institute for Public Health and the Environment (RIVM) is responsible for monitoring food composition and food consumption in the

Netherlands. Traditionally, monitoring relies on national food composition tables (FCT's) with aggregated average nutritional compositions. More recently, analytic food data (carried out by the food safety authority and food sectors), as well as nutrient information provided on a voluntary basis by food companies, is used for monitoring the progress in food reformulations in the Netherlands (specifically focused on salt, saturated fatty acids and sugar contents) [15,16]. New information technologies and the provision of general principles and requirements of labelling established in the European Regulation (EU) No. 1169/2011 [17] bring opportunities to explore new methods of data collection to improve and/or simplify the accuracy and adequacy of monitoring progress at the individual product level.

One recent technological development in this area was initiated by international collaboration: the Global Food Monitoring Group (GFMG), led by The George Institute for Global Health. This group aims to collate data on nutrient information (or lack thereof) from labels of packaged foods using a standardised methodology across multiple countries [18]. Label information is collated in an (online) global branded food composition database [19]. Product evaluations can be used to drive national and international category-wide improvements in the nutritional composition of processed food products, which even if small, can deliver population health gains.

1.1 Overall Goal and Objective

The objective of this study was to evaluate recent efforts to achieve reductions in the sodium and saturated fat content in meat products in the Netherlands. The main four sub-objectives were:

1. To examine the presence of sodium/salt levels, Guideline Daily Amounts (GDA) and total Nutrition Information Panels (NIPs).
2. To determine the number and proportion of meat products in 2015 that complied with the Choices nutrient criteria for a health logo.
3. To examine the sodium and saturated fat levels in meat products in 2015.
4. To compare the sodium and saturated fat levels from 2015 to data available from existing food reformulation monitoring reports (2012 & 2014) and to assess changes over time [15,16].
5. To evaluate if the levels of sodium and saturated fat in processed meat products were in line with the reformulation targets in the Netherlands that were due to be met by January 1, 2015 (14).

2. METHODOLOGY

The applied methodology was based on an existing protocol for monitoring and evaluation of processed foods from the Global Food Monitoring Group [20].

2.1 Data Sources and Data Collection

Data were obtained by photographing the front-of-pack (FOP), Nutrition Information Panels (NIPs) and other back-of-pack (BOP) information on product labels from processed foods in-store using smartphone technology (The George Institute's Data Collector App) (Fig. 1). Collected data included barcode, brand name, product name, nutrient information per 100g, ingredient list, information on allergens and presence of serving size information, GDA and (health) logos.

During 6 days in March 2015, all relevant labelling information from the processed meat products were collected. To ensure that the collected data were a good representation of the offered supply, permission to collect the data was requested at the two largest supermarket chains in the Netherlands, which cover together 41% of the Grocery Retailers Company Shares in The Netherlands [21]. All available data for premium brand meat products were collected. Available data from 'supermarkets own label' (private label) were collected for approximately 99% in these two supermarkets.

After data collection, photos were uploaded into an online, password-protected, central branded food composition database [22] and entered manually. If photographs in the database were unreadable (<1%), data were obtained from websites where the supermarkets provide nutritional information about their products. All missing data were recorded as such. Products which only displayed product and company name without nutritional values were still included to highlight the absence of detailed data.

After entering the products, all data were screened by researchers to identify errors by comparing the data against the original photo source. Products were checked for correct product categorisation typing errors and correct nutritional values. A small number of products (*n*=48) were removed from the dataset during this process for various reasons such as duplicates, products with unclear or incomplete data or products that appeared not to belong to one of the selected product categories.

When all data were checked, a Microsoft Excel spreadsheet with all entered data was extracted from the database for further analysis.

2.2 Categorization of Foods

Data were categorized into a hierarchical structure of food groups, categories and subcategories compared with the structure of previous monitoring reports in the Netherlands [15,16] to make comparisons possible.

This categorization included only meat cold cuts and their alternatives (used as sandwich fillings). Meat preparations (fresh processed meat products e.g. ‘fresh raw beef burgers’, ‘fresh sausages’) were not included in this category due to time constraints. The meat products were evaluated in the following manner for classification: prepared products underwent a heat treatment (e.g. cooked, boiled, grilled, fried, baked, hot smoked or through hot steam). Raw meat products did not have a heat treatment, they could be smoked (cold), dried, salted, fermented or a combination of the preceding. Within products where a muscular structure could be seen, the product was singular, regardless of the meat content or added additives. Products without visual muscular structure belonged to the combined meat products, regardless of the meat content or added additives. In Table 1 the categorisation is shown.

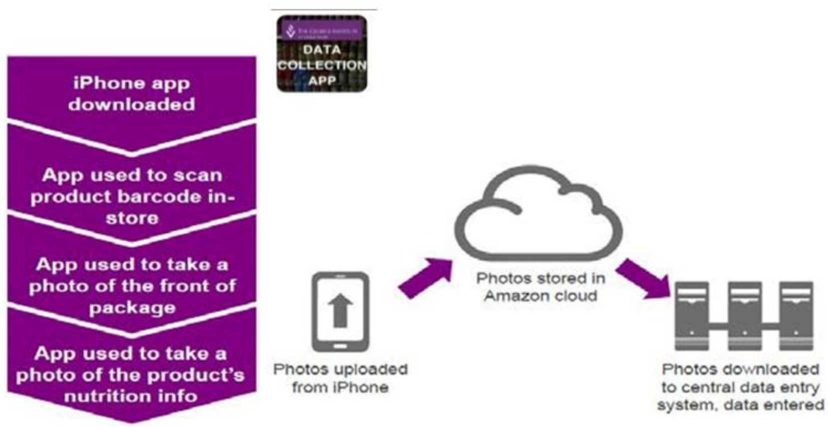

Fig. 1. Data collection process (18)

Table 1. Classification of meat products

		Examples		
Meat cold cuts and meat preparations	Meat cold cuts	Heated (prepared) meat products	Single, heated	For consumption bread: Ham, chicken breast, York ham, grilled bacon
			Combined, heated	(Hausmacher) liver sausage, pâté, Berliner, luncheon meat
		Raw meat products	Single, raw	Raw ham, carpaccio, bacon
			Combined, raw	Filet Americain, salami, chorizo
		Meat alternatives		Vegetarian liver sausage, vegetarian filet Americain, vegetarian smoked bacon
	Meat preparations*	-		Fresh processed meat products, fresh sausages

**Part of the larger product group meat cold cuts and meat preparations. Not included in this study*

2.3 Data Reporting and Analysis

2.3.1 Data cleaning

Before all data were analysed, a second cleaning step was performed. Data were checked for possible errors and corrections were made if necessary. To detect these inaccurate records from the dataset, all product groups were analysed separately (using SPSS), with descriptive statistics such as mean levels, standard deviations (SD) and ranges determined. Outliers and missing values were identified for each subcategory and amended with verification against the original NIP or information provided on the supermarket's or manufacturer's website. This process was repeated until no errors were found. In total, 11 records were identified as erroneous and corrected. During this step, no records were removed from the dataset.

2.3.2 Data analysis

The analysis was initially focused on the primary outcome measures: salt/sodium, saturated fat and the front-of- pack (FOP) communications (GDA and the Choices health logo). The presence of salt or sodium levels on the packaging was also examined. All non-numeric values (GDA and Choices health logo) from the GFMG database 2015 were assessed as being present or absent on the product packaging. For the Choices health logo, all products were specifically checked using the nutrient criteria for meat products specified by the Choices programme (in the Netherlands): sodium (≤900 mg/100g), trans fat (not added), saturated fat (≤13 en%) and added sugars (≤2.5 g/100g) For meat alternatives equivalent criteria should also be met and contain at least two of the following nutrients in sufficient amount per 100 grams of product: Vitamin A/Retinol-equivalent (70 µg), Vitamin B1 (0,11 mg), Vitamin D (0,5 µg), iron (0,8 mg), Vitamin B12 (0,24 µg) [11,23].

The baseline and progress measurements for sodium and saturated fat levels of meat products were collected from the RIVM monitoring reports in 2012 and 2014 [15,16]. These data were based on the data from the Dutch food composition database (NEVO) from 2011, 2013 and the reformulations monitor (HFM) of 2014.

For the evaluation of the reformulation targets, subcategories were created in accordance with the reformulation categorisation to allow comparison [14]. The 10% sodium reduction and 5% saturated fat reduction, which should have been achieved by the beginning of 2015, were calculated and determined by the meat covenant as maximum values per 100 grams of product. On the basis of these data, it was determined how many products were within this specified target after January 2015 [13].

2.3.3 Statistical analysis

For all numeric variables, the mean level, standard deviation, median and range were determined using SPSS IBM statistics 20.0. Significant differences ($P<0.05$) were tested using ANOVA, only when a sufficient ($n \geq 10$) of comparable products were present.

3. RESULTS

Data were collected for 911 meat products, with 863 remaining after data checking, with 86% (*n*=745) displaying a NIP. However, salt/sodium, saturated fat and sugars levels were not displayed on the label in 3% (*n*=22) of products NIP; only energy content, protein, total fat and carbohydrate levels were available for these products. That left a total of 723 products with a complete NIP and 16% (*n*=140) with no NIP or an incomplete NIP. Descriptive statistics for all nutritional values can be seen in Appendix 2.

