Assessing the variability of the fatty acid profile and cholesterol content of meat sausages

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Eighteen different brands of meat sausages including pork, poultry and the mixture of both meats (pork and poultry) in sausages, were analysed for their nutritional composition (total fat, moisture, crude protein and ash), cholesterol content and fatty acid composition. As expected, the pork Frankfurter sausages presented a higher fat content compared to sausages that include poultry meat in their composition. A multivariate statistical analysis was applied to the data showing the existence of significant differences among samples. Regarding fatty acid composition, significant differences were verified in canonical variate plots when the samples were grouped by sausage type, suggesting that the fatty acid profile is strongly influenced by the type of meats, as well as other ingredients such as vegetable oil and lard, used in its formulation. The group of poultry Frankfurter sausages presented lower levels of SFA and higher levels of PUFA, which can point to a healthier profile compared to the pork and meat mixture sausages. Nevertheless, some poultry sausages showed a higher cholesterol content compared to the pork Frankfurters. The lowest mean cholesterol content was obtained for the group of pork Frankfurters, which somehow contradicts the consumers' idea that pork meat products should be avoided due to its high cholesterol levels.
Keywords: Frankfurter sausages, pork meat, poultry meat, cholesterol, fatty acid composition

Accesso alla variabilità del profilo degli acidi grassi e del colesterolo contenuti nelle salsicce di carne

Diciotto diverse marche di salsicce di carne che comprendono carni suine, pollame e miscela di entrambe le carni (maiale e pollame), sono state analizzate per la loro composizione nutrizionale (grassi totali, umidità, proteine grezze e ceneri), contenuto di colesterolo e composizione in acidi grassi. Come previsto, le salsicce di maiale Frankfurter hanno presentato un più alto contenuto di grassi rispetto alle salsicce che nella loro composizione comprendono carne di pollame. Ai dati è stata applicata l'analisi statistica multivariata che mostra l'esistenza di differenze significative tra i campioni. Per quanto riguarda la composizione in acidi grassi, sono state verificate differenze significative quando i campioni sono stati raggruppati in base al tipo di salsiccia, il che suggerisce che il profilo degli acidi grassi è fortemente influenzato dal tipo di carne, così come da altri ingredienti come l'olio vegetale e lo strutto, utilizzati per la sua formulazione.
Il gruppo di salsicce di pollame Frankfurter ha presentato livelli più bassi di SFA e livelli più alti di PUFA, che può puntare a un profilo più sano rispetto a salsicce con carne di maiale e a salsicce a base di miscele di carni. Tuttavia, alcune salsicce di pollame hanno mostrato contenuto di colesterolo più elevato rispetto alle salsicce di maiale Frankfurter. Il più basso contenuto di colesterolo medio è stato ottenuto per il gruppo di salsicce di maiale Frankfurter e contraddice in qualche modo l'idea dei consumatori che i prodotti a base di carne di maiale dovrebbero essere evitati per i loro alti livelli di colesterolo.
Parole Chiave: Salsicce Frankfurter, carne di maiale, carne di pollame, colesterolo, composizione degli acidi grassi

1. INTRODUCTION

Frankfurter sausages are non-fermented meat emulsions formed from a viscous dispersion of water, fat and proteins, which during heating are transformed into a protein gel filled with fat particles [1,2]. They are generally produced from pork meat and fat, and added with additional ingredients such as other meats (beef and/or poultry), salt and spices, among others [3]. This type of processed meat product is very popular in many countries, being largely consumed and especially appreciated by young people. Nevertheless, they are generally perceived by consumers as unhealthy products to avoid since they are considered to contain high fat, cholesterol and saturated fatty acids (SFA). Nowadays, consumers are increasingly paying attention to the relation between diet and health and are becoming interested about the chemistry of what they eat. Consequently, the food industry is supplying the market with new products and/or healthier formulations [4]. In the specific case of processed meat products, such as sausages, the industry is trying to respond to the consumer's demand for low-fat and healthier products, while maintaining a high standard of quality of their meat products [4]. Although healthier sausages can be readily obtained by changing the formulation and decreasing pork backfat content, this approach may cause technological problems, leading to firmer, more rubbery and less juicy frankfurters [2, 5].

The incorporation of vegetable oils in meat products seems to be an alternative for this purpose, since they are free of cholesterol and have a high content of monounsaturated (MUFA) and polyunsaturated fatty acids (PUFA) [5]. However, its lower melting points can be a technological disadvantageous [5]. Hydrogenation of vegetable oils could be an option to overcome this problem, but it increases saturated and trans-unsaturated fatty acid contents [5], which are associated with a higher risk of coronary heart disease (CHD). Other processing strategies have been suggested, including the use of formulations with leaner meats [2, 6], the substitution of pork backfat by more nutritional ingredients such as walnuts [7], the use of non-meat ingredients with a desirable texture and water-holding properties, such as soybean protein, and changing the animals' diets in order to obtain meats with improved nutritional quality [8]. Among those, the use of leaner meats as a substitution to pork meat generated an increasing number of poultry meat based products available on supermarket shelves. When compared to pork meat, consumers generally associate poultry meat with lower levels of cholesterol and total fat, classifying the latter as a healthier meat. Moreover, the good acceptability due to its neutral taste and smooth texture is another important factor responsible for poultry meat growing on the market place [9]. In general, turkey and chicken meat (without skin) are associated with a higher PUFA content, while pork meat is characterised by the presence of larger amounts of MUFA, mostly oleic acid [10-12]. Compared to pork and poultry, beef generally contains lower amounts of PUFA and slightly higher proportions of SFA [10, 12, 13]. Nevertheless, it should be noticed that the amount and type of fatty acids depends not only on the animal species, but is also affected by a number of factors such as the part of the carcass, gender, age, feeding, among other things [10, 11]. Moreover, both raw chicken (broiler) and turkey muscle present different fatty acid compositions depending on whether they are considered with or without skin. In both cases, the presence of the skin is associated with increased MUFA and decreased PUFA contents, besides significantly increasing the total fat content [10].

Since the risk of CHD is increasing in most of the world's population, cardiologists and nutritionists have been advising consumers to reduce the overall intake of fat, especially of harmful SFA and cholesterol, privileging the intake of MUFA and PUFA. Although several pieces of data are available concerning the nutritional composition and fatty acid profile of different meat species, including information for different animal tissues, gender and age, few reports have been published concerning the evaluation of commercially available meat processed products, such as Frankfurter sausages. Thus, the main objective of this study was to provide nutritional information concerning meat Frankfurter sausages, a widely consumed food product. In this study, three types of meat sausages, mainly based on pork meat, poultry meat and a mixture of both meats (pork and poultry) were evaluated. Eighteen different brands of meat sausages randomly acquired in local supermarkets were analysed for their nutritional composition (total fat, moisture, crude protein and ash), cholesterol content and fatty acid profile.

2. MATERIALS AND METHODS

2.1 SAMPLES

Eighteen different samples of Frankfurter type sausages were randomly purchased in local supermarkets, comprising different brands. Table I presents the labelling statements of each meat sausage.

Before the chemical analysis, the samples were crushed and homogenised in a meat grinder (Moulinex, Spain). To obtain oil for further analysis of fatty acid composition the samples were extracted with light petroleum ether (bp 40-60°C) in a Soxhlet apparatus for 3 hours and the remaining solvent was removed under a nitrogen flow. In order to avoid fatty acid oxidation, BHT was used as an antioxidant and added to the samples prior to extraction. Duplicate extractions were performed for all samples. The extracted oil was kept in tubes, flushed with nitrogen, and stored in the dark at 4°C until the analysis was performed (no more than a week).

