Nutrient composition of Swiss cooked sausages

Keywords
- Cooked sausages
- Nutrient analyses
- Composition
- Vitamins
- Minerals

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Besides fresh meat, meat products are widespread and amongst them, cooked sausages are well known and very popular. The aim of the present study was to determine the content of macro- and micronutrients in various, commercially available Swiss cooked sausages. For each sausage type five different samples (packed products) were bought in the retail business and analysed. The results show, that the sausages contain on average 58 to 65 g water, 11 to 16 g protein, 16 to 23 g fat and carbohydrates < 2 g per 100 g sausage. The cholesterol content ranges from 46 to 67 mg/100 g. Relating to the dietary reference intakes cooked sausages are a good source for the vitamins B_1 (0.1–0.5 mg/100 g), B_{12} (0.4–0.9 μg/100 g) and Niacin (2.4–4.7 mg/100 g), and some of them for vitamin C (2.2–41.9 mg/100 g). They also contain the vitamins D, B_2, B_6 and pantothenic acid but lack in vitamin A and E. They supply important amounts of phosphor, zinc, iron and selenium, but they also feature a high sodium content.

Meat is a food with high nutritional qualities. It is rich in protein, low in carbohydrates and depending on the piece and cut it is also low in fat. In Switzerland meat is the most important source for the vitamins A, B_1, B_{12} and niacin as well as for the elements sodium and iron (EICHHOLZER et al., 2005). Additionally, it contributes substantially to the supply of the vitamins B_2, B_6 and pantothenic acid and to the elements phosphorus and zinc. Besides fresh meat, meat products are also widespread. About 90,000 t of meat products are eaten each year in Switzerland with growing tendency; 20% of the meat consumed in private households are sausages (PROVIANDE, 2008 and 2007). Meat products of the cooked-sausage type, such as Cervelat, frying sausage from veal or pork and Vienna sausage, are among the most well-known and popular meat products in Switzerland.

Although cooked sausages are consumed in large quantities there is no information in Switzerland regarding their nutrient composition (except the macronutrients) based on chemical analyses. The currently existing data in the Swiss food composition tables were calculated on the basis of common sausage recipes. However, up-to-date and accurate information about the composition of food is essential for many areas of the nutrition and food science, especially as recipes as well as meat cuts tend to change over time. Also the increased interest of consumers for health and nutrition topics demands a correct and broad data basis for local food products. Nutrient data of comparable foreign (e.g. German) meat products are available (DFA, 2000) but need chemical confirmation for Swiss products because of partly deviating recipes and manufacturing processes. Therefore, the aim of the present study was to determine the content of macro- and micronutrients in the most important commercially available Swiss cooked sausages. The data from the present study is foreseen to update the Swiss Food Composition Database.

Materials and methods

▶ Samples

Eight diverging sorts of cooked sausages were included in this study. The chosen products had to be 1) Swiss products with a high degree of popularity, 2) disseminated country-wide and not only regionally, 3) consumed in substantial amounts and 4) differing from each other in the composition or the manufacturing process. The finally chosen sausages were: frying sausage from veal, Cervelat (also called "cervelas"), Vienna sausage, Lyoner sausage, meat loaf, frying sausage from pork (strictly a raw sausage), pork sausage and Lyoner sausage from poultry. The first four sausages (frying sausage from veal, Cervelat, Vienna sausage, and Lyoner) were collected in November 2006, the second four sausages in June 2007. For each sausage type five different samples (packed products) were bought in the retail business (40 samples in total). The following specifications were applied:

- Only standard products (no budget or premium products) with the proper, previously defined denomination were purchased.
- Only Swiss products were considered, whose producer and place of production were identifiable.
- To achieve high market coverage, only products of medium and large scale manufacturers were chosen (no products of individual butcheries) and the products of the two market-leading retailer groups in Switzerland (market coverage: close to 80%) were included imperatively.
- A Swiss wide allocation of the products and the producers, respectively, was mandatory to account for regional differences.