For analyzing sodium/salt levels in meat products, data were available for 723 products, of which 11% (*n*=78) displayed a sodium level and 83% (*n*=599) displayed a salt level on the NIP. About 6% (*n=46*) of meat products had both salt and sodium levels displayed. For analysing sodium levels (in subparagraphs 3.2 - 3.4): the salt levels on the product packaging were converted into sodium levels using a conversion factor of 2.5.

For all analysed meat products (*n*=863), about 15% (*n*=126) had a GDA label displayed on their product packaging. The percentage varied by product category (Table 2).

Table 3 shows the proportion of products that complied with the Choices nutrient criteria and the proportion of products which displayed a health logo. Of all products examined (*n*=723), 5.3% (*n*=38) met the Choices nutrient criteria to display such a health logo, however, only 2.4% (*n*=17) actually displayed the health logo on product packaging. There were no products displaying the Choices health logo that did not meet the criteria.

Table 2. Presence of GDA* displayed on the product label of meat products (n=863) in 2015

	(n)	GDA (%)
Single heated (*n*= 120)	4	3
Combined heated (*n*= 401)	92	23
Single raw (*n*= 103)	2	2
Combined raw (*n*= 227)	22	10
Meat alternatives (*n*= 12)	6	50
Total meat products with NIP (*n*= 863)	**126**	**15**

** Guideline daily amounts*

Table 3. Number (n) and proportion (%) of meat products in 2015 that complied with the Choices nutrient criteria*

Product category	Total meat products	Products that met Choices nutrient criteria		Products that met nutrient criteria and displayed Choices health logo		Products that displayed Choices health logo but did not meet Choices nutrient criteria	
	(n)	(n)	(%)	(n)	(%)	(n)	(%)
Single heated	100	21	21	8	8	0	0
Combined heated	350	8	2	6	2	0	0
Single raw	76	1	1	0	0	0	0
Combined raw	186	5	3	0	0	0	0
Meat alternatives	11	3	27	3	27	0	0
Total meat products with complete NIP	**723**	**38**	**5**	**17**	**2**	**0**	**0**

** The Choices programme uses specific nutrient criteria for meat products: sodium (≤900mg/100g), trans-fat[1] (not added), saturated fat (≤13 en%) and added sugars[2] (≤2.5g/100g).*
[1]Trans-fat: no values available, not used in analysis.
[2]Assumption: added sugars are equal to 'sugars' on labelling. No distinction can be made between naturally occurring or added sugars

3.1 Results: Sodium and Saturated fat Levels in Meat Products in 2015

Boxplots are given for sodium levels in mg/100g of product (Fig. 2) and saturated fat content expressed as g/100g of product (Fig. 3) and as a proportion of energy density (Fig. 4).

Mean sodium levels of meat products varied. Only combined heated meat products (865 mg/100g) and meat alternatives (875 mg/100g) had mean levels that were below the Choices criterion (≤900 mg/100g). The mean sodium level of the single heated meat products (1044 mg/100g) was just above the Choices criterion, mean levels of combined raw meat products (1317 mg/100g) and single raw meat products (1564 mg/100g) were above the Choices criterion.

The saturated fat levels (g/100g) of the meat products also varied. The mean saturated fat levels of the products were as follows: single heated meat products (4 g/100g), combined heated meat products (8 g/100g), single raw meat products (6 g/100g) and a peak in the mean saturated fat level of combined raw meat products (13 g/100g). The meat alternatives had the lowest mean saturated fat (3 g/100g).

The distribution of the saturated fat levels in percent energy was equal to the distribution of saturated fat in grams, as displayed in Fig. 3. Mean levels did not fall under the Choices criterion level (≤13 en%) except for the meat alternatives (9 en%). In contrast, single heated meat products (18 en%), combined heated meat products (26 en%), single raw meat products (21 en%) and combined raw meat products (29 en%) were all above the Choices criterion.

3.2 Comparison of Sodium and Saturated Fat Levels (2015) to Previous Years

In Figs. 5 and 6, the mean levels and their corresponding standard deviations of sodium and

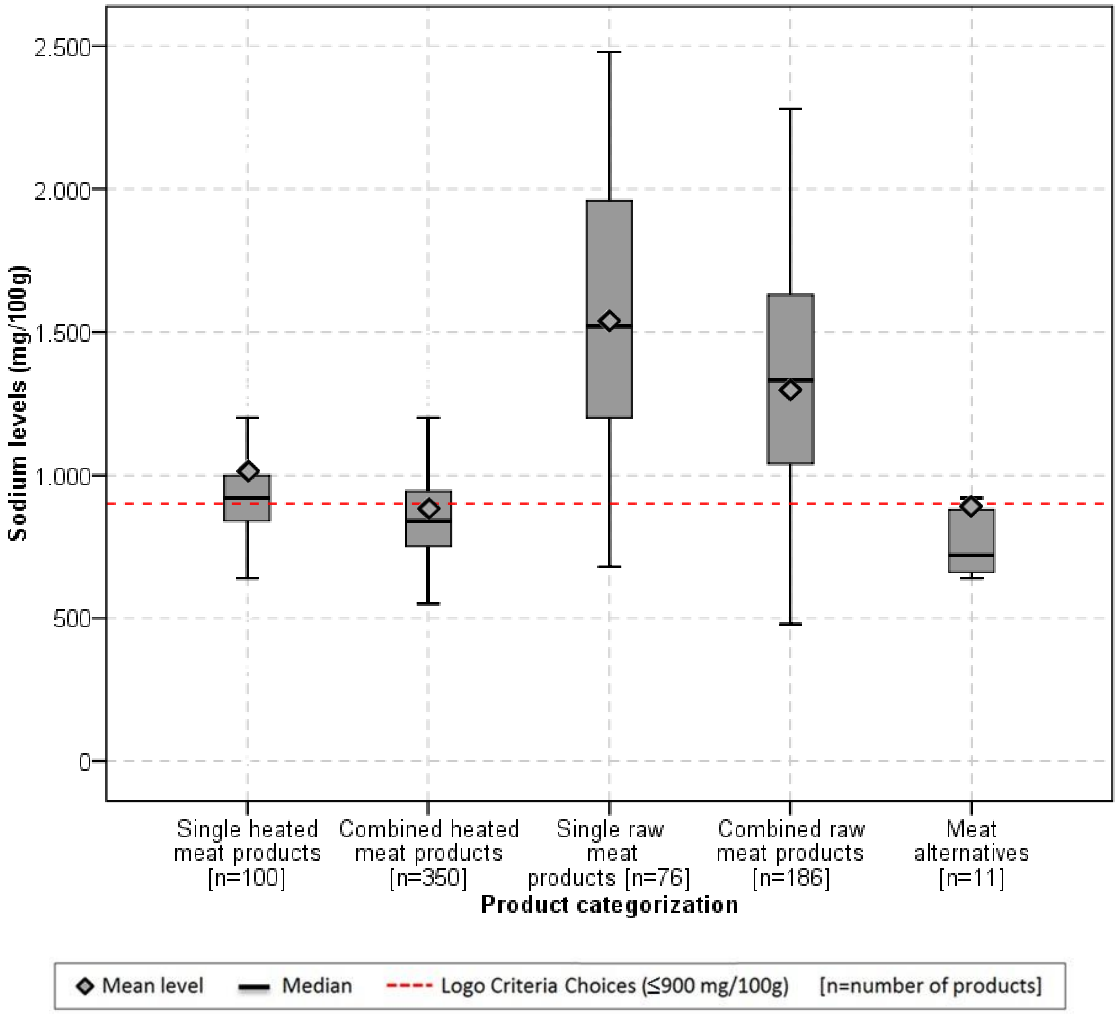

Fig. 2. Sodium levels (mg/100g) of meat products in 2015. The variation in compositions: the 25th percentile (bottom of the box), 75th percentile (top of the box), lowest value in data (bottom of the whisker) and highest value of data (top of the whisker)

saturated fat are displayed compared to the data available from previous years' monitoring reports. Meat alternatives were not captured in previous monitoring reports, so they were excluded in this particular comparison.

Fig. 5 shows mean (± SD) sodium levels in meat products (mg/100g). There were no significant differences found between sodium levels from NEVO 2011, 2013, HFM 2014 and GFM 2015 when examined by product category.

Fig. 6 shows mean (± SD) saturated fat levels in meat products (g/100g). Within the combined heated category, a significant difference was found between mean levels of HFM 2014 and GFM 2015 ($P<0.001$).

3.3 Evaluation Reformulation Targets of Meat Products in 2015

The projected range (in percentages) per product category which complied with the reformulation targets for sodium levels in 2015 was 14%-93% (Table 4). For saturated fat levels, the percentages ranged per product category between 25%-88% (Table 5). Scatterplots can be found in Appendix 3.