2.2 PROXIMATE ANALYSIS

Analyses of moisture, total fat, ash and crude protein were carried out in triplicate for each sample. Moisture was determined (ca. 5 g test sample) using a SMO 01 infrared moisture balance (Scaltec, Goettingen, Germany) at 100±2°C. Ash, crude protein (N × 6.25), and total fat content were determined according to AOAC Official Methods [14]. Carbohydrate content was estimated using the following formula:

carbohydrate content = 100% - (%moisture + %protein + %fat + %ash).

2.3 FATTY ACID COMPOSITION

The fatty acid profile was determined by gas-liquid chromatography with flame ionisation detection (GLC-FID)/capillary column. The fatty acids were converted to fatty acid methyl esters (FAME) by hydrolysis of the extracted oil with a 11 g/L methanolic potassium hydroxide solution, followed by methyl esterification with BF_3/MeOH, extraction with *n*-heptane and quantification using a Chrompack CP 9001 chromatograph (Middelburg, The Netherlands) equipped with a split-splitless injector, a FID and an autosampler Chrompack CP-9050. The temperatures of the injector and detector were 230°C and 270°C, respectively. Separation was achieved on a 50 m × 0.25 mm i.d. fused silica capillary column coated with a 0.19 µm film of CP-Sil 88 (Chrompack). Helium was used as a carrier gas at an internal pressure of 120 kPa. The column temperature was 160°C, with a one minute hold, and then programmed to increase to 239°C at a rate of 4°C/min and then 10 minutes hold. The split ratio was 1:50 and the injected volume was 1.2 µL. The results were expressed in relative percentage of each fatty acid, calculated by internal normalisation of the chromatographic peak area. Fatty acid identification was made by comparing the relative retention times of fatty acid methyl esters (FAME) peaks with standards. A Supelco mixture of 37 FAME was used as the standard. The fatty acid isomers methyl *cis*-9-*trans*-12-octadecadienoate, methyl *trans*-9-*cis*-12-octadecadienoate and methyl *cis*-11-octadecenoate were identified using individual standards purchased from Supelco. Analyses were carried out in triplicate assays for each sample.

2.4 CHOLESTEROL

Cholesterol content was determined based on a methodology previously reported [15]. Briefly, approximately 1 g of each sample was accurately weighed into a glass screw cap tube and dispersed in 3 mL ethanol solution (96%) by vortex mixing. Saponification was performed by adding 2 mL of KOH (50%) in water. The mixture was stirred for 1 min, sonicated for 10 min and put in a water bath at 70°C with agitation for 30 min. After hydrolysis, 2.5 mL of cold water were added and the mixture was allowed to cool to room temperature. Subsequently, 5 mL of *n*-hexane were added, the mixture was vigorously vortex stirred for 1 min, centrifuged (3 min, 4000 *g*) (Heraeus Sepatech, Germany) and the clean *n*-hexane layer was collected into another glass tube. The mixture was re-extracted twice, the combined extracts were taken to

Table I - Composition of the different Frankfurter sausages according to label information

Sample	Ingredients
Pork meat based	
F1	Pork meat, ice, mechanically separated pork meat, connective tissue, vegetal protein, salt, spices.
F2	Pork meat, ice, pork fat, salt, spices, soya protein, dairy proteins, dextrose. Contains: celery, soybean, mustard, milk and wheat.
F3	Pork meat, water, salt, dairy proteins, spices, sugar, hydrolysed vegetable protein.
F4	Pork meat, water, soya protein, salt, extract of paprika, spices, chilli, spicy, sugar.
F5	Pork meat, water, salt, sodium caseinate, spices (with celery), condiments, lactose, smoke.
F6	Pork meat, water, salt, milk protein, spices, mustard, condiments, celery, lactose, dextrose, smoke.
F7	Pork meat, water, salt, dairy proteins, spices (with celery), hydrolysed whey milk protein, lactose, smoke.
Poultry meat based	
F8	Poultry meat (chicken and turkey), water, lard, salt, dairy proteins, aromatic herbs, spices, sugar, maltodextrin.
F9	Turkey meat, water, vegetable fat, mechanically recovered meats from poultry, salt, milk proteins, soya protein, spices, dextrose.
F10	Mechanically separated meats from poultry, ice, poultry meat, vegetable oil, starches, soya protein, poultry fat, salt, spices, sugars, dairy proteins, dextrose.
F11	Poultry mechanically recovered meat, water, soy protein, maize starch, salt, dextrose, spices.
F12	Poultry meat (chicken, turkey), water, lard, salt, spices (with celery), hydrolysed whey milk protein, lactose and smoke.
F13	Turkey meat, water, vegetable oil, spices, extract of spices, condiments, lactose.
F14	Chicken meat, water, mechanically recovered meats from poultry, salt, soya protein, milk proteins, spices, dextrose, sugars.
Pork and Poultry mixtures	
F15	Pork meat, ice, mechanically separated meats from poultry, pork fat, rind of pork, soya protein, gluten, salt, spices, dairy proteins.
F16	Pork meat, ice, mechanically separated meats from poultry, connective tissue, soybean protein, starch, salt, spices.
F17	Pork meat, ice, mechanically separated meats from poultry, fat pig, soybean protein, gluten, salt, spices, sugar, dairy proteins, dextrose.
F18	Mechanically separated meats from turkey/chicken, water, pork meat, salt, dairy proteins, spices (with celery), hydrolysed vegetable protein.

dryness under a nitrogen stream on a Reacti-Therm module (Pierce, Rockford, IL) operating at ambient temperature, and the residue was reconstituted to a final volume of 2 mL with *n*-hexane. The extract was transferred to a 2 mL vial and 20 µL were analysed by High Performance Liquid Chromatography (HPLC). A Jasco integrated system (Japan) equipped with an AS-950 automated injector, a PU-980 pump and a MD-910 multiwavelength diode array detector (DAD) was used for the analysis of cholesterol. Separation was carried out on a 75 × 3.0 mm (3 µm) Supelcosil™ LC-SI normal phase column from Supelco (Bellefonte, PA, USA) operating at room temperature (~20°C). The mobile phase used consisted of a mixture of hexane and 1,4-dioxane (97.5:2.5, v/v) at a flow rate of 1 mL/min. All solvents were reagent-grade for extraction and HPLC grade for chromatography. Cholesterol identification was made by comparing the relative retention times and UV spectra of peaks with data from cholesterol standard obtained from Sigma-Aldrich (Madrid, Spain). Chromatographic data were analysed using a Borwin-PDA Controller 156 Software (JMBS, France) 1.5 version based on the chromatograms recorded at 210 nm. Quantification was carried out by external standardisation. The standard solutions were subjected to the entire extraction method described above and a calibration curve with a concentration range from 0.14 to 0.56 mg/mL was used for quantification purposes. Analyses were carried out in triplicate assays for each sample.