Each sample comprised 2.5 kg of the same product (but not necessarily of the same production lot). The samples were collected directly in the chosen shops and transferred in coolers to Agroscope Liebefeld-Posieux Research Station (ALP) by ALP-staff, where the individual products were registered firstly. All information given on the packages were noted (name of product, producer, lot number, composition, nutrient declaration, etc.) and entered in a database. The samples were then portioned, coded and forwarded to the internal and external laboratories responsible for the various nutrient analyses. During transport and preparation of the samples, they were kept under continuous cool conditions. The samples to be analysed for crude protein, amino acids, crude fat, cholesterol, total sugar, vitamins A and E as well as the elements sodium, potassium, magnesium, calcium, phosphorus, chloride, copper, selenium, iron, zinc and manganese were freeze-dried (lyophilised) and stored at –20 °C (–4 °F) until analyses occurred.

▶ Chemical Analyses

All analyses were carried out in accredited laboratories, either at ALP or otherwise when stated, with two analytical replicates per sample.

Macronutrients

Macronutrients were determined as described in HADORN et al. (2008). Water was calculated by subtraction of the dry mass which was obtained by gravimetry after heating the sample at 105 °C for 2:40 h. Protein was calculated by multiplying the total nitrogen content by a factor of 6.25, which was obtained via Kjeldahl analysis. Crude fat was determined by gravimetry after extraction with petrol-ether in a sox-

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tec installation. Carbohydrates were determined as total sugar (mono- and oligosaccharides) after extraction with 80% hot ethanol and colorimetric detection of the monomers in the distillate upon reaction with orcin/sulfuric acid. For analysing cholesterol the samples were saponified and the sterols extracted with hexane. After a derivatisation with BSTFA/pyridine the cholesterol concentration was determined with GC-FID (NAEEMI et al., 1995; RODRIGUEZ-PALMERO et al., 1994).

Minerals and trace elements

Sodium, potassium, magnesium, calcium, phosphorus, copper, iron, zinc and manganese were determined by ICP-OES after a wet digestion (EN 15510, 2008). Chloride was quantified by potentiometric titration with silver nitrate after an acidic wet digestion (SLMB method 322.1). To determine selenium the samples were digested with nitric acid in the presence of hydrogen peroxide and magnesium nitrate and the residues dried and combusted. The ashes were treated with hydrochloric acid before measuring the selenium content via flow injection-hydride-GFAAS (graphite furnace atomic absorption spectroscopy) (Perkin-Elmer GF-AAS Analyst 600).

Vitamins

Vitamins A, E, B_1, B_2 and B_6 were also performed at ALP. For the determination of vitamins B_1, B_2 and B_6, meat samples were homogenised with water and hydrolysed with hydrochloric acid followed by enzymatic hydrolysis with taka diastase. Vitamin B_1 (thiamine) was oxidised to thiochrome with alkaline potassium hexacyanoferrat-(III), whereas no additional treatment was applied for vitamin B_2 and B_6. HPLC analysis with fluorescence detection was carried out on a reversed phase column to determine the three vitamins. The vitamin B_6-result represents the sum of the three vitamers pyridoxamin, pyridoxal and pyridoxine converted to pyridoxine (TAGLIAFERRI et al., 1992a,b; BOGNAR, 1992).

For the determination of the vitamins A and E the sample material was saponified in an alkaline milieu by addition of butylated hydroxytoluene followed by an extraction with *n*-hexane. The extract was evaporated and the remnant solved in methanol. Vitamin A und E concentrations were determined by reversed phase HPLC with a diode array detector (DAD) (SÖDERHJELM and ANDERSSON, 1978). Since the vitamin A and E results of the first 20 samples (first four sausage types) were below the analytical detection limits and further samples were not expected to have higher concentrations, only composite samples of the 5 product samples of each sausage type were analyzed in the second series of analysis.