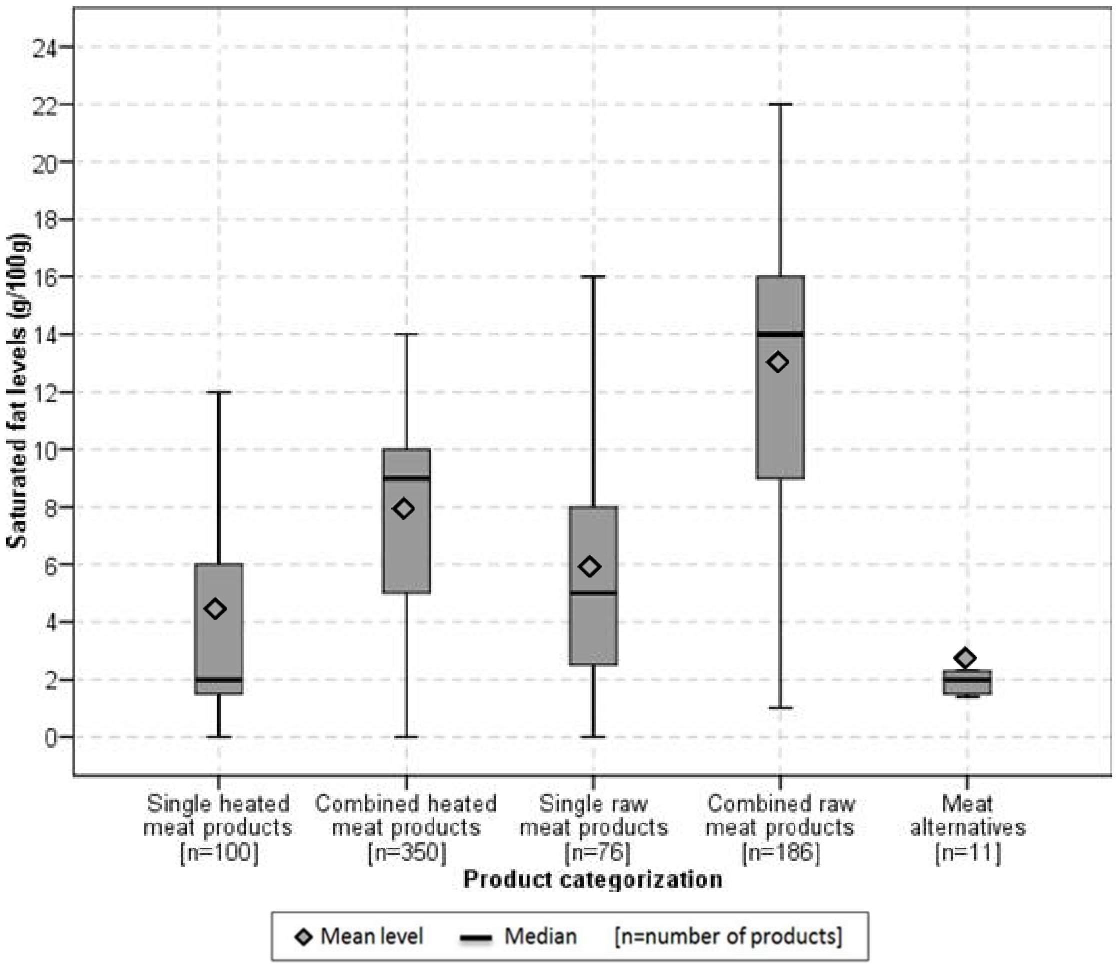

Fig. 3. Saturated fat levels (g/100g) of meat products in 2015. The variation in compositions: the 25th percentile (bottom of the box), 75th percentile (top of the box), lowest value in data (bottom of the whisker) and highest value of data (top of the whisker)

Table 4. Reformulation targets for meat products: Sodium levels (mg/100 g)

Product categorisation reformulation covenant*		**Agreed maximum sodium per 100 gram of product**	**Number of products analysed in 2015 GFM database**	**Percentage of products that achieved the reformulation targets in 2015**
Single heated meat products	Grilled bacon	1120 mg	N= 7	14%
	Remaining single heated products	1015 mg	N= 93	82%
Combined, heated meat products		945 mg	N= 350	75 %
Combined, raw meat products	Filet Americain	900 mg	N= 27	93%
	Remaining combined raw products	1280 mg	N= 159	35%

** Single raw meat products were not included in the reformulation monitor reports*

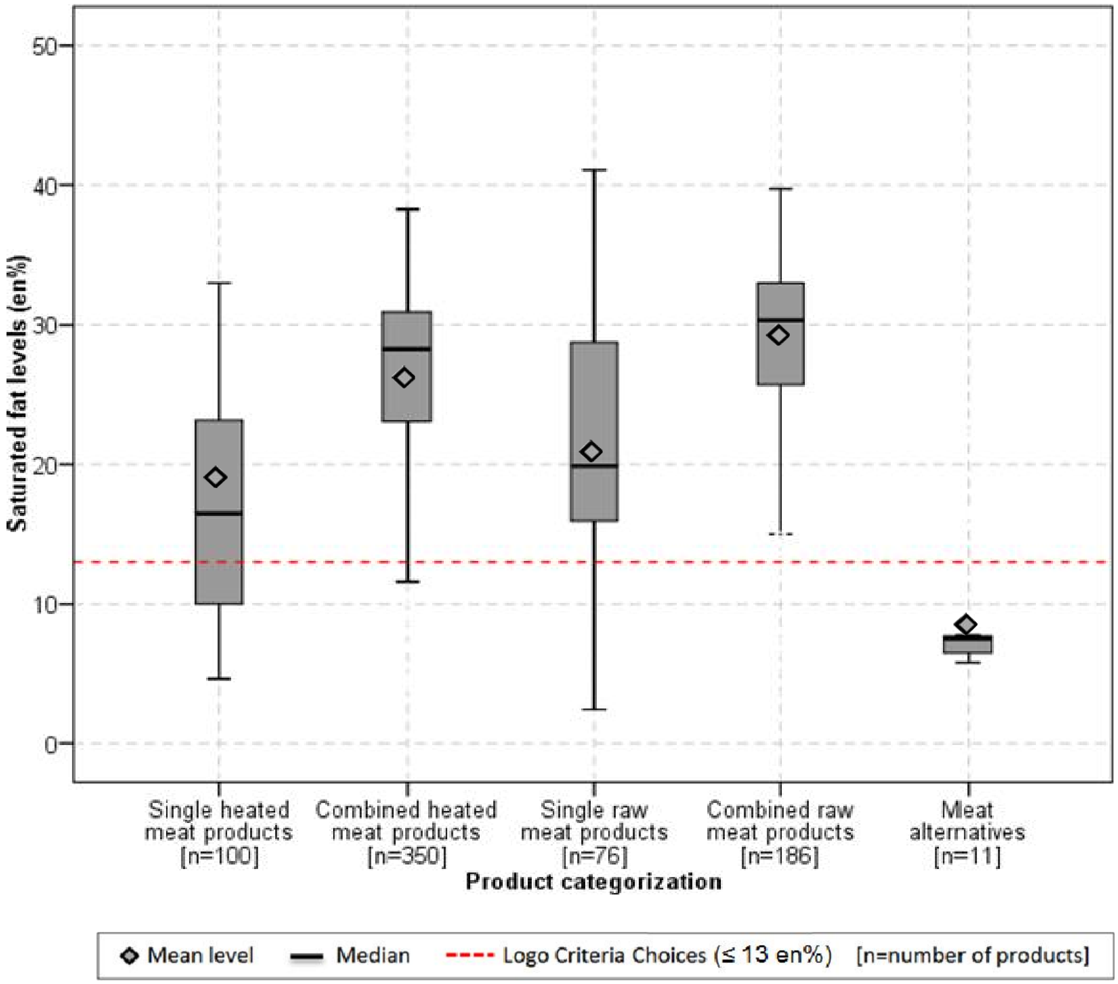

Fig. 4. Saturated fat energy percent (en%) of meat products from in 2015. The variation in compositions: the 25th percentile (bottom of the box), 75th percentile (top of the box), lowest value in data (bottom of the whisker) and highest value of data (top of the whisker)

Table 5. Reformulation targets of (a part of) combined heated meat products: saturated fat levels (g/100 g)

Product categorisation reformulation covenant	**Agreed maximum saturated fat per 100 gram of product**	**Number of products analysed in 2015 GFM database**	**Percentage of products that achieved the reformulation targets in 2015**
Roasted meatloaf	9,75 g	N= 5	60%
Grilled sausage	9,70 g	N= 14	57%
Liver cheese/ Berliner	11,10 g	N= 8	88%
Pâté	11,85 g	N= 36	78%
Smoked sausage*	10,55 g	N= 20	25%
Luncheon meat	10,20 g	N= 23	78%
Cooked sausage	10,80 g	N= 13	54%
Liver sausage/ Hausmacher	9,00 g	N= 46	39%
Liver sausage spread	10,35 g	N= 10	70%

** Lean products were excluded from this comparison: no reformulation targets were defined for saturated fat levels of lean products*