2.5 STATISTICAL ANALYSIS

Data were reported as mean ± standard deviation. Analysis of variance (ANOVA) and Tukey's HSD test were carried out to identify significant differences (p <0.05) concerning the cholesterol content. To evaluate significant differences among samples regarding its nutritional composition (fat, protein, carbohydrates, ash and moisture contents) data were subjected to multivariate analysis comprising:

i) MANOVA to evaluate the hypothesis "there is at least one group different from the others in at least one parameter", also calculating the Wilks' lambda and the Pillai-Bartlett trace values;

ii) Hotelling T^2 tests applied to pairs of groups, to evaluate the hypothesis that "the two groups are significantly different in at least one parameter", calculating T^2 values and calculating and tabling the respective F values and corresponding probabilities;

iii) forward stepwise discriminant analysis to select the most discriminant variables;

iv) canonical variate analysis (CVA) based on a subset of the selected variables to further analyse the differences between groups and display those differences in convenient canonical variate plots. Multivariate analysis of data concerning the fatty acid composition of samples included a forward stepwise discriminant analysis to select the most discriminant variables followed by CVA based on a subset of the selected variables to further analyse the differences between groups and display those differences in convenient canonical variate plots. All analyses were carried out in the Statistica for Windows statistical package (Statistica for Windows, StatSoft Inc., Tulsa, OK).

3. RESULTS AND DISCUSSION

3.1 NUTRITIONAL COMPOSITION

So far, several studies have been performed focusing on Frankfurter sausages, yet they mainly concern technological or nutritional improvements regarding their production or microbiological safety evaluation, with very few reports concerning nutritional data of commercial Frankfurters. Table I shows the ingredients stated on the label of each analysed sample and Table II shows the chemical composition obtained for the eighteen Frankfurters, evidencing the nutritional differences among pork, poultry and pork/poultry meat based sausages. In all samples, moisture was the predominant component, followed by fat and protein, which is in good agreement with other previously published results for commercial Frankfurters [9, 16-18]. When compared with data for pork Frankfurters reported in the USDA National Nutrient Database for Standard Reference [19], the mean value for moisture in the analysed samples (64.85%) was slightly higher than the one of the USDA database (59.85%), with only one sample presenting a much lower value (50.92%). Identical values were obtained for protein (12.70% versus 12.81% USDA database), lower values were found for ash content (2.07% versus 3.35% USDA database) and higher values were calculated by difference for carbohydrates (2.21% versus 0.28% USDA database). Regarding total fat, mean content (18.17%) was below the value reported in the USDA database (23.68%), with 3 samples presenting much lower values. This might indicate an increased carefulness by the industry in lowering the fat content of these products, although maintaining the protein level.

In what concerns the poultry meat based sausages, compared to the USDA values reported for chicken and turkey Frankfurters, all the analysed samples showed higher moisture contents and lower fat contents. In general, ash and carbohydrates were lower and protein levels were identical or slightly lower than the values reported in the USDA database.

Similar analyses were carried out by González-Viñas *et al.* [16] in 10 samples of commercial Frankfurters purchased in Spain, comprising of only one pork meat based sausage, with the remaining composed of both pork and poultry meat. Compared to the results for the herein studied Frankfurters produced with meat mixtures, the values reported by González-Viñas *et al.* [16] are mainly different regarding moisture contents, which were much lower (54.5-63.8%). Moreover, some samples had higher fat (10.83-21.92%) and

Table II - Chemical composition of commercial Frankfurters (g/100 g of sample, mean ± standard deviation).

Sample	Moisture	Crude protein	Total fat	Ash	Carbohydrates	Fat/protein
Pork meat based						
F1	75.86 ± 0.23	11.58 ± 0.29	8.54 ± 0.01	2.05 ± 0.14	1.98 ± 0.66	0.74
F2	66.22 ± 0.33	14.97 ± 0.25	15.88 ± 0.00	1.80 ± 0.01	1.13 ± 0.08	1.06
F3	68.18 ± 0.11	12.40 ± 0.17	15.25 ± 0.49	2.10 ± 0.02	2.07 ± 0.45	1.23
F4	50.92 ± 0.62	16.08 ± 0.27	25.36 ± 0.16	2.95 ± 0.03	4.70 ± 0.54	1.58
F5	62.89 ± 0.51	11.49 ± 0.23	20.04 ± 0.09	1.88 ± 0.06	3.71 ± 0.77	1.74
F6	64.93 ± 0.04	11.28 ± 0.22	21.09 ± 0.29	1.77 ± 0.01	0.92 ± 0.46	1.87
F7	64.92 ± 0.03	11.13 ± 0.02	21.07 ± 0.09	1.94 ± 0.01	0.94 ± 0.12	1.89
Mean	64.85	12.70	18.17	2.07	2.21	1.44
Range	50.9 - 75.9	11.1 - 16.1	8.5 - 25.4	1.8 - 3.0	0.9 - 4.7	0.7 - 1.9
Poultry meat based						
F8	68.76 ± 0.42	12.21 ± 0.41	13.64 ± 0.10	2.56 ± 0.03	2.83 ± 0.14	1.12
F9	70.75 ± 0.11	11.32 ± 0.32	11.76 ± 0.19	1.96 ± 0.06	4.21 ± 0.46	1.04
F10	71.02 ± 0.19	13.90 ± 0.12	8.83 ± 0.08	2.65 ± 0.01	3.60 ± 0.21	0.64
F11	70.18 ± 0.38	14.01 ± 0.04	11.05 ± 0.05	2.33 ± 0.17	2.43 ± 0.30	0.79
F12	71.49 ± 0.23	11.69 ± 0.07	14.33 ± 0.08	1.99 ± 0.15	0.51 ± 0.10	1.23
F13	71.08 ± 0.10	14.18 ± 0.36	11.36 ± 0.68	1.97 ± 0.05	1.41 ± 0.17	0.80
F14	76.50 ± 0.42	12.94 ± 0.08	6.91 ± 0.05	1.79 ± 0.03	1.86 ± 0.42	0.53
Mean	71.39	12.89	11.13	2.18	2.41	0.88
Range	68.8 - 76.5	11.3 - 14.2	6.9 - 14.3	1.8 - 2.7	0.5 - 4.2	0.5 - 1.2
Pork and Poultry mixtures						
F15	69.89 ± 0.06	9.97 ± 0.07	14.54 ± 0.19	2.04 ± 0.02	3.56 ± 0.20	1.46
F16	72.70 ± 0.08	8.86 ± 0.14	12.11 ± 0.06	2.11 ± 0.05	4.21 ± 0.24	1.37
F17	69.51 ± 0.18	10.82 ± 0.03	14.53 ± 0.69	1.75 ± 0.07	3.40 ± 0.95	1.34
F18	67.85 ± 0.01	15.04 ± 0.09	13.06 ± 0.18	2.62 ± 0.03	1.44 ± 0.11	0.87
Mean	69.99	11.17	13.56	2.13	3.15	1.18
Range	69.5 - 72.7	8.9 - 15.0	12.1 - 14.5	1.8 - 2.6	1.4 - 4.2	0.9 - 1.5

protein (11.13-6.06%) contents when compared with the values obtained in the present study (Tab. II).
In general, variations can be observed within the groups (Tab. II), which can be explained by the ingredients used in each brand formulation since, as referred, different tissues from the same animal species can vary widely in moisture, protein and fat content, thus affecting the sausage composition. To check for significant differences among the 3 groups considered (pork, poultry and meat mixture based Frankfurters), multivariate statistical analysis was carried out to exploit data for nutritional composition. The results of Hotelling T^2 tests (Tab. III) showed that all groups were statistically different, with pork sausages significantly presenting higher fat and lower moisture contents, while poultry sausages presented significantly lower fat and higher protein contents when compared to meat mixture based sausages. Univariate analysis of variance and Discriminant analysis (DA) were subsequently carried out to check for the most important parameters in the discrimination among the groups and a canonical variate analysis (CVA) was performed to enable the visualisation of the results. Figure 1 shows the plot of Canonical Variates 1 versus 2, where all the information is condensed: 88.3% of data information is represented in the first dimension, mainly separating pork Frankfurters from the other two groups reflecting its higher fat content. The

Table III - MANOVA and Hotelling T^2 tests for the overall difference between group samples of Frankfurters based on the chemical composition.