The analyses of the vitamins B_{12}, C, D_3 (cholecalciferol), K_2 (menachinone), niacin, pantothenic acid and biotin were carried out at the Interlabor Belp AG, Belp, Switzerland. For the vitamins D_3, K_2 and biotin only composite samples of the 5 product samples of each sausage type were analysed, because results below or around the limit of detection were expected.

Niacin (nicotinic acid and nicotinamide) was extracted with a diluted acid from the sample material and quantified by HPLC-DAD (SLMB method 1555.1).

Vitamin B_{12} was determined microbiologically with *Lactobacillus delbruckii* (ATCC 7830) according to the AOAC method 952.20.

Vitamin C was determined with HPLC-UV after an extraction with dithiothreitol (SLMB method 1559.1).

For vitamin D_3 analysis ergocalciferol (D_2) was added to the samples as a retrieval standard. The samples then were subject to an alkaline saponification followed by an extraction with *iso*-hexane. The extract was concentrated and an aliquot fractionated on a semi preparative HPLC-column. The obtained vitamin D_2/D_3 fraction was again concentrated and then analysed by HPLC with UV detection (SLMB method 1537.1; EN 12821:1997E).

For determination of pantothenic acid the vitamin was extracted from sample materials with the help of a buffer solution. Of the extract as well as a Ca-D-pantothenate standard solution geometrical dilution series were prepared in a pantothenic acid free assay medium. The dilution series were inoculated with *Lactobacillus plantarum* (ATCC 8014) and incubated at 37 °C. The degree of opacity in the sample preparations was measured photometrically at 525 nm (SLMB method 1556.1).

For the determination of vitamin K_2, vitamin K_1 was used as retrieval standard. Vitamin K_1 was added to the homogenised sample and the whole was subject to an enzymatic lipolysis. Vitamin K was then extracted with hexane from the sample material and cleaned with semi preparative HPLC. After the successful separation of vitamin K_2 by HPLC using a zinc column it was reduced and its concentration determined by fluorescence detection. The response factor of vitamin K_2 (menachinon 4) to vitamin K_1 was used to quantify the findings (SLMB method 1540.1).

Biotin was extracted by acid hydrolysis. Of the extract as well as a biotin standard solution geometrical dilution series were prepared in a biotin free assay medium. The dilution series were inoculated with *Lactobacillus plantarum* (ATCC 8014) and incubated at 37 °C. The degree of opacity in the sample preparations was measured photometrically (SLMB method 1550.1).

Energy

The energy values (kJ per 100 g) of the sausages were calculated according the Swiss Food Manual (SLMB method 469.2) applying the following factors (per g): fat 37 kJ, protein 17 kJ and carbohydrates 17 kJ. For the conversion from kJ in kcal, the factor 0.239 was used.

▶ Data treatment

For every type of cooked sausage the arithmetic mean of the various macro- and micronutrients was calculated. Exceptions are the results of the vitamins A, E, D, K and biotin which originate from the composite samples. All calculations were performed with Systat® for Windows version 11 (Richmond, CA, USA) and Microsoft Excel 2003. The results in this publication are given as mean of the 5 sausage samples per sausage type with the standard deviation in brackets. All values refer to 100 g fresh weight of the raw, edible sausage parts. Where indications regarding the contribution to the recommended intakes for certain vitamins and minerals are made, the calculations are based on the dietary reference intakes (DRIs) for males aged 19-50 y (Food and Nutrition Board, 2004).