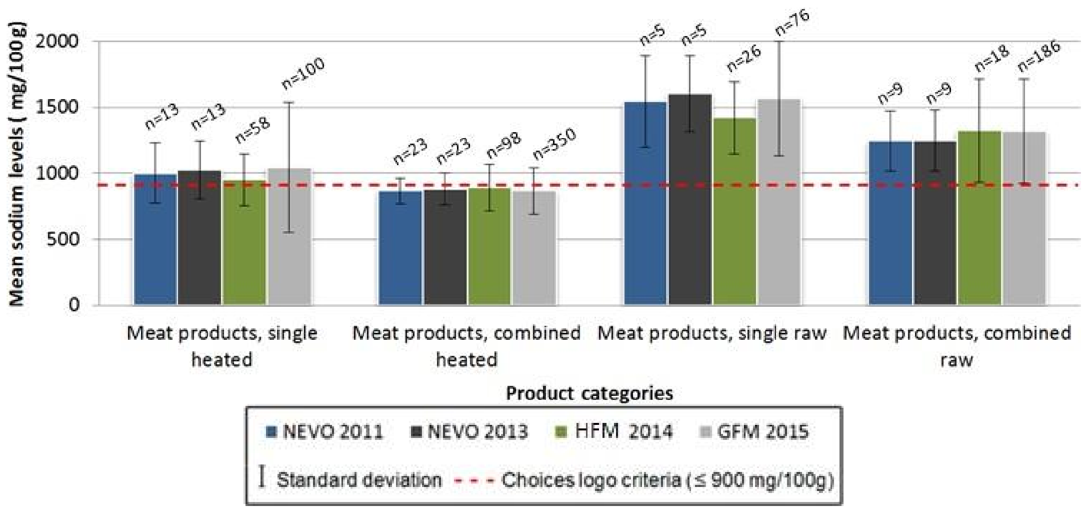

Fig. 5. Comparison of mean sodium levels (mg/100g) of meat products (n) in 2015 with NEVO (2011 & 2013) and HFM tables (2014)

Note: NEVO 2011 and 2013, as well as HFM 2014, were based on aggregated numbers based on a combination of analytic food data and nutrient information provided on a voluntary basis by food companies. HFM 2014 was based on a set of new data created for the reformulations monitor (and will be of later use for NEVO 2016 tables). GFM 2015 is based on label information only

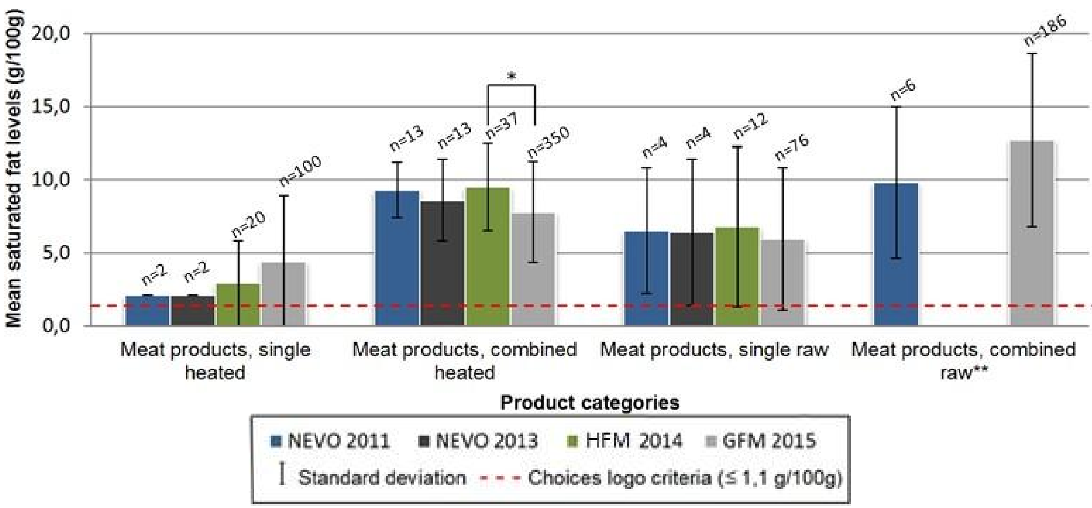

Fig. 6. Comparison of mean saturated fat levels (g/100g) of meat products (n) in 2015 with NEVO (2011 & 2013) and HFM tables (2014)

Note: NEVO 2011 and 2013, as well as HFM 2014, were based on aggregated numbers based on a combination of analytic food data and nutrient information provided on a voluntary basis by food companies. HFM 2014 was based on a set of new data created for the reformulations monitor (and will be of later use for NEVO 2016 tables). GFM 2015 is based on label information only.

** P<0.05 for difference (ANOVA).*

*** Insufficient amount of data delivered by NEVO 2013 & HFM 2014*

4. DISCUSSION

The present study reveals there was no change in sodium levels and little change in saturated fat levels of meat products between 2011 and 2015 in the Netherlands. This study also found that a small proportion of meat products (16% with no NIP or an incomplete NIP) did not display the required nutrients on product labels as set out by the European Regulation No. 1169/2011, which states that manufacturers must include the energy value, fat, saturated fat, carbohydrates, sugars, proteins and salt levels on the nutrition label (Art. 30.1. a,b.) [17]. The absence of NIPs on some meat products may have limited the analysis. However, highlighting the absence of data is an important secondary output from this project, and could be used to address transparency of food manufactures in the Netherlands.

Based on the comparison between NEVO 2011-2013, HFM 2014 and GFM 2015, no changes in sodium level were found over the past four years in the Netherlands. Similar results have been reported for other countries. For example, a study in New Zealand, which explored a 10-year change in sodium contents of nine processed food categories, showed no significant differences in matched products over time [24]. Also, because of its preservative effect, it is reportedly difficult to decrease salt/sodium levels in (single) raw meat products. Temme et al (2017) compared salt content of various products, including meat products in the Dutch market between 2011 and 2016. The study found that certain types of bread had 19 per cent lower salt content and certain types of sauce, soup, crisps and canned vegetables and legumes had 12 to 26 percent lower salt content. Salt in a small selection of meat products was only slightly reduced. Estimated overall salt intake did not change between 2006, 2010 and 2015 and exceeded the recommended maximum intake of 6 grams per day [25].

For saturated fat only one significant difference was found in the subcategory of combined, heated meat products between (GFM) 2015 versus (HFM) 2014. This may be explained by the reformulation targets set, only for the combined, heated meat products, suggesting that target-setting can be effective in achieving reductions in the levels of saturated fat. All other subcategories were excluded for reformulation on saturated fat. This means that reformulation targets (for saturated fat) in meat products are achieved but only for a small fraction of meat products.

The new EU labelling requirements, in combination with the methodology of the GFMG, has enabled the collection of data for a large number of products within a short time period. The quantities analysed were different between the two methods, as compared with the number of products used in the monitoring reports of the RIVM [5] which are based on a combination of food analysis as well as aggregated average compositions from label information provided on a voluntary basis by food companies. The nutritional values of the products in the GFM database are directly obtained from product packaging and are reflective of what people buy. Hence, the data used to assess changes over years were generated with different methods and, therefore, the comparison was difficult and should be interpreted with caution. Nonetheless, the label information ultimately leads to the same conclusion as the combination of label and chemical analyses information.

A limitation of the GFM database was the illegibility of some product pictures. In these cases, data had to be obtained from the supermarket websites. However, even website data were not always up-to-date: information on the physical packaging was sometimes non-corresponding in relation to the information on the supermarket's website (depending on the supermarket), especially with respect to data of non- private label products. Next to the illegibility, information was limited to the data given on the packaging, usually no micronutrients were given (with the exception of meat alternatives) and numbers were often rounded.

Past experiences with trans-fat has shown that obligated declaration can lead to innovation and/ or reformulation, because food companies are forced to think about the health effects of their products [26]. However, the presence of products with no NIP that was found can be explained with (EU) Regulation No. 1169/2011, which includes a list of foods that are exempted from the requirement of the mandatory nutrition declaration, including fresh meat products (Annex V regulation: point 19). In addition, manufacturers have a transition period to put a (complete) NIP on their packaging until December 2016 [17].

Our analyses showed that only a very small proportion (5%) of meat products complied with the criteria to carry a health logo (Choices). This could imply that these criteria are challenging for meat products, or that manufactures in this product category are less inclined to reformulate their products to meet the Choices nutrient criteria. Even fewer products (2%) actually carried a Choices health logo, indicating the healthier choice within a product category. Unlike the required NIP, health logos are voluntary front-of-pack labelling options. It is up to the manufacturer to decide whether to use them. According to Vyth et al. the Choices health logo played a role in the actual food purchases of people who were health conscious and weight conscious [26] and thereby influenced food manufactures to reformulate their products [8, 12]. The increased availability of healthier products within a category, such as those carrying the Choices health logo, could be an efficient way to improve the diets of all consumer groups, whether or not they are health-conscious consumers. This was illustrated by a study predicting that- when consuming more Choices-compliant foods, nutrient intake would shift towards population intake goals [27].

Another voluntary front-of-pack communication is the GDA label, which is initiated by the food industry and aims to make the healthier choice easier. Our analyses showed that only 15% of meat products displayed the GDA. In a comparison of the effectiveness of four different FOP labelling systems it was concluded that- any structured and legible presentation of key nutrient and energy information on the FOP label was sufficient to enable consumers to detect a healthier alternative within a food category when provided with foods that have distinctly different levels of healthiness [28]. However, these results should be used with caution because many studies often lack a validated methodology. Recommended are longitudinal, randomized, controlled designs in a real-life setting with biomarkers to measure the health effects of FOP labelling [29].