Summary of MANOVA tests			
Wilks' Lambda = 0.35361		Pillai-Bartlett trace = 0.75894	
Summary of Hotelling T^2 tests			
	Pork	**Poultry**	**Mixture**
Pork	-----	Fat Moisture	Fat Moisture
Poultry	$F_{(5,36)} = 9.0126$ $p < 0.00001$	-----	Protein Fat
Mixture	$F_{(5,27)} = 5.1809$ $p < 0.00185$	$F_{(5,27)} = 2.9691$ $p < 0.02912$	-----

Lower triangle: F_{obs} values (Hotelling T^2); Upper triangle: variables for which t_{obs} values were found to be significant on the univariate test of the hypothesis that two group means are equal.

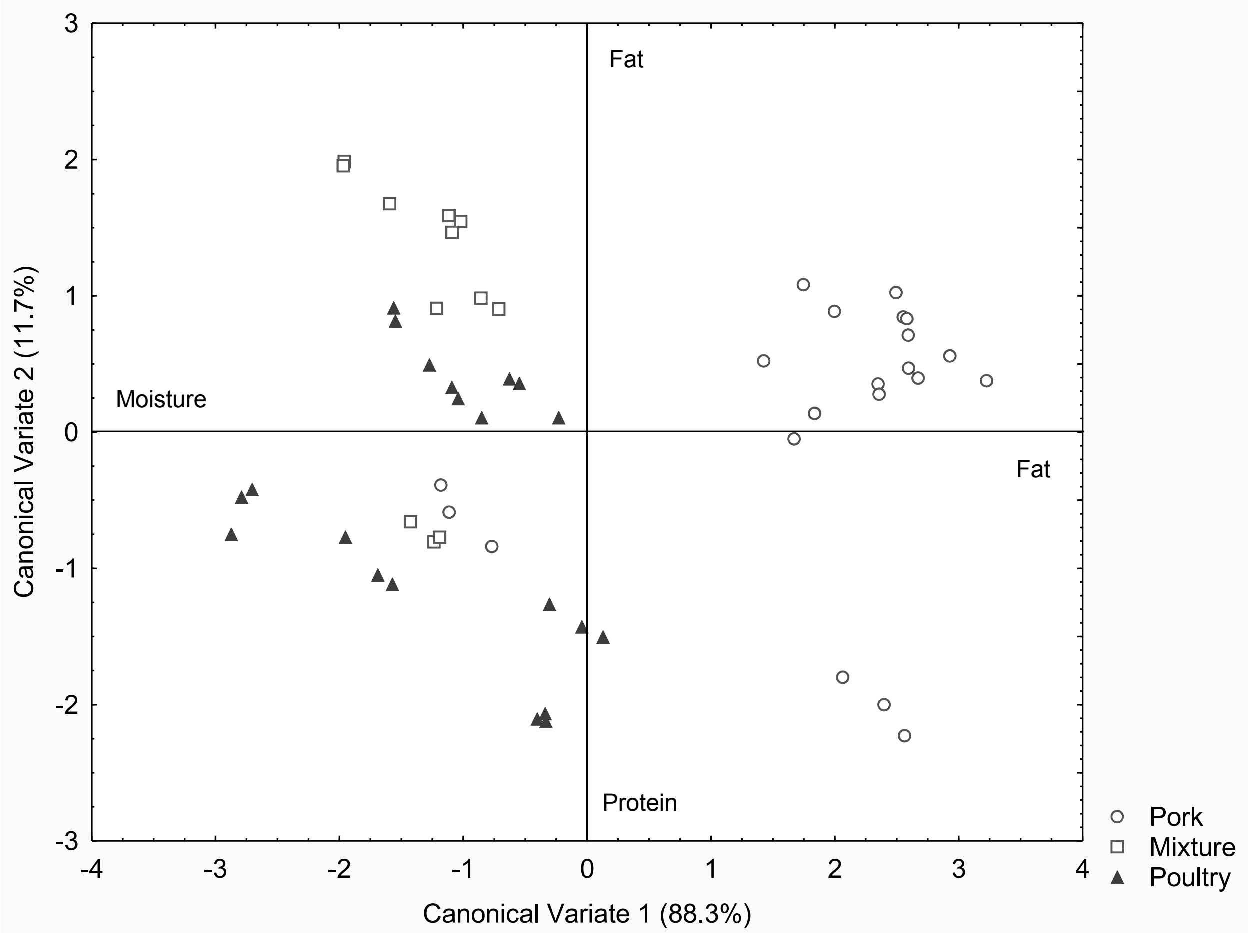

Figure 1 - Biplot of canonical variates 1 versus 2 obtained by a CVA applied to chemical composition data with the type of Frankfurter as the grouping factor (parameters labelling canonical axes are important for their interpretation).

second canonical dimension expresses the fact that some poultry Frankfurters have lower fat and higher protein contents compared to the meat mixture based sausages. Nevertheless, it can be observed that some poultry and meat mixture based sausages have a similar composition, with the two groups being close to each other in the biplot. The achieved results showed that, as expected, commercial pork Frankfurters have a higher fat content when compared to those that include poultry meat in their composition.

3.2 FATTY ACID COMPOSITION

Nowadays, there is a general agreement that the type of fat or fatty acids consumed is of utmost importance with regard to our health. In fact, fatty acid composition can influence various physiological and biochemical processes, including blood pressure regulation, glucose metabolism, lipidic metabolism, platelet aggregation, and erythrocyte deformability [20].

The fatty acid profile of the analysed Frankfurters is shown in Table IV. The data shows that the samples of pork and pork/poultry meats present more within the group similarities than the ones belonging to the group of poultry Frankfurters, which present a higher variability regarding fatty acid composition.

With one exception (sample F9), oleic acid was the predominant compound in all groups of Frankfurters. All samples also presented considerable amounts of palmitic, linoleic and stearic acids, with some variations regarding their proportions depending on the Frankfurter type. In the case of the pork and poultry meat mixture and most pork meat samples, oleic acid was followed by palmitic, linoleic and stearic acids (with some pork sausages having higher contents of stearic rather than linoleic acid). These results are in good agreement with data reported for pork Frankfurters manufactured in pilot plants [7, 21]. In the group of poultry samples, a higher dispersion of results was observed as had been already referred to: in some samples oleic acid was followed by linoleic, palmitic and steric acids, while others presented higher levels of palmitic rather than linoleic acid. The variability of results regarding fatty acid composition of this group of Frankfurters can possibly be related to the use of different ingredients in its production. For example, samples F8 and F12 refer to the use of lard, which is associated with higher SFA contents. Samples F9, F10 and F13 refer to the use of vegetable oil, which present a higher MUFA or PUFA content depending on the oil, and samples F9, F10, F11

Table IV - Fatty acid composition of the oil extracted from commercial Frankfurters (mg/100 g of oil, mean ± standard deviation).