Tab. 1: Energy, water, protein, fat, cholesterol and carbohydrates (mean and SD) in the investigated 8 Swiss cooked sausages (per 100 g edible parts)

	Frying veal sausage	Cervelat	Vienna sausage	Lyoner	Meat loaf	Frying pork sausage	Pork sausage	Poultry lyoner
	N=5	N=5	N=5	N=5	N=5	N=5	N=5	N=5
Energy (kJ)	943 (71)	1032 (112)	1000 (45)	1010 (102)	1060 (56)	978 (42)	1113 (179)	852 (129)
Energy (kcal)	225 (17)	247 (27)	239 (11)	241 (25)	253 (13)	234 (10)	266 (43)	204 (31)
Water (g)	63.4 (1.6)	61.8 (2.4)	61.9 (1.1)	62.9 (3.1)	60.1 (2.0)	61.8 (1.2)	57.8 (3.8)	65.3 (2.7)
Protein (g)	12.5 (1.0)	13.4 (0.8)	13.9 (0.4)	11.5 (0.7)	12.5 (0.7)	16.2 (0.5)	16.2 (1.4)	13.5 (2.1)
Fat (g)	19.2 (2.1)	21.5 (3.4)	20.4 (1.3)	21.8 (2.9)	22.3 (1.5)	18.8 (1.2)	22.4 (5.5)	16.4 (4.4)
Cholesterol (mg)	52.5 (1.8)	51.0 (2.7)	51.2 (4.7)	46.1 (2.8)	51.4 (4.4)	66.6 (4.3)	61.0 (8.1)	65.0 (9.8)
Carbohydrates (g)	1.2 (0.3)	0.5 (0.1)	0.6 (0.03)	0.5 (0.2)	1.4 (0.8)	0.5 (0.3)	0.5 (0.2)	0.9 (0.4)

Source: SCHMID et al. Fleischwirtschaft International 6/2009

Results and discussion

▶ Macronutrients

The energy, protein, fat, cholesterol, carbohydrate, and water contents of the investigated cooked sausages are given in Table 1. The analysed cooked sausages contain 58 to 65 g water per 100 g of sausage. The lowest value is found in the pork sausage (57.8 g), the highest in the Lyoner from poultry (65.3 g). Comparing the Swiss sausages with the same sausage types in Germany (frying sausage from veal, Cervelat (in Germany "Bockwurst"), Vienna sausage, Lyoner, meat loaf, frying sausage from pork) revealed generally a slightly lower water content in the German products (min/max: 57.0 g/62.0 g) (DFA, 2000). The German Lyoner shows the highest difference to the Swiss version in regard to the water content (58.8 g versus 62.9 g). The protein content varies from 11.5 g/100 g (Lyoner) to 16.2 g/100 g (pork sausage and frying sausage from pork). Comparable values are seen in five of the six German products. However, the frying sausage from pork, presenting relatively high protein values in Switzerland (16.2 g), is rather low in protein (11.5 g) in Germany. The fat content of the analysed Swiss sausages is around 20 g (with the exception of the Lyoner from poultry with 16.4 g). The same sausages based on German recipes congruently characterise with a higher fat content (on average 26.7 g). To be highlighted is again the frying sausage from pork with a difference of 10 g between the two countries. The higher fat proportion is reflected in the energy value of the German products: They generally are higher in energy content than their Swiss counterparts (data not shown). As expected the energy value of the Lyoner from poultry is the lowest (852 kJ per 100 g); the highest value presents the meat loaf with 1,060 kJ. The carbohydrates do not play an important role in cooked sausages, they range between 0.5 and 1.4 g/100 g. The Lyoner contain the lowest amount of cholesterol with 46.1 mg/100 g sausage whereas the frying sausages from pork show the highest content (66.6 mg/100 g). The present amount of cholesterol should not be overrated since scientific findings state that most people do not have to restrict dietary cholesterol intake because of its limited effect on blood cholesterol level (Federal Office of Public Health, 2007).