5. CONCLUSION

This study showed that there had been little change in the sodium and saturated fat values of processed meat products in the Netherlands between 2011 and 2015. This study provided a more detailed insight in sodium and saturated fat levels in specific subcategories of meat products and provides both a baseline to monitor future reformulation efforts. In the light of the Netherlands' reformulation covenant of 2014, more focus is needed to meet the national commitment to reduce sodium and saturated fat in meat products. These results could be used to make more effective use of resources and identify new strategies.

In the short-term, this method of monitoring and evaluation of progress in reformulation could be extended to other commonly consumed food categories. The ultimate goals would be to motivate the industry and to decrease the burden of nutrition-associated disease in the Netherlands. More focus could be on reducing reformulation barriers to strengthen the commitment of the industry when implementing targets. In the long term, the effectiveness of food reformulation strategies is recommended to be measured in terms of health outcomes.

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SJ is a student at Maastricht University, who performed the research and wrote the initial project report. The paper was produced on the basis of a MSc student's Master Thesis with the Master Health Food Innovation Management of Maastricht University.

AR, ED, HV and KN provided feedback on subsequent drafts and provided insight into the direction of the paper.

COMPETING INTERESTS

The author Hans Verhagen is employed with the European Food Safety Authority (EFSA). However, the present article is published under the sole responsibility of Hans Verhagen and the positions and opinions presented in this article are those of the authors alone and are not intended to represent the views or scientific works of EFSA.

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APPENDIX - 1

Agreement on improvements in product composition & covenant reformulation meat products

Choosing healthier products should be made easier for consumers. A healthy diet is important for good health. Therefore an agreement is signed for improving the composition of products and total product supply as a whole [13] by the Dutch government and the private sector (In Dutch: Akkoord Verbetering Productsamenstelling). This agreement aims at reducing the levels of salt, saturated fat, sugar and energy content. Ultimately, this will lead to a healthier product offering.

The parties signed on the following joint ambitions:

- Reducing salt in the product range. Making it easier for consumers not to exceed the maximum values of 6 gram salt per day. To be achieved by 2020.
- Reducing the saturated fat content in the product range. Making it easier for consumers not to exceed the maximum of 10 energy percent per day. To be achieved by 2020.
- Making it easier for consumers to consume less energy. To be achieved by 2020 and where possible reduce energy content through the reduction of sugar and/or (saturated) fat and/ or reduce portion size and to continue promoting fruit and vegetables.

When working on these ambitions, the priority of product categories will be based on the relevance of public health. Products intended for children will get a high priority.

Agreements for bread, canned vegetables, meat products and Gouda cheese have already been made.

Covenant reformulation meat products

The covenant reformulation meat products [14], which is signed by the Association of the Dutch meat industry (known as VNV) and the Central food retail office (Dutch: CBL), focuses on the following specific objectives:

1) The reduction of the mean sodium levels in the product groups ‘single heated meat products’ (subdivided in ‘grilled bacon’ and ‘other single heated meat products’), ‘combined heated meat products’ and ‘combined raw meat products’ (subdivided in ‘filet Americain’ and ‘other raw combined meat products’) with 10% (Table 1).
2) The reduction of SAFA in the product group combined heated meat products (subdivided to multiple products) with 5% (Table 2).

Table 1. Maximum sodium levels (mg/100 g): agreed on in reformulation covenant meat products

Product (group)	Maximum per 100 gram of product
Single heated meat products	
Grilled bacon	1120 mg
Other single heated meat products	1015 mg
Combined heated meat products	945 mg
Combined raw meat products	
Filet Americain	900 mg
Other combined raw meat products	1280 mg

Table 2. Maximum saturated fat levels (g/100 g): agreed on in reformulation covenant meat products

Product (group)	Maximum per 100 gram of product
Roasted meatloaf	9,75 g
Grilled sausage	9,70 g
Liver cheese/ Berliner	11,10 g
Pâté	11,85 g
Smoked sausage*	10,55 g
Luncheon meat	10,20 g
Cooked sausage	10,80 g
Liver sausage/ Hausmacher	9,00 g
Liver sausage spread	10,35 g

** Lean products are excluded from the reformulation in SAFA.*

APPENDIX – 2

Descriptive statistics of the nutritional values of the meat products in the Netherlands in 2015

Table 3. Descriptive statistics single heated meat products per 100 grams

	N	Minimum	Maximum	Mean	Std. Deviation
Energy (kJ/100 g)	99	400	2850	796	540
Energy (kcal/100 g)	100	95	688	192	130
Protein (g/100 g)	100	13	74	22	12
Fat, Total (g/100 g)	100	2	64	11	12
Saturated fat (g/100 g)	100	0	24	4	5
Unsaturated fat, Total (g/100 g)	4	2	24	17	10
Monounsaturated fat (g/100 g)	50	1	16	4	4
Polyunsaturated (g/100 g)	49	0	5	2	1
Trans fat (g/100 g)	1	0	0	0	.
Carbohydrate (g/100 g)	100	0	9	2	2
Sugars (g/100 g)	100	0	3	1	1
Salt (g/100 g)	91	0	9	2	1
Sodium (mg/100 g)	17	720	2400	1098	456
Fibre (g/100 g)	87	0	2	0	1

Table 4. Descriptive statistics combined heated meat products per 100 grams

	N	Minimum	Maximum	Mean	Std. deviation
Energy (kJ/100 g)	351	186	1880	1049	299
Energy (kcal/100 g)	358	69	774	254	77
Protein (g/100 g)	358	6	33	13	3
Fat, Total (g/100 g)	358	1	43	20	9
Saturated fat (g/100 g)	350	0	19	8	4
Unsaturated fat, Total (g/100 g)	18	4	20	12	6
Monounsaturated fat (g/100 g)	114	1	18	9	4
Polyunsaturated (g/100 g)	115	0	12	4	2
Trans fat(g/100 g)	5	0	13	3	6
Carbohydrate (g/100 g)	358	0	16	4	3
Sugars (g/100 g)	347	0	10	1	2
Salt (g/100 g)	311	1	4	2	0
Sodium (mg/100 g)	53	550	1390	875	156
Fibre (g/100 g)	252	0	3	0	1

Table 5. Descriptive statistics single raw meat products per 100 grams

	N	Minimum	Maximum	Mean	Std. Deviation
Energy (kJ/100 g)	73	425	3225	974	484
Energy (kcal/100 g)	77	100	770	232	115
Protein (g/100 g)	77	2	41	21	6
Fat, Total (g/100 g)	77	1	86	16	15
Saturated fat (g/100 g)	76	0	30	6	5
Unsaturated fat, Total (g/100 g)	7	7	13	10	2
Monounsaturated fat (g/100 g)	34	0	17	6	5
Polyunsaturated (g/100 g)	34	0	5	2	2
Trans fat (g/100 g)	0				
Carbohydrate (g/100 g)	77	0	6	1	1
Sugars (g/100 g)	76	0	3	0	1
Salt (g/100 g)	67	2	6	4	1
Sodium (mg/100 g)	16	940	2240	1574	405
Fibre (g/100 g)	61	0	2	0	0

Table 6. Descriptive statistics combined raw meat products per 100 grams

	N	Minimum	Maximum	Mean	Std. Deviation
Energy (kJ/100 g)	185	380	2360	1596	444
Energy (kcal/100 g)	197	90	570	387	106
Protein (g/100 g)	196	3	50	20	7
Fat, Total (g/100 g)	196	2	54	33	11
Saturated fat (g/100 g)	186	1	49	13	6
Unsaturated fat, Total (g/100 g)	19	0	30	20	7
Monounsaturated fat (g/100 g)	62	1	24	15	5
Polyunsaturated (g/100 g)	62	0	7	4	2
Trans fat (g/100 g)	2	0	0	0	0
Carbohydrate (g/100 g)	194	0	21	2	3
Sugars (g/100 g)	187	0	20	1	2
Salt (g/100 g)	166	1	6	3	1
Sodium (mg/100 g)	37	850	1980	1444	248
Fibre (g/100 g)	130	0	4	0	1

Table 7. Descriptive statistics meat alternatives per 100 grams

	N	Minimum	Maximum	Mean	Std. Deviation
Energy (kJ/100 g)	12	824	1476	1044	187
Energy (kcal/100 g)	12	197	352	250	45
Protein (g/100 g)	12	4	23	14	7
Fat, Total (g/100 g)	12	10	32	18	6
Saturated fat (g/100 g)	11	1	8	3	2
Unsaturated fat, Total (g/100 g)	0				
Monounsaturated fat (g/100 g)	2	4	8	6	3
Polyunsaturated (g/100 g)	2	4	6	5	1
Trans fat (g/100 g)	0				
Carbohydrate (g/100 g)	12	2	14	9	3
Sugars (g/100 g)	11	0	2	1	1
Salt (g/100 g)	10	2	5	2	1
Sodium (mg/100 g)	1	800	800	800	0
Fibre (g/100 g)	6	0	4	2	1

APPENDIX - 3

Scatter plots: reformulation of meat products

The information displayed in Tables 4 and 5 in the article can be visualized using the scatter plots below. The red line indicates the maximum level of nutrient per 100 grams of product, recorded in the agreement of reformulations of meat products [14] and Appendix 1. Each cross represents one product. The green crosses indicate the products that have achieved the reformulation target. The red crosses indicate the products that have not yet achieved the reformulation target. [n] Stands for the number of products analyzed.