Sample	Fatty acids													
	C12:0	C14:0	C15:0	C16:0	C16:1n9	C16:1n7	C17:0	C17:1n7	C18:0	C18:1n9t	C18:1n9	C18:1n7	C18:2n6	C20:0
Pork based														
F1	0.09 ± 0.02	1.23 ± 0.01	0.09 ± 0.01	22.78 ± 0.23	0.37 ± 0.00	2.24 ± 0.01	0.46 ± 0.00	0.36 ± 0.04	12.03 ± 0.09	0.32 ± 0.03	39.23 ± 0.34	3.10 ± 0.04	13.93 ± 0.18	0.20 ± 0.01
F2	0.09 ± 0.00	1.25 ± 0.02	0.06 ± 0.00	22.85 ± 0.14	0.36 ± 0.03	2.42 ± 0.04	0.36 ± 0.02	0.28 ± 0.02	13.31 ± 0.11	0.24 ± 0.01	40.21 ± 0.29	3.44 ± 0.01	11.30 ± 0.14	0.24 ± 0.02
F3	0.09 ± 0.01	1.22 ± 0.06	0.10 ± 0.00	23.17 ± 0.01	0.37 ± 0.01	2.00 ± 0.06	0.52 ± 0.01	0.40 ± 0.00	13.64 ± 0.33	0.38 ± 0.02	38.27 ± 0.05	2.92 ± 0.00	13.48 ± 0.27	0.23 ± 0.02
F4	0.08 ± 0.00	1.28 ± 0.04	0.08 ± 0.02	22.57 ± 0.02	0.37 ± 0.00	2.33 ± 0.04	0.45 ± 0.02	0.35 ± 0.03	12.03 ± 0.13	0.28 ± 0.00	39.11 ± 0.25	3.20 ± 0.04	14.19 ± 0.20	0.23 ± 0.01
F5	0.13 ± 0.01	1.32 ± 0.04	0.08 ± 0.03	21.80 ± 0.62	0.40 ± 0.02	1.98 ± 0.01	0.36 ± 0.02	0.24 ± 0.01	12.44 ± 0.57	0.23 ± 0.01	40.32 ± 1.41	3.06 ± 0.03	13.33 ± 0.19	0.29 ± 0.04
F6	0.09 ± 0.00	1.31 ± 0.11	0.09 ± 0.00	21.91 ± 0.11	0.42 ± 0.01	2.72 ± 0.80	0.30 ± 0.04	0.19 ± 0.00	11.97 ± 0.57	0.30 ± 0.00	40.32 ± 1.06	3.45 ± 0.03	12.73 ± 0.78	0.32 ± 0.01
F7	0.07 ± 0.01	1.19 ± 0.00	0.00 ± 0.00	22.16 ± 0.18	0.39 ± 0.00	2.27 ± 0.03	0.27 ± 0.01	0.31 ± 0.07	12.14 ± 0.26	0.25 ± 0.01	42.97 ± 0.23	3.73 ± 0.02	10.21 ± 0.02	0.33 ± 0.04
Mean	0.09	1.26	0.07	22.46	0.38	2.28	0.39	0.31	12.51	0.29	40.06	3.27	12.74	0.26
Range	0.07 - 0.13	1.19 - 1.32	0.00 - 0.10	21.80 - 23.17	0.36 - 0.42	1.98 - 2.72	0.27 - 0.52	0.19 - 0.40	11.97 - 13.64	0.23 - 0.38	38.27 - 42.97	2.92 - 3.73	10.21 - 14.19	0.20 - 0.33
Poultry based														
F8	0.05 ± 0.00	1.08 ± 0.08	0.12 ± 0.02	24.96 ± 0.36	0.29 ± 0.01	3.92 ± 0.06	0.20 ± 0.01	0.10 ± 0.01	7.41 ± 0.07	0.33 ± 0.04	36.48 ± 0.29	2.17 ± 0.01	19.49 ± 0.36	0.15 ± 0.01
F9	0.03 ± 0.01	0.30 ± 0.00	0.02 ± 0.00	13.02 ± 0.10	0.45 ± 0.14	0.90 ± 0.00	0.14 ± 0.01	0.07 ± 0.00	4.77 ± 0.09	0.13 ± 0.00	27.18 ± 0.17	1.70 ± 0.02	45.39 ± 0.44	0.34 ± 0.01
F10	0.05 ± 0.02	0.81 ± 0.08	0.12 ± 0.02	19.22 ± 0.36	0.30 ± 0.03	2.57 ± 0.17	0.25 ± 0.01	0.14 ± 0.01	7.31 ± 0.16	0.34 ± 0.00	35.56 ± 0.93	1.84 ± 0.03	28.83 ± 0.30	0.16 ± 0.00
F11	0.00 ± 0.00	1.05 ± 0.00	0.13 ± 0.00	23.27 ± 0.07	0.41 ± 0.00	3.16 ± 0.00	0.32 ± 0.00	0.17 ± 0.00	8.85 ± 0.12	0.46 ± 0.01	37.88 ± 0.04	2.28 ± 0.01	19.29 ± 0.08	0.12 ± 0.00
F12	0.09 ± 0.01	0.98 ± 0.04	0.00 ± 0.00	21.17 ± 0.04	0.37 ± 0.01	2.39 ± 0.05	0.24 ± 0.01	0.14 ± 0.00	10.41 ± 0.15	0.25 ± 0.01	40.69 ± 0.14	3.16 ± 0.01	15.87 ± 0.05	0.30 ± 0.01
F13	0.14 ± 0.01	0.37 ± 0.01	0.06 ± 0.00	12.26 ± 0.34	0.17 ± 0.00	1.90 ± 0.05	0.11 ± 0.00	0.06 ± 0.00	3.79 ± 0.15	0.17 ± 0.02	47.31 ± 1.26	2.50 ± 0.19	23.41 ± 0.55	0.40 ± 0.07
F14	0.07 ± 0.01	0.95 ± 0.01	0.13 ± 0.00	22.90 ± 0.01	0.40 ± 0.00	3.64 ± 0.00	0.27 ± 0.00	0.15 ± 0.00	7.90 ± 0.07	0.45 ± 0.01	37.69 ± 0.15	2.22 ± 0.01	20.15 ± 0.24	0.12 ± 0.01
Mean	0.06	0.79	0.08	19.54	0.34	2.64	0.22	0.12	7.21	0.30	37.54	2.27	24.63	0.23
Range	0.00 - 0.14	0.30 - 1.08	0.00 - 0.13	12.26 - 23.27	0.17 - 0.45	0.90 - 3.92	0.11 - 0.32	0.06 - 0.17	3.79 - 10.41	0.13 - 0.46	27.18 - 47.31	1.70 - 3.16	15.87 - 45.39	0.12 - 0.40
Meat mixture based														
F15	0.08 ± 0.00	1.21 ± 0.03	0.11 ± 0.01	22.91 ± 0.07	0.40 ± 0.00	2.40 ± 0.03	0.52 ± 0.02	0.36 ± 0.04	11.96 ± 0.39	0.36 ± 0.01	39.33 ± 0.14	3.02 ± 0.03	13.76 ± 0.24	0.18 ± 0.00
F16	0.09 ± 0.00	1.22 ± 0.04	0.10 ± 0.00	22.54 ± 0.04	0.36 ± 0.01	2.34 ± 0.06	0.43 ± 0.01	0.29 ± 0.01	11.26 ± 0.03	0.32 ± 0.01	39.39 ± 0.33	2.96 ± 0.03	15.05 ± 0.06	0.19 ± 0.01
F17	0.07 ± 0.02	1.13 ± 0.09	0.10 ± 0.01	22.01 ± 0.66	0.40 ± 0.01	2.15 ± 0.05	0.49 ± 0.00	0.29 ± 0.00	12.18 ± 0.09	0.31 ± 0.06	38.41 ± 0.58	2.83 ± 0.02	15.88 ± 0.20	0.20 ± 0.00
F18	0.14 ± 0.02	1.21 ± 0.04	0.08 ± 0.02	22.53 ± 0.11	0.38 ± 0.03	3.20 ± 0.08	0.28 ± 0.00	0.21 ± 0.01	10.14 ± 0.02	0.26 ± 0.02	41.17 ± 0.46	3.28 ± 0.02	13.15 ± 0.07	0.19 ± 0.02
Mean	0.10	1.19	0.10	22.49	0.39	2.52	0.43	0.29	11.39	0.31	39.58	3.02	14.46	0.19
Range	0.07 - 0.14	1.13 - 1.22	0.08 - 0.11	22.49 - 22.53	0.36 - 0.40	2.15 - 3.20	0.28 - 0.52	0.21 - 0.36	10.14 - 12.18	0.26 - 0.36	38.41 - 41.17	2.83 - 3.28	13.15 - 15.88	0.18 - 0.20