▶ Vitamins

The results for the vitamin contents in the cooked sausages are given in Table 2. The analyses of the first four sausage types yielded for vitamin A mostly values below the limit of detection (1,000 IU per kg DM), hence it was decided to use composite samples for the next analyses. The same was applied for vitamin E when the first 20 analyses of the first four sausages resulted in values below the detection limit of 10 mg per kg DM. The vitamin B_1 results mirror the type of meat utilised in the sausages. The highest values are found in the frying sausage of pork (legally defined high pork meat proportion) with a mean of 0.48 mg, followed by the pork sausage averaging 0.29 mg. Thus the consumption of 100 g of one of these two sausages contributes 42% and 25%, respectively to the DRIs (Food and Nutrition Board, 2004) for vitamin B_1. On the opposite the Lyoner made from turkey and/or chicken meat contains on average only 0.05 mg vitamin B_1. Vitamin B_2 exists only in small amounts (average: 0.12 mg) in cooked sausages with no difference between the sausage types. The concentration of vitamin B_6 is slightly higher in the sausages with distinct pork meat amounts. Most of the analysed cooked sausage types have vitamin B_{12} contents between 0.7 and 0.9 µg per 100 g; only meat loaf (0.5 µg) and frying sausage from pork (0.4 µg) are lower. With values of 0.7 to 0.9 µg per 100 g, 30 to 40% of the DRI for vitamin B_{12} can be covered with a sausage portion of 100 g. Niacin and pantothenic acid are found in rather low amounts in cooked sausages. The highest value of pantothenic acid (mean of 0.9 mg) is present in Lyoner from poultry. The niacin content varies between on average 2.4 and 4.7 mg depending on the sausage type. The measured vitamin C values are associated with its application as antioxidant and curing adjuvant. With one exception, vitamin C was not used in the analysed frying sausages from veal, which explains the low mean value found in this product. However, the comparable low value in frying sausage from pork may be due to reductions during production and storage since the labels of these sausages declare consistently the addition of ascorbic acid. With the consumption of 100 g of each Cervelat, Lyoner, meat loaf, pork sausage and Lyoner from poultry, 40 to 45% of the DRI for vitamin C can be covered. The two sausages with large proportions of pork meat (frying sausage from pork and pork sausage) as well as the Lyoner from poultry contain only traces of vitamin D_3. The other analysed cooked sausages offer quantities between 0.7 and 1.0 µg/100 g, which corresponds between 14 and 20% of the DRI for vitamin D. The vitamin K_2 concentrations lie between 2.7 and 8.2 µg per 100 g of the sausages and with this the contribution to the DRI for vitamin K is rather low (<10%). Only the Lyoner from poultry makes an exception with an average amount of 35.0 µg/100 g (29% of the DRI). The biotin content is also low in all analysed sausages (100 g sausage contribute less than 8% of the DRI for biotin).

Tab. 2: Vitamin content of 8 Swiss cooked sausages (mean and SD; per 100 g edible parts)

	Frying sausage from veal	Cervelat	Vienna sausage	Lyoner	Meat loaf	Frying sausage from pork	Pork sausage	Lyoner from poultry
	N=5	N=5	N=5	N=5	N=5	N=5	N=5	N=5
Vitamin A (IU)	52.1 (7.2)	nd	nd	nd	nd#	256.2#	nd#	nd#
Vitamin B_1 (mg)	0.14 (0.02)	0.25 (0.07)	0.22 (0.02)	0.24 (0.09)	0.24 (0.05)	0.48 (0.06)	0.29 (0.09)	0.05 (0.02)
Vitamin B_2 (mg)	0.11 (0.01)	0.12 (0.00)	0.11 (0.01)	0.12 (0.02)	0.11 (0.02)	0.12 (0.01)	0.13 (0.01)	0.11 (0.02)
Vitamin B_6 (mg)	0.13 (0.01)	0.12 (0.03)	0.12 (0.02)	0.16 (0.02)[a]	0.13 (0.04)[b]	0.21 (0.05)	0.16 (0.02)[a]	0.18 (0.07)
Vitamin B_{12} (µg)	0.8 (0.09)	0.7 (0.15)	0.8 (0.06)	0.7 (0.17)	0.5 (0.09)	0.4 (0.08)	0.8 (0.24)	0.9 (0.40)
Vitamin C (mg)	5.7 (9.7)	37.3 (19.5)	17.5 (9.8)	39.7 (16.3)	41.9 (11.0)	2.2 (1.7)	34.6 (8.5)	36.3 (16.5)
Vitamin E (mg)	nd	nd	nd	nd	nd#	nd#	nd#	nd#
Pantothenic acid (mg)	0.3 (0.04)	0.4 (0.06)	0.5 (0.04)	0.5 (0.09)	0.4 (0.07)	0.7 (0.10)	0.6 (0.09)	0.9 (0.30)
Niacin (mg)	2.4 (0.1)	3.1 (0.4)	3.1 (0.3)	2.6 (0.2)	3.1 (0.4)	4.7 (0.5)	4.0 (0.4)	4.6 (1.4)
Vitamin D_3 (µg)	0.8#	0.7#	1.0#	1.0#	0.9#	tr#	tr#	tr#
Vitamin K_2 (µg)	8.2#	6.4#	6.6#	6.2#	6.2#	4.1#	2.7#	35.0#
Biotin (µg)	0.9#	0.9#	1.6#	1.0#	2.2#	2.5#	1.8#	2.0#