Sodium levels (mg/100 g)

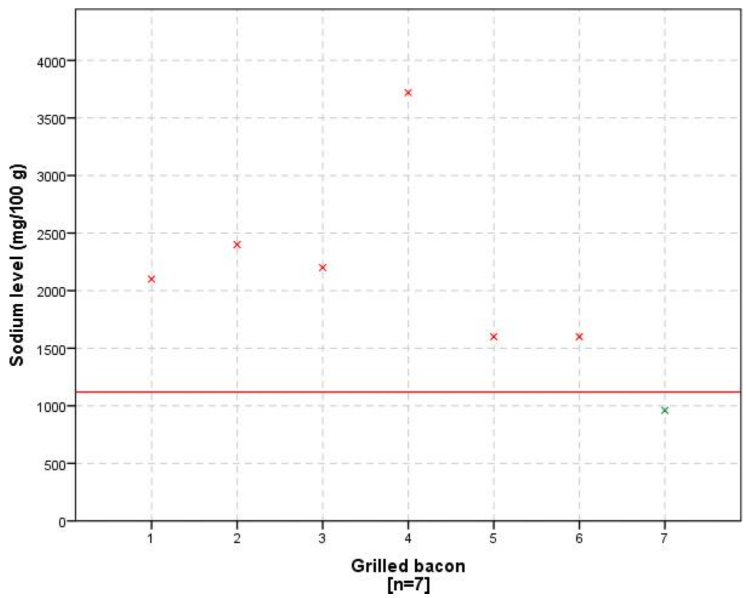

Fig. 1. Sodium levels in grilled bacon compared to the reformulation target in 2015

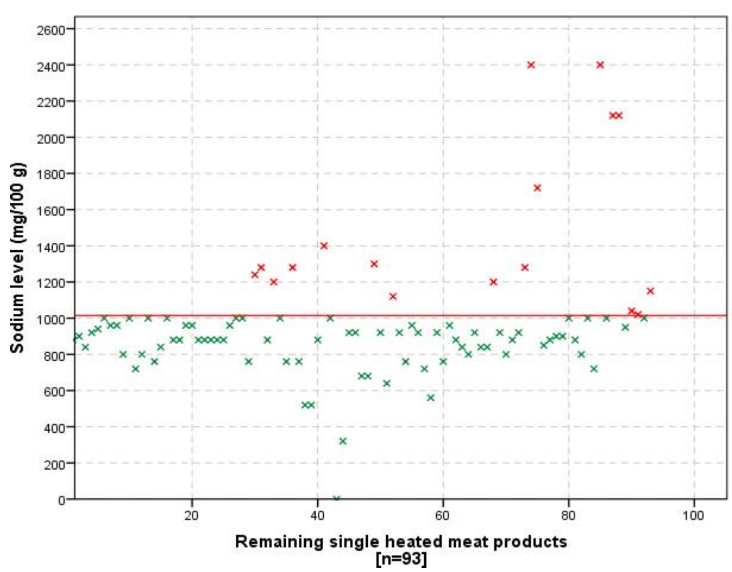

Fig. 2. Sodium levels of the remaining single heated meat products compared to the reformulation target in 2015

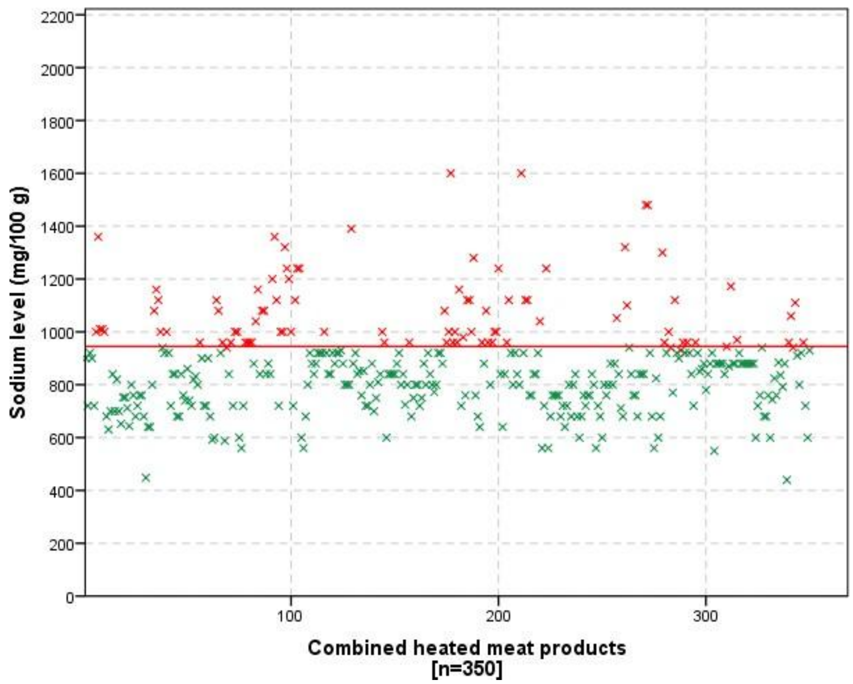

Fig. 3. Sodium levels of the combined heated meat products compared to the reformulation target in 2015

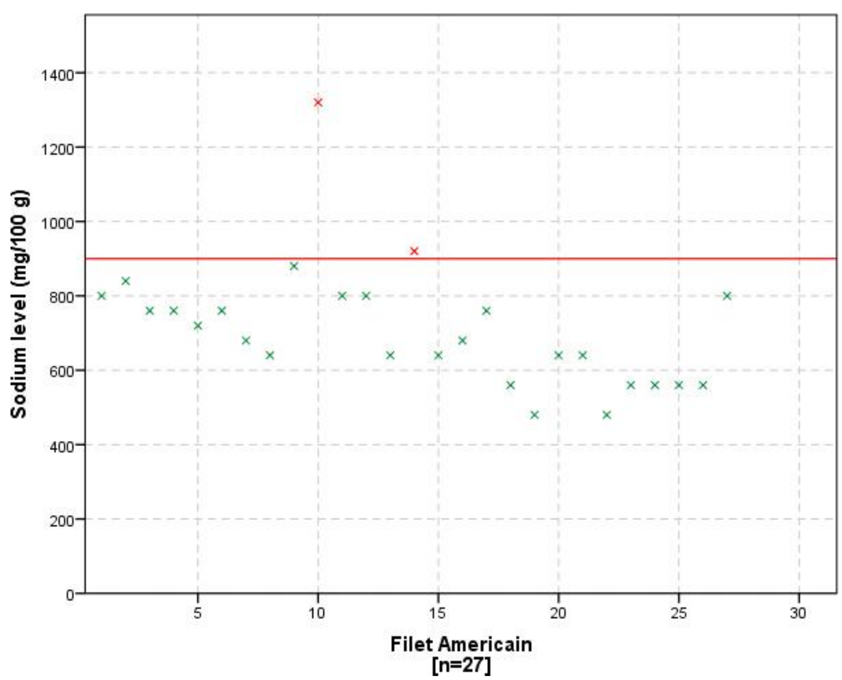

Fig. 4. Sodium levels of filet Americain compared to the reformulation target in 2015

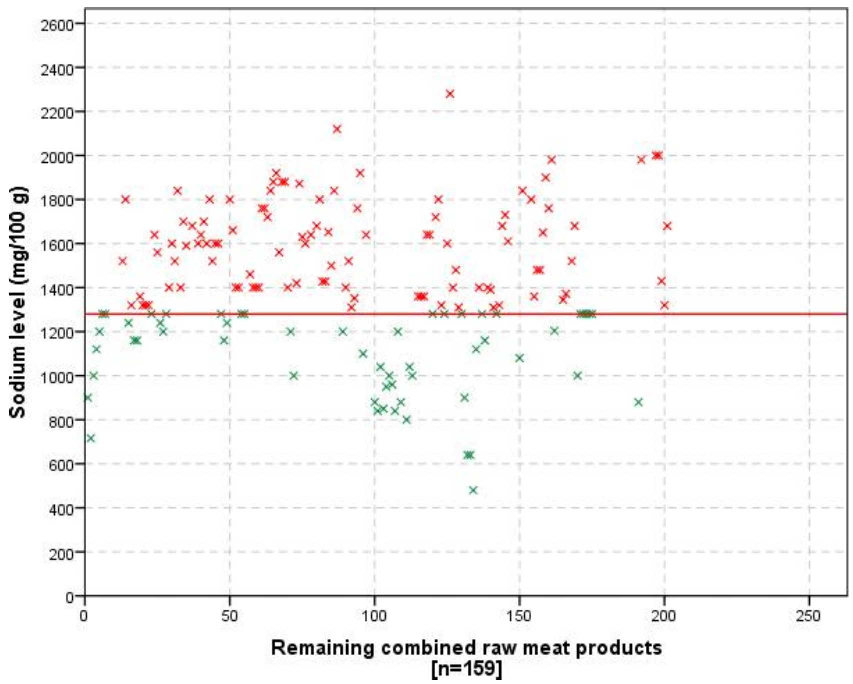

Fig. 5. Sodium levels of the remaining combined raw meat products compared to the reformulation target in 2015