Table IV *- (continuation)*

Sample	Fatty acids										Σ	Σ	Σ	ratio
	C20:1n9	C18:3n3	C21:0	C20:2n6	C22:0	C20:3n6	C20:3n3	C20:4n6	C22:4n3	C22:5n3	SFA	MUFA	PUFA	ω-6/ω-3
Pork based														
F1	0.20 ± 0.01	0.88 ± 0.00	0.07 ± 0.01	0.65 ± 0.00	0.08 ± 0.02	0.14 ± 0.01	0.16 ± 0.01	0.30 ± 0.00	0.17 ± 0.00	0.14 ± 0.02	37.03	46.61	16.36	11
F2	0.24 ± 0.03	0.89 ± 0.01	0.06 ± 0.01	0.60 ± 0.01	0.06 ± 0.01	0.11 ± 0.01	0.18 ± 0.01	0.26 ± 0.00	0.14 ± 0.00	0.17 ± 0.03	38.27	48.07	13.66	9
F3	0.23 ± 0.02	0.83 ± 0.10	0.08 ± 0.00	0.69 ± 0.04	0.03 ± 0.01	0.10 ± 0.04	0.19 ± 0.02	0.27 ± 0.06	0.07 ± 0.00	0.00 ± 0.00	39.06	45.29	15.64	13
F4	0.23 ± 0.04	0.87 ± 0.01	0.06 ± 0.03	0.71 ± 0.02	0.08 ± 0.02	0.15 ± 0.02	0.16 ± 0.00	0.27 ± 0.01	0.16 ± 0.00	0.02 ± 0.03	36.85	46.62	16.54	13
F5	0.29 ± 0.09	1.13 ± 0.03	0.06 ± 0.00	0.75 ± 0.03	0.07 ± 0.00	0.11 ± 0.00	0.23 ± 0.02	0.21 ± 0.00	0.16 ± 0.00	0.00 ± 0.00	36.55	47.52	15.92	9
F6	0.32 ± 0.01	0.85 ± 0.05	0.00 ± 0.00	0.81 ± 0.01	0.08 ± 0.02	0.13 ± 0.02	0.19 ± 0.00	0.23 ± 0.03	0.00 ± 0.00	0.00 ± 0.00	36.07	49.00	14.93	13
F7	0.33 ± 0.05	0.66 ± 0.01	0.00 ± 0.00	0.69 ± 0.04	0.10 ± 0.00	0.12 ± 0.02	0.18 ± 0.01	0.21 ± 0.03	0.13 ± 0.01	0.00 ± 0.00	36.26	51.53	12.21	12
Mean	0.26	0.87	0.05	0.70	0.07	0.12	0.18	0.25	0.12	0.05	37.16	47.81	15.04	11
Range	0.20 - 0.33	0.66 - 1.13	0.00 - 0.08	0.60 - 0.81	0.03 - 0.10	0.10 - 0.15	0.16 - 0.23	0.21 - 0.30	0.00 - 0.17	0.00 - 0.17	36.1-39.1	45.3-51.5	12.2-16.5	11
Poultry based														
F8	0.15 ± 0.03	1.72 ± 0.03	0.02 ± 0.00	0.22 ± 0.01	0.08 ± 0.01	0.08 ± 0.01	0.10 ± 0.04	0.28 ± 0.01	0.11 ± 0.02	0.09 ± 0.02	34.06	43.85	22.08	10
F9	0.34 ± 0.01	4.23 ± 0.11	0.00 ± 0.00	0.10 ± 0.01	0.49 ± 0.01	0.00 ± 0.00	0.00 ± 0.00	0.19 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	19.11	30.98	49.91	11
F10	0.16 ± 0.00	1.04 ± 0.06	0.02 ± 0.00	0.20 ± 0.02	0.25 ± 0.02	0.08 ± 0.00	0.00 ± 0.00	0.26 ± 0.01	0.07 ± 0.00	0.06 ± 0.00	28.19	41.27	30.54	25
F11	0.12 ± 0.01	1.19 ± 0.00	0.00 ± 0.00	0.26 ± 0.01	0.08 ± 0.00	0.10 ± 0.00	0.00 ± 0.00	0.30 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	33.83	45.03	21.14	17
F12	0.30 ± 0.02	0.94 ± 0.02	0.00 ± 0.00	0.71 ± 0.01	0.08 ± 0.00	0.12 ± 0.00	0.14 ± 0.00	0.27 ± 0.01	0.10 ± 0.01	0.16 ± 0.04	33.27	48.42	18.31	13
F13	0.40 ± 0.10	5.33 ± 0.10	0.00 ± 0.00	0.15 ± 0.02	0.26 ± 0.02	0.00 ± 0.00	0.00 ± 0.00	0.24 ± 0.01	0.07 ± 0.01	0.00 ± 0.00	17.41	53.39	29.20	4
F14	0.12 ± 0.01	1.61 ± 0.01	0.00 ± 0.00	0.25 ± 0.00	0.09 ± 0.01	0.11 ± 0.01	0.00 ± 0.00	0.24 ± 0.00	0.06 ± 0.01	0.00 ± 0.00	32.42	45.16	22.42	12
Mean	0.23	2.29	0.01	0.27	0.19	0.07	0.03	0.25	0.06	0.04	28.33	44.01	27.66	10
Range	0.12 - 0.40	0.94 - 5.33	0.00 - 0.02	0.10 - 0.71	0.08 - 0.49	0.00 - 0.12	0.00 - 0.14	0.19 - 0.30	0.00 - 0.11	0.00 - 0.16	17.4-34.1	31.0-53.4	18.3-49.9	13
Meat mixture based														
F15	0.18 ± 0.04	0.94 ± 0.04	0.08 ± 0.00	0.58 ± 0.01	0.05 ± 0.01	0.12 ± 0.00	0.14 ± 0.00	0.24 ± 0.00	0.12 ± 0.01	0.10 ± 0.01	37.11	46.90	15.99	11
F16	0.19 ± 0.00	0.95 ± 0.03	0.05 ± 0.02	0.61 ± 0.01	0.06 ± 0.01	0.12 ± 0.01	0.14 ± 0.01	0.29 ± 0.01	0.14 ± 0.01	0.11 ± 0.01	35.94	46.67	17.39	12
F17	0.20 ± 0.01	0.96 ± 0.05	0.07 ± 0.00	0.68 ± 0.01	0.06 ± 0.01	0.12 ± 0.01	0.13 ± 0.00	0.28 ± 0.01	0.14 ± 0.00	0.10 ± 0.01	36.32	45.40	18.29	13
F18	0.19 ± 0.01	1.43 ± 0.01	0.05 ± 0.02	0.49 ± 0.01	0.07 ± 0.02	0.13 ± 0.02	0.16 ± 0.03	0.23 ± 0.00	0.13 ± 0.03	0.17 ± 0.02	34.68	49.43	15.90	7
Mean	0.19	1.07	0.06	0.59	0.06	0.12	0.14	0.26	0.13	0.12	36.01	47.10	16.89	11
Range	0.18 - 0.20	0.94 - 1.43	0.05 - 0.08	0.49 - 0.68	0.05 - 0.07	0.12 - 0.13	0.13 - 0.16	0.23 - 0.29	0.12 - 0.14	0.10 - 0.17	34.7-37.1	45.4-49.4	15.9-18.3	11