nd = below the analytical detection limit (vitamin A: <1,000 IU/kg DM, vitamin E: <10 mg/kg DM); tr = traces (vitamin D_3: between 0.25 and 0.50 µg/100 g)
# a composite sample of the 5 product samples was analysed; [a] n = 4; [b] n = 3

Source: Schmid et al. Fleischwirtschaft International 6/2009

Tab. 3: Minerals and trace elements in 8 Swiss cooked sausages (mean and SD; per 100 g edible parts)

	Frying veal sausage	Cervelat	Vienna sausage	Lyoner	Meat loaf	Frying pork sausage	Pork sausage	Poultry lyoner
	N=5	N=5	N=5	N=5	N=5	N=5	N=5	N=5
Sodium (mg)	759 (22)	839 (80)	869 (101)	853 (53)	899 (76)	762 (147)	929 (111)	917 (94)
Chloride (mg)	1024 (61)	1141 (119)	1175 (156)	1164 (116)	1172 (124)	1063 (168)	1291 (105)	1186 (59)
Potassium (mg)	145 (12)	188 (20)	192 (7)	174 (12)	180 (22)	263 (42)	260 (55)	205 (32)
Phosphorus (mg)	178 (16)	190 (18)	187 (15)	179 (12)	188 (14)	157 (16)	192 (35)	214 (33)
Calcium (mg)	20 (9)	11 (1)	8 (4)	6 (3)	19 (11)	10 (2)	10 (2)	13 (6)
Magnesium (mg)	12 (1)	13 (2)	13 (1)	11 (1)	12 (1)	18 (1)	17 (2)	17 (2)
Iron (mg)	0.5 (0.05)	0.8 (0.04)	0.8 (0.08)	0.5 (0.04)	0.5 (0.17)	1.0 (0.29)	1.0 (0.23)	0.5 (0.25)
Zinc (mg)	1.5 (0.22)	1.6 (0.09)	1.8 (0.05)	1.3 (0.14)	1.4 (0.14)	2.1 (0.25)	2.3 (0.33)	1.1 (0.32)
Selenium (µg)	5.1 (0.5)	6.8 (0.5)	7.3 (0.6)	6.1 (1.1)	6.0 (0.8)	8.3 (1.1)	8.4 (1.2)	8.6 (1.5)

