EVALUATION OF THE CHEMICAL COMPOSITION AND THE NUTRITIONAL QUALITY OF TRADITIONAL (VILLAGE) STYLE GREEK SAUSAGES

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Abstract – The aim of this study was to determine the chemical composition and nutritional characteristics of traditional Greek sausages produced in butcher shops. A second aim was to compare the results with published data to evaluate compliance with the food legislation. Sausages (n=25) were instrumentally assessed for moisture, ash, protein, fat, sodium chloride (salt) and nitrite content, and lipid oxidation levels. The average moisture, ash, protein, fat, salt and nitrite content was 49.60 %, 2.75 %, 14.14 %, 31.74 %, 2.08 % and 4.66 ppm respectively. Average lipid oxidation, expressed as TBARS, was 0.935 mg malonaldehyde/kg sample. There were wide differences in the values of the examined characteristics. Chemical and nutritional evaluation showed great variability in product formulation but better compliance (or adherence) to food legislation and improved nutritional quality in relation to the guidelines and the recommendations for healthy food consumption.

Key Words – Chemical composition, Greek traditional sausages, Health risks, Nutritional value

I. INTRODUCTION

Traditional (village) style Greek sausages are very popular and widely consumed products in Greece. In the past, sausages were produced at home according to local recipes whereas nowadays, they are produced either in butcher's shops or in sausage manufacturing companies. Pork meat and fat are coarsely chopped and thoroughly mixed with salt, pepper and other seasonings. The sausage batter is stuffed in natural casings and the end product is kept under refrigerated storage until consumption. According to the Greek Food Legislation [1], traditional sausages are characterized as fresh (non cooked sausages), manufactured only from lean meat and fat. The fat content should not be higher than 35%. The addition of salt, phosphates, nitrites, monosodium glutamate (MSG), ascorbic acid/salt and sugars is also allowed but it is not mandatory. Sausages may be subjected to semi-drying or smoking processes, and they should be consumed only after thermal processing (frying, grilling or cooking) [2]. The quality characteristics of traditional sausages sold in northern Greece have been examined in the past [2, 3] and the results have shown great variability in the chemical composition as well as failure to comply with the food legislation in aspects such as fat content and nitrite concentration.

Nutritional and health value characteristics of traditional sausages, in relation to public health importance, refer to parameters such fat, salt and nitrites content and to the level of lipid oxidation. The European Food Safety Authority [4] recommends that the total fat intake should be in the range of 20-35% of the total dietary energy intake. Salt consumption should not exceed 5 g/day [5] whereas mean daily salt intakes of populations in Europe range from 8 to 11g) [6]. Increased fat and salt intakes are related to the incidence of cardiovascular disease and hypertension. Nitrite is used for curing meat products and it is usually added as potassium or sodium salts. The addition of nitrites in non-heated meat products (calculated as sodium nitrite) is limited to 100 ppm due to the formation of carcinogenic nitrosamines [7]. The mean intake

estimates for dietary nitrites vary from 0 to 20 mg/d with most nitrite intake deriving from nitrite food additives in processed and cured meat products [8]. Lipid oxidation is one of the primary causes for the deterioration of colour, texture, flavour, taste, nutritional value of muscle foods. Consumption of oxidized fat represents a health risk because some of the lipid oxidation products are related to harmful biological properties [9].

The purpose of this study was to determine the chemical composition of traditional sausages and to compare the results with those reported in previous studies on samples collected in the same geographical area, in order to find differences in product formulation over a period of several years and to assess compliance with the food legislation. A second aim was to evaluate the nutritional quality of traditional sausages in relation to recent nutritional guidelines and regulations, and modern consumer food-related health concerns.

II. MATERIALS AND METHODS

Traditional fresh sausages were purchased from 25 butcher shops 1-2 days after the end of their production, as declared by the seller. The shops produced and sold sausages in their premises and they were located in the urban agglomeration of the city of Thessaloniki. Care was taken to collect samples from low, middle and high income areas to adjust for product variability related to socio-economic food liking patterns. Samples from the same batch were placed in oxygen permeable food bags and they were stored at 4°C until analysed. Analyses were performed in 1kg samples, consisting of 2-3 sausages, to ensure product homogeneity due to the fact that the sausage batter is mixed manually. All analyses were conducted in duplicate and they were completed within 1 week following sample collection.