Saturated fat levels (g/100 g)

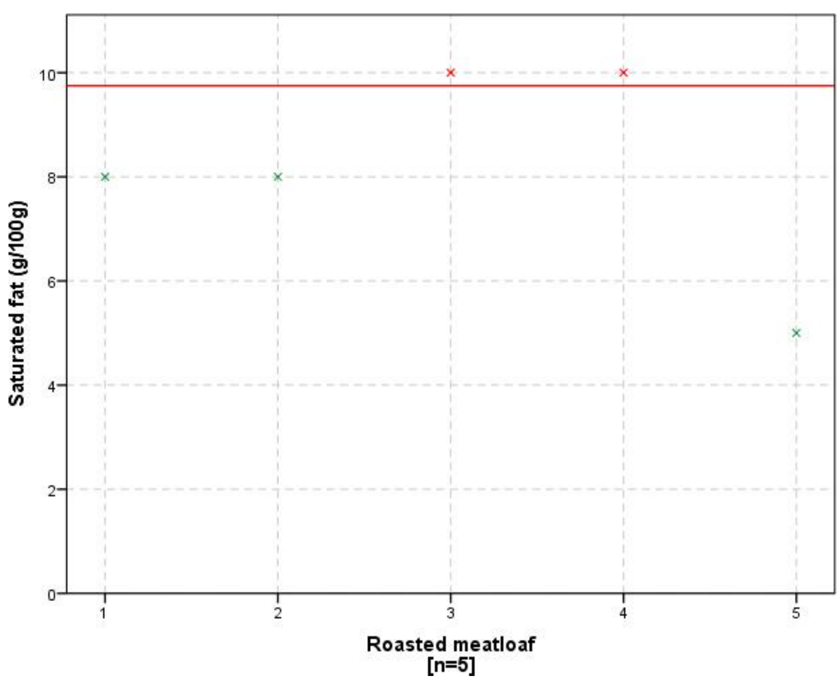

Fig. 6. Saturated fat levels of roasted meatloaf compared to the reformulation target in 2015

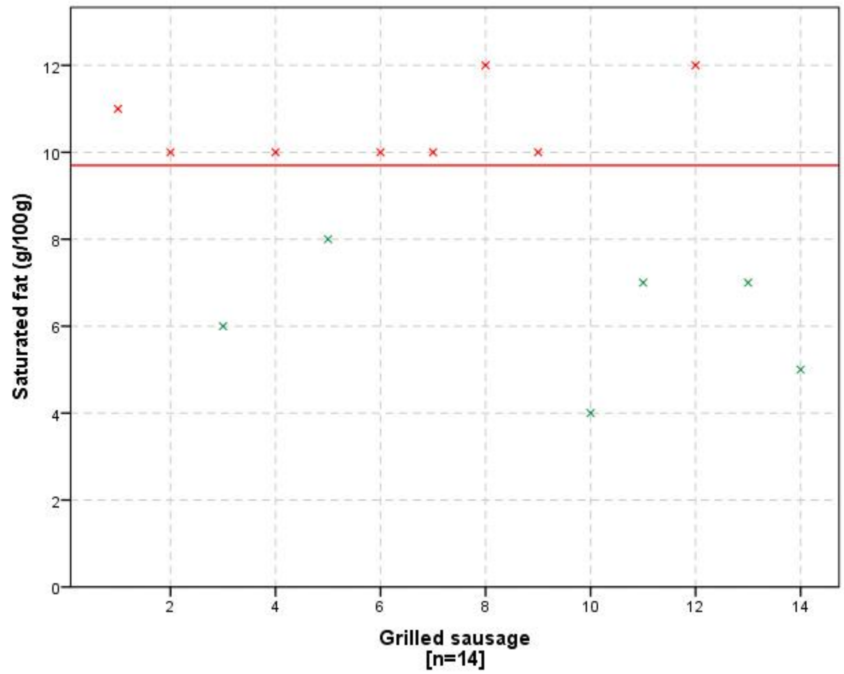

Fig. 7. Saturated fat levels of grilled sausage compared to the reformulation target in 2015

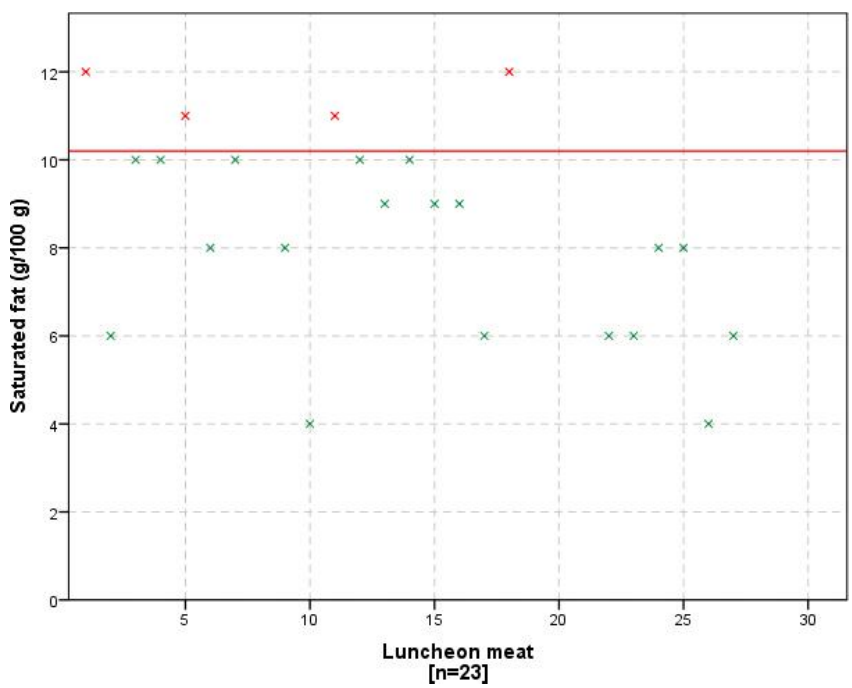

Fig. 8. Saturated fat levels of luncheon meat compared to the reformulation target in 2015

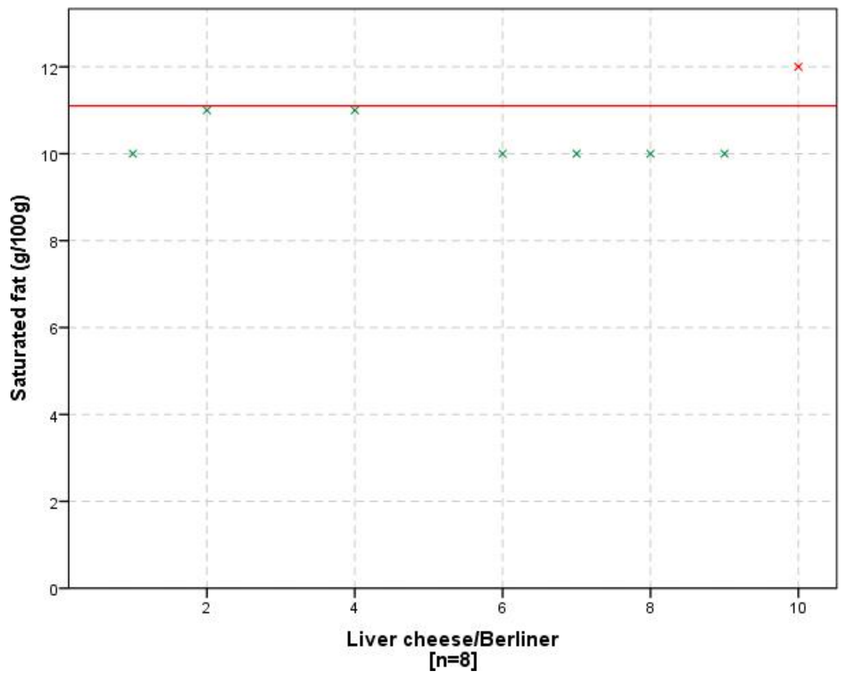

Fig. 9. Saturated fat levels of liver cheese/Berliner compared to the reformulation target in 2015

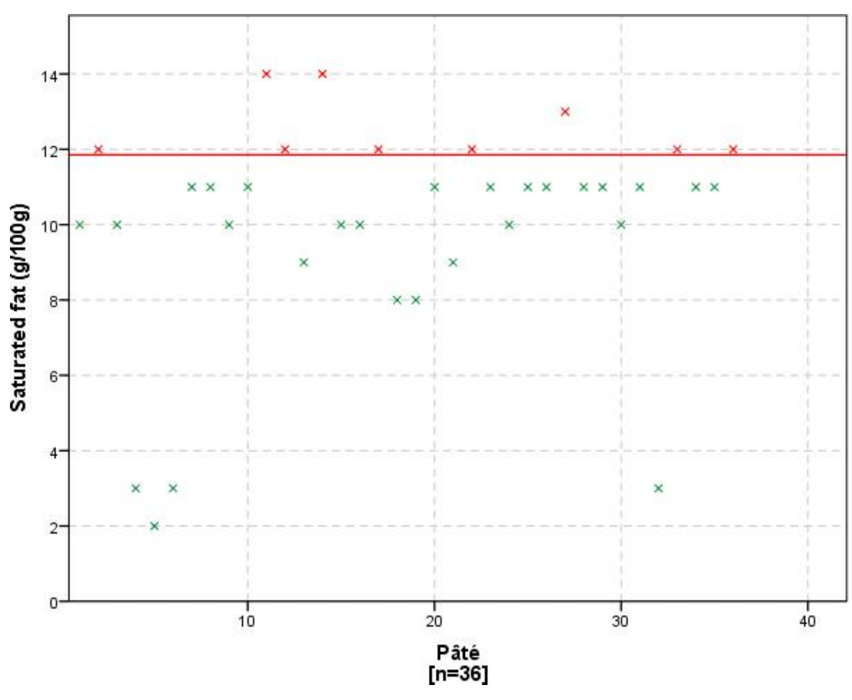

Fig. 10. Saturated fat levels of pâté compared to the reformulation target in 2015