and F14 refer to the inclusion of mechanically separated meats. Previous studies concerning the effects of deboning methods on the chemical composition of turkey meat showed that mechanical deboning resulted on lower levels of stearic and arachidonic acids and higher levels of oleic, linoleic and linolenic acids, when compared to turkey meat separated by hand deboning processes [22]. Moreover, differences have been reported concerning the fatty acid composition of light versus dark meat, both for chicken and turkey meats as well as to the presence of the skin [10]. Besides increasing the fat content, the use of skin in the case of chicken meat increases the MUFA content while decreasing the PUFA, in comparison with the same meat without skin. In the case of turkey, the meat with skin is associated with higher MUFA and lower SFA and PUFA contents [10]. Since these specifications (quantity and type of oil, quantity of lard, quantity and type of meat (light/dark), quantity of mechanically deboned meat, meat with/without skin) are not referred to on the label of products, it is very difficult to correlate the differences in fatty acid composition with the differences in formulations.
Considering the three groups of fatty acids (Tab. IV), almost all samples presented MUFA as the major group, followed by SFA and PUFA. Nevertheless, 3 samples of poultry Frankfurters presented a different profile, namely sample F9 (with PUFA>MUFA>SFA) and samples F10 and F13 (with MUFA>PUFA>SFA). This is probably associated with the addition of vegetable oil that is declared on the label of the referred three samples. The same samples were also those with the highest linoleic acid content and the lowest levels of miristic, palmitic and steric acids. Samples F10 and F13 also presented the highest α-linolenic acid content, while sample F9 presented the highest content of oleic acid. As referred to, this can be probably explained due to the addition of different vegetable oils. It can be hypothesised that in the case of sample F9, a vegetable oil rich in oleic acid, such as olive oil was probably used, while samples F10 and F13 probably included soybean oil, which present high levels of linoleic acid in its composition.
To check for significant differences concerning the fatty acid composition among the three groups considered (pork, poultry and meat mixture based Frankfurter sausages) multivariate statistical analysis was carried out. A forward stepwise DA was applied to the data from the three groups of samples in order to select the fatty acids with relevant information for the evaluation of significant differences among the groups. A CVA was then performed based on the se-

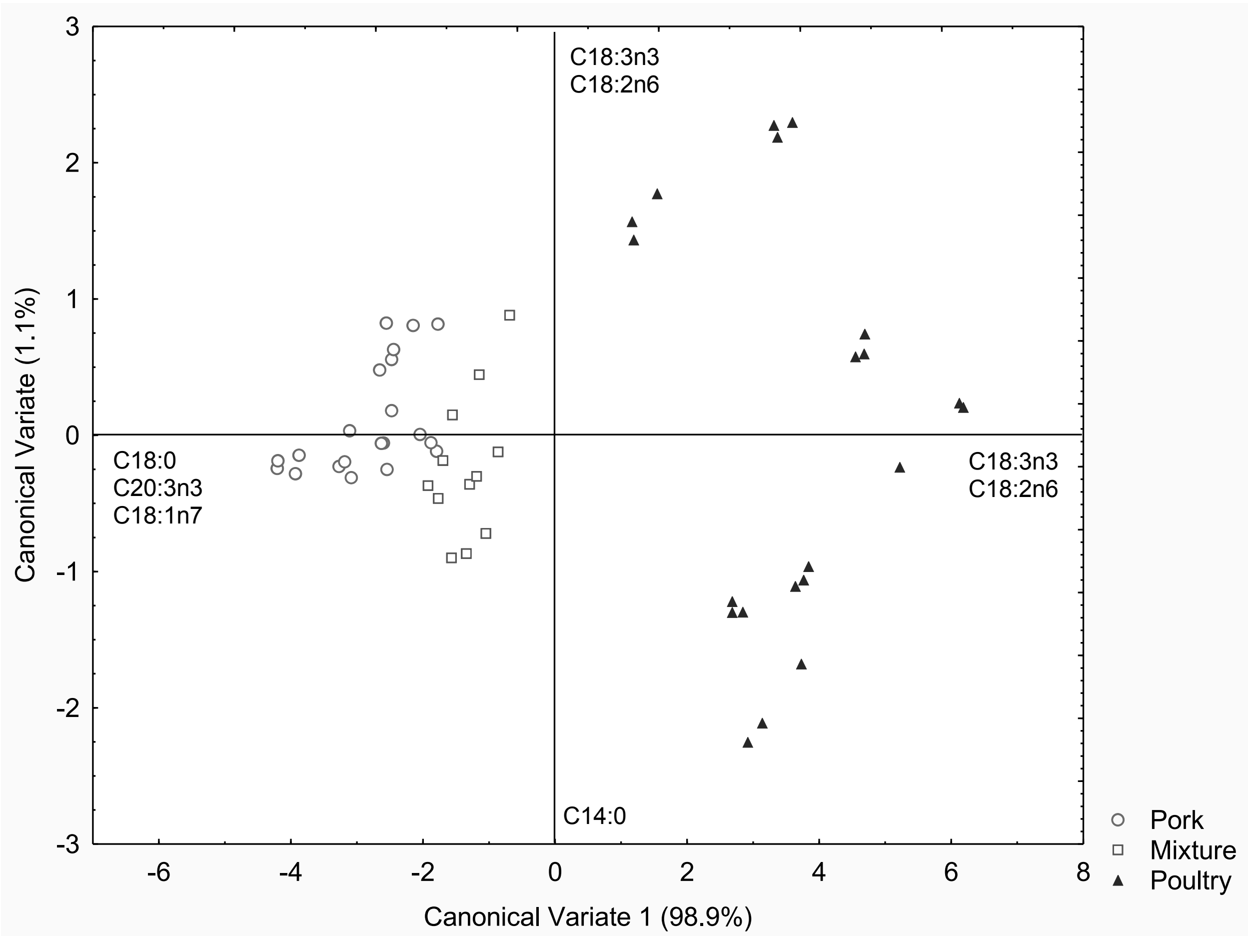

Figure 2 - Biplot of canonical variates 1 versus 2 obtained by a CVA applied to fatty acid composition data with the type of Frankfurter as the grouping factor (parameters labelling canonical axes are important for their interpretation).

lected fatty acids, displaying the differences among the groups in a canonical variate plot (Fig. 2). As it can be observed, almost all the information in the data is represented in the first dimension of the plot, separating the poultry Frankfurters from the other samples and reflecting their higher contents in linoleic (C18:2n6) and α-linolenic (C18:3n3) acids and lower contents in stearic (C18:0), vaccenic (C18:1n7) and *cis*-11,14,17-eicosatrienoic (C20:3n3) acids. The plot also evidences the similarities between the fatty acid composition of the pork Frankfurters and the meat mixture Frankfurters. Although the pork sausages presented slightly higher contents of stearic, vaccenic and *cis*-11,14,17-eicosatrienoic acids, both groups are very close to each other. These results suggest that larger quantities of pork rather than poultry meat are used in the production of meat mixture based Frankfurters. Nevertheless, it should be noted that two samples of this type of Frankfurter (F15 and F17) declared the presence of lard/pig fat on their labels.