Source: SCHMID et al. Fleischwirtschaft International 6/2009

▶ Minerals and trace elements

The results for the minerals and the trace elements in Swiss cooked sausages are given in Table 3. Cooked sausages are generally high in salt, which was confirmed by the results of the analysed products. The mean salt content ranged from 1.7 to 2.1 g/100 g sausage. The sodium concentration detected was between 759 (frying sausage from veal) and 929 mg (pork sausage) per 100 g. With this amount, already 50 to 60% of the DRI for sodium are covered. A glance at the German cooked sausages reveals that the "Bockwurst", the meat loaf and the frying sausage from pork contain less sodium than their Swiss counterparts (700, 599 and 520 mg/100 g versus 839, 899 and 762 mg/100 g, respectively) (DFA, 2000). Only the German Vienna sausage is higher in sodium (941 mg/100 g) than the Swiss one (869 mg/100 g). This suggests possible points of action in light of the actual European wide aims to reduce sodium. Besides sodium, the cooked sausages also contain large amounts of phosphorus: 100 g of the sausages deliver 157 to 214 mg phosphorus and 22 to 31% of the DRI, respectively. The phosphorus concentration in the analyzed sausages is comparable to the one in fresh meat (SwissFIR, 2009). On the one hand, phosphorus is a native ingredient of the included meat, on the other hand, it is added in form of phosphate (above all E 450, E 451, and E 452) to most of the cooked sausages. Four of the 5 analysed frying sausages from pork had no phosphate added (based on the list of ingredients) what explains their lower mean phosphorus content (157 mg/100 g). The potassium content is rather low; it ranges from an average of 145 mg to 263 mg per 100 g of veal and pork frying sausage, respectively. Hence the contribution to the DRI for potassium is also low (<6%). The present results also confirmed that cooked sausages are generally bad sources for calcium and magnesium. Mean calcium concentrations were found to be in a range of 6 to 20 mg per 100 g sausage. Compared to the DRI of 1,000 mg/d for calcium, these sausages account for no more than 2% of the daily recommendation. Magnesium concentrations were in the same span: the cooked sausages averaged between 11 and 18 mg per 100 g, contributing less than 5% to the DRI for magnesium. Cooked sausages are better sources for the trace elements iron, zinc and selenium. The contribution of 100 g cooked sausage to the DRI is between 6 and 13% for iron and between 10 and 20% for selenium and zinc. These trace elements derive from the meat fraction in the sausages, so a rather high bioavailability can be assumed (HURRELL, 1997; SANDSTRÖM and CEDERBLAD, 1980).

The comparison of the overall results of minerals and trace element contents of the eight sausage types, reveal frying sausages from pork as the most advantageous products in relation to their relatively high contents of iron, zinc, selenium, potassium, magnesium and rather low amounts of sodium. Pork sausages are comparable but contain on average a much higher sodium concentration (929 versus 762 mg). On the one hand, Lyoner from poultry are also very high in sodium but have iron and zinc values on the lower end of the range. On the other hand, their selenium content is highest (8.6 µg) among the analyzed sausages. Frying sausages from veal stand out with the lowest sodium content (759 mg) but feature also potassium, magnesium, iron, and selenium contents at the lower end of the determined range.

Conclusion

This study provides the first extensive analytical data regarding the nutrient composition of Swiss cooked sausages. Our results show that cooked sausages are a valuable source for some but not all nutrients. Partly large differences exist in the content of individual nutrients between the sausage types, which is attributable to variations in the recipes and the used meat type(s). Cooked sausages should therefore not be judged jointly regarding their nutritional qualities but have to be evaluated individually. Cooked sausages are often not eaten out of nutritional reasons but mainly for pleasure. However, they can be recommended as part of a balanced diet and help to meet the nutrient requirements.

Importance for practice

On the one hand, up-to-date and accurate information about the composition of food is essential for many areas of the nutrition and food science; on the other hand, the increased interest of consumers for health and nutrition topics demands a correct and broad data basis for food products. Globalisation enables to have products of various countries in the same retail shop making it important to have access to detailed product information. Data about macro- and micronutrients can be used to compare products of different origin what eventually may result in ideas for product modifications (e.g. salt or fat content). This study provides the first extensive analytical data regarding the nutrient composition of Swiss cooked sausages.

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Literature references can be downloaded at *www.fleischwirtschaft.com/literature* or requested from the author and the editorial office, respectively.

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