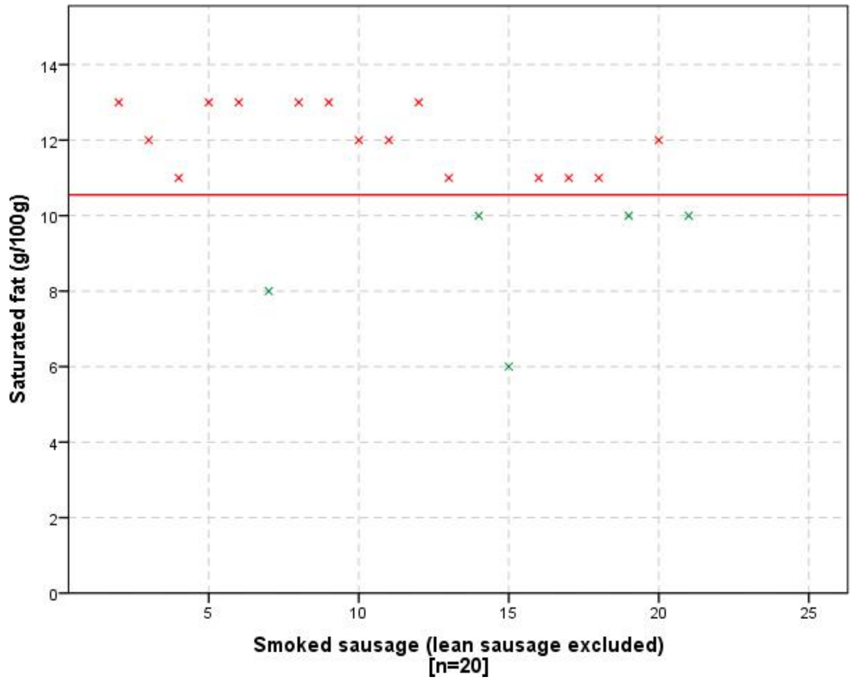

Fig. 11. Saturated fat levels of smoked sausage compared to the reformulation target in 2015

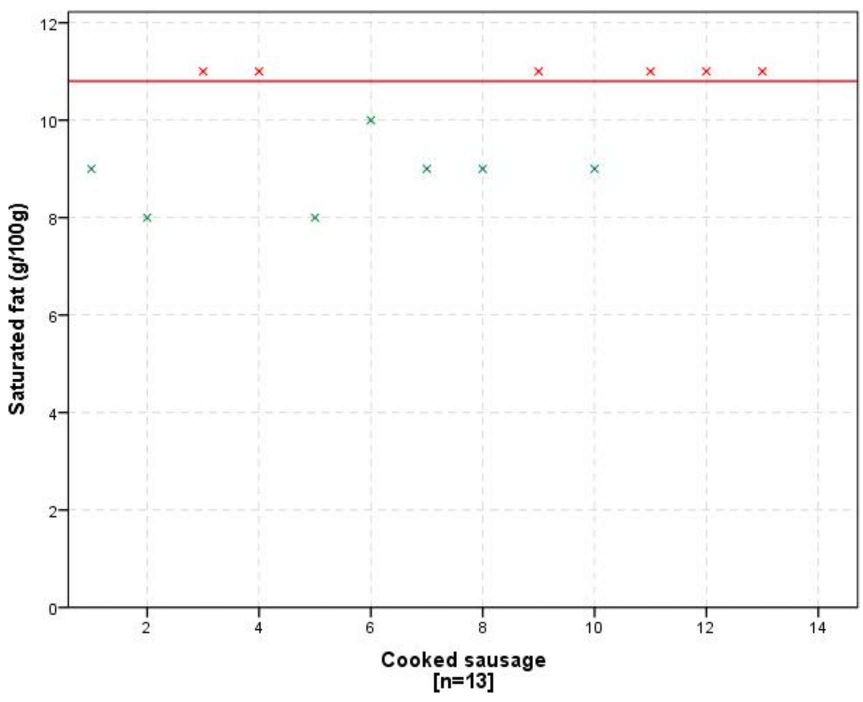

Fig. 12. Saturated fat levels of cooked sausage compared to the reformulation target in 2015

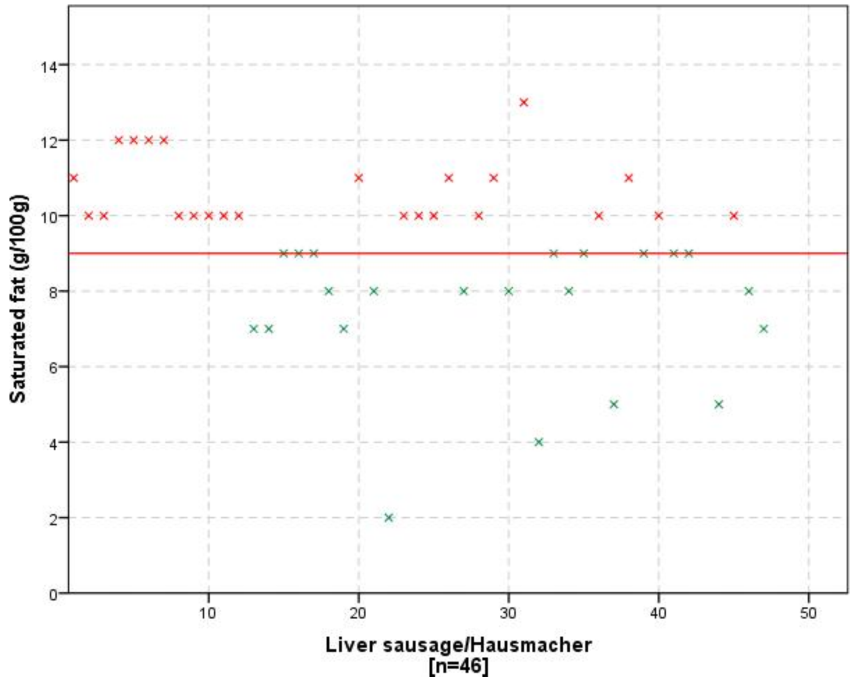

Fig. 13. Saturated fat levels of liver sausage/Hausmacher compared to the reformulation target in 2015

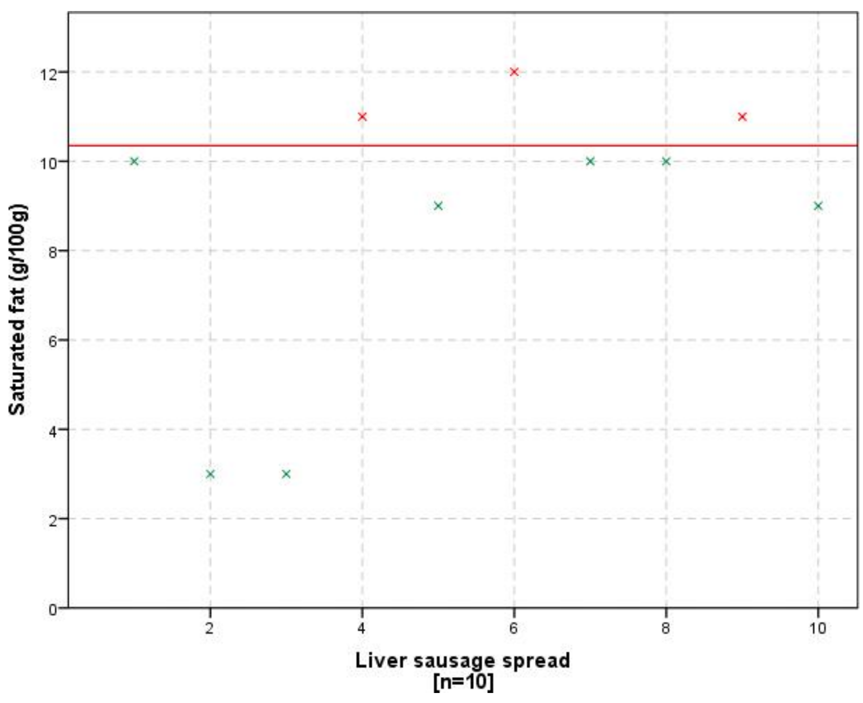

Fig. 14. Saturated fat levels of liver sausage spread compared to the reformulation target in 2015