Moisture, ash, protein and fat content were determined according to the standard AOAC [10] procedures. Sodium chloride content was determined by titration with a standard silver nitrate solution and potassium chromate as indicator. Sodium nitrite concentration was determined with a modification of the AOAC [10] method. Lipid oxidation was determined as thiobarbituric acid reactive substances (TBARS) using a modification of the method of Vyncke [11] on storage day 2 (3rd day after production). The energy content (kcal per 100g of raw product) was calculated from the chemical composition data for protein and fat.

Data were analysed using descriptive statistics with SPSS Statistics 20 software package (SPSS Inc., Chigaco, IL, USA).

III. RESULTS AND DISCUSSION

Descriptive statistics of the examined variables are presented in Table 1 and comparisons between mean values of the present study with the corresponding values of the two previous studies are presented in Table 2. Chemical composition analysis has showed that moisture content was higher in our study in comparison to the study of Papadima *et al*. [3] and similar to the content reported by Ambrosiadis *et al*. [2]. In the latter study the sausages were purchased 2-6 days after the end day of their production whereas in the former study the samples were collected 2-21 after their production and this may account for the lower moisture content as the sausages were probably drier. Ash content was lower in our study in relation to the other two studies [2, 3]. Protein content was lower in the present in comparison to the previous studies. The highest protein content was observed in the study of Papadima *et al.* [3]. The results for protein content revealed that there is probably a gradual decrease in the amount of lean meat used for the production of traditional sausages. Fat was the component with the highest variability. Papadima *et al*. [3] and Ambrosiadis *et al*. [2] also reported fat as the component with the greater variability (Table 2). The average fat content was in accordance with the regulations of the Greek Food Legislation [1] but 28% of the samples had fat content higher than 35% that is the highest permitted level. The fat percentage was similar to the one reported by Ambrosiadis *et al*. [2] and lower to the percentage reported by Papadima *et al*. [3]. The latter study was conducted in 1999, a period that the higher fat content was more acceptable and favoured by the consumers. It should be noted that in response to the lower moisture percentage in the study of Papadima *et al.* [3] the percentages of ash, protein and fat are elevated, and this may not reflect actual differences in product formulation but projected differences resulting from the higher dry matter

content of the analysed samples. On the other hand, the reported proximate analysis refers to the nutrient content of the consumed (end) product allowing thus for direct comparisons with the other studies. The sodium chloride (salt) content was approximately 37% lower than the salt content reported by Papadima *et al*. [3]. The high salt content in the latter study is attributed to the fact that in the past salt was added to the sausage batter in high quantities as the only used preservative. Nowadays, the use of herbs and spices such as pepper, paprika, rosemary, sage, thyme, oregano, etc as natural preservatives is promoted because they appeal to the health conscious consumers that demand products with lower sodium content and exciting flavours [12]. The average nitrite content was 4.66 ppm whereas 68% of the samples contained nitrites at levels lower than the detection limit of 0.001 ppm. Additionally, there were no samples that the residual nitrite concentration exceeded the maximum permitted limit of 100 ppm [7]. In the study of Papadima *et al.* [3] the average nitrite concentration was approximately 83% lower than the average nitrite concentration of the present study. The very low concentrations of nitrites indicate that there was no direct addition of nitrites in the sausage batter and the measured levels of nitrites are considered as residual resulting from the reduction of nitrates, that are commonly found in spices and leeks usually used in sausage mixtures, to nitrites. Regarding lipid oxidation, TBARS value was 0.935 mg malonaldehyde (MDA)/kg sample and approximately 40% lower than the lipid oxidation levels reported by Papadima *et al.* [3]. In 5% of the samples, though, TBARS values exceeded the value of 1 mg malondialdehyde/kg sample considered the threshold value for the detection of rancidity in meat products. The higher TBARS values and the greater variability in the study of Papadima *et al.* [3] may be related to the longer storage period of these samples (2-21 days) and to the higher content of salt that exhibits prooxidant function. Other factors affecting lipid oxidation levels in traditional sausages are the quantity, the quality and the degree of lipid unsaturation of the added fat, and the presence of antioxidant and prooxidant compounds. The calculated energy density of a portion (100g raw product) was 349 calories and it was similar to the ones reported in the studies of Ambrosiadis *et al*. [2] and Papadima *et al*. [3].