The plot also evidences a larger variation of fatty acid composition within the poultry group of samples. As referred to, this group is characterised by lower levels of SFA and higher levels of PUFA, which can point to a healthier profile of this type of sausage compared to the other two groups. In particular, samples F9 and F13 showed a much lower level of SFA, with special emphasis for miristic and palmitic acids, which are considered as having more atherogenic potential than stearic acid. Samples F9 and F13 also showed a much higher level of the omega-3 α-linolenic acid, which has been associated to the prevention of CHD due to antiarrythmic, hypolipipdemic, antithrombotic and anti-inflammatory properties [23]. Sample F13 also followed the recommendation respecting the balance between ω-6/ω-3 PUFA, which is considered a risk factor for CHD and should be approximately 4. The values presented on Table IV shows that, with the exception of two poultry Frankfurters having a ratio ω-6/ω-3 of 25 and 17 (samples F10 and F11, respectively), all other samples showed similar values ranging from 9 to 13. Regarding the presence of harmful *trans* fatty acids, all samples showed very low contents (< 0.5%), thus having a negligible impact on the nutritional value of the Frankfurters.

3.3 CHOLESTEROL CONTENT

The external standard method was used for cholesterol quantification purposes. Linearity was tested using five concentration levels ranging from 140 to 700 μg/mL, each subjected to the entire extraction protocol. A linear relationship between the cholesterol concentration and the detector response was obtained under the assayed conditions. A calibration curve was obtained by plotting the peak-area versus standard concentration, achieving a correlation coefficient of 0.9935. To assess the method precision, reproducibility was evaluated by preparing four replicates of the same Frankfurter sample, each analysed twice. A variation coefficient of 6.02% was obtained showing the reproducibility of the used method.

The results obtained for cholesterol content of the analysed samples are presented in Table V. Mean values of 62.7 mg/100 g, 80.5 mg/100 g and 63.4 mg/100 g were obtained for pork, poultry and meat mixture Frankfurters, respectively. These values are in good agreement with the ones reported in the USDA database for pork (66 mg/100 g), turkey (77 mg/100 g) and chicken (96 mg/100 g) Frankfurters. The lowest cholesterol found in some pork sausages can be possibly explained by the fact that pork fat is mostly accumulated in a subcutaneous layer, being easily removed, thus allowing the control of the quantity of fat incorporated in the sausages in the form of pork backfat. Additionally, the cholesterol content in pork backfat (57 mg/100 g) is reported to be generally lower when compared to different types (dark and light, with and without skin) of chicken (ranging from 58 to 83 mg/100 g) and turkey meat (ranging from 65 to 74 mg/100 g). Bragagnolo and Rodriguez-Amaya [24] reported a mean of 33 mg of cholesterol per 100 g of adult pig backfat, which was significantly lower than the values obtained by the same authors in previous studies (54 mg/100 g). The reported differences were attributed to the animal breed analysed in the sec-

Table V - Cholesterol content of commercial Frankfurters (mg/100 g of sample, mean ± standard deviation)

Sample	Cholesterol*
Pork meat based	
F1	60.26 ± 3.63^{b}
F2	76.77 ± 0.28^{f}
F3	64.96 ± 1.78^{c}
F4	72.88 ± 2.46^{e,f}
F5	48.25 ± 0.83^{a}
F6	58.13 ± 0.83^{b}
F7	57.26 ± 0.99^{b}
mean	62.65
range	48.3 – 76.8
Poultry meat based	
F8	95.89 ± 1.26^{h}
F9	81.56 ± 0.40^{g}
F10	60.04 ± 0.23^{b}
F11	70.40 ± 3.63^{d,e}
F12	68.30 ± 0.24^{c,d}
F13	121.91 ± 4.33^{i}
F14	65.17 ± 0.14^{c}
mean	80.47
range	60.0 – 121.9
Pork and Poultry mixtures	
F15	60.08 ± 1.08^{b}
F16	47.43 ± 0.19^{a}
F17	73.95 ± 0.62^{e,f}
F18	72.21 ± 0.58^{e}
mean	63.42
range	47.4 – 72.2

* values with different letters indicate significant differences (p <0.05)

ond study, which was being introduced as a low-fat and low-cholesterol pork. These findings are also in agreement with the results reported by Baggio and Bragagnolo [18], who found lower cholesterol levels in Brazilian commercial sausages produced only with pork, when compared to Frankfurters with other meats in their formulation. These authors reported a mean cholesterol value of 33.4 mg/100g in processed pork sausages (ranging from 27.4 to 36.7 mg/100g in 5 brands) and of 51.8 mg/100 g in meat mixture Frankfurters (ranging from 44.3 to 71.1 mg/100 g in 5 brands of Frankfurters containing pork, beef and mechanically deboned poultry meat).
Identically to what was observed for fatty acid composition, Table V also allows verifying a larger variation in the cholesterol contents within the group of poultry Frankfurters. As mentioned above, several factors such as breed, age, diet and part of the animal might affect the final content of meat cholesterol and, consequently in the final processed product. One way-ANOVA analysis applied to the three considered groups evidenced the significantly higher cholesterol content of the poultry Frankfurters group (p <0.05) compared to the other analysed samples, and showed that the pork and meat mixture Frankfurters presented similar cholesterol contents (p >0.05).
According to the World Health Organization and the American Heart Association, the daily cholesterol intake should be below 300 mg/day. Hence, considering the mean values obtained for the three considered groups, the consumption of 100 g of Frankfurters would provide around 20 to 27% of cholesterol total intake.

4. CONCLUSIONS

In this work, several brands of commercial Frankfurters were evaluated for nutritional composition (including moisture, protein, fat, carbohydrates and ash contents), fatty acid composition and cholesterol content. The obtained results showed that, in general, commercial pork Frankfurters presented a higher fat content than the other samples with poultry meat in their composition. Regarding the fatty acid profile, the results suggest that it is strongly influenced by the type of meats, as well as other ingredients such as vegetable oil and lard, used in the formulation of Frankfurters. In general, the group of poultry Frankfurters was characterised by lower levels of SFA and higher levels of PUFA, which can point to a healthier profile of this type of sausages compared to the other two groups. Nevertheless, it should be noticed that some samples of this group presented higher levels of cholesterol compared to the pork and meat mixture Frankfurters. In fact, the group of pork Frankfurters was the one with the lowest mean cholesterol content, which somehow contradicts the consumers' idea that pork meat products should be avoided due to its high cholesterol levels.

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Conflict of interest statement

The Authors declare that there is no conflict of interest.

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