Table 1 Mean, minimum, maximum, standard deviation (SD) and per cent coefficient of variation on the examined parameters (n=25)

Variable	Mean	Min	Max	SD	CV%
Moisture (%)	49.60	31.98	61.50	7.535	15.19
Ash (%)	2.75	2.05	3.56	0.380	13.81
Protein (%)	14.14	9.62	19.36	2.508	17.74
Fat (%)	31.74	19.74	53.57	8.175	25.76
Sodium chloride (NaCl) (%)	2.08	1.37	3.28	0.424	20.37
Nitrites (ppm)	4.66	0.00	36.85	9.274	198.85
TBARS (mg MDA/kg sample)	0.935	0.479	2.852	0.6212	66.41
Energy (kcal/100g raw product)	349	242	530	70.1	20.06

Table 2 Comparison of the examined variables (mean values) with previous studies.

Variable	Current study (n=25)	Study 1[1] (n=67)	Study 2[2] (n=31)
Moisture (%)	49.60	49.17	43.98
Ash (%)	2.75	2.99	3.33
Protein (%)	14.14	17.62	19.19
Fat (%)	31.74	29.74	33.50
Sodium chloride (NaCl) (%)	2.08	ND [3]	3.31
Nitrites (ppm)	4.66	ND [3]	0.77
TBARS (mg MDA/kg sample)	0.935	ND [3]	1.56
Energy (kcal/100g raw product)	349	340	378

[1] Ambrosiadis *et al*. [2]; [2] Papadima *et al.* [3]; [3] ND; Not determined

The effect of the health related sausage components on daily dietary intakes is presented in Table 3. A portion of sausage provides consumers with approximately 40% of the recommended daily allowance for salt consumption. Processed meat products comprise one of the major sources of salt in the human diet. Reducing salt content, though, is a challenge for the producers of processed meat products due to the important sensory and technological properties of salt in product making [13]. The nitrite content

was particularly low showing that traditional sausages satisfy consumers' growing preferences for natural foods without any chemical additives.

Table 3 Contribution of a traditional sausage portion to intakes of salt, nitrites, energy and fat in relation to nutritional guidelines

Variable (100g raw product)	Mean values	Percentage of allowed intake
Sodium chloride (NaCl)[1]	2.08	41.6
Nitrites[2]	0.47	2.35
Energy (kcal)[3]	349	17.5
Calories from fat content (kcal)[3],[4]	285	14.2

[1] WHO [4]
[2] Calculated on the maximum estimated daily intake (20 mg)
[3] Based on an adult diet of 2000 kcal/day
[4] European Food Safety Authority [3]

The contribution of sausage portion to daily fat intake is considerably high according to the European Food Safety Authority guidelines [4]. Furthermore, 16% of the samples had a fat content higher than 37% providing, thus, consumers with more than 50% of the maximum recommended fat daily intake. Nutritional guidelines refer to diet as a whole, though, and therefore the high fat content of a sausage can be "corrected" by consumption of other food products. Finally, regarding lipid oxidation, the levels of consumption of oxidised fat that can affect human health have not been determined. Consumption of food containing oxidised fat should be avoided, though [9, 14].

IV. CONCLUSION

In conclusion, chemical composition analysis showed wide differences in product formulation but greater compliance with the food regulations. Evaluation of the nutritional and health value characteristics revealed product improvement in order to meet the growing consumers' demands for healthier food products.

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