

# Mineral content variability of two dry-cured ham types

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## Abstract

The aim of this study was to elaborate on the mineral content variability of two dry-cured ham types for better understanding of the contribution of minerals to reference daily intake (RDI). These two ham types were based on Istrian and Dalmatian ham manufacturing process. Significantly higher ( $P < 0.05$ ) contents of ash, NaCl, sodium (Na), potassium (K), phosphorus (P), zinc (Zn), iron (Fe), copper (Cu), and manganese (Mn) were found in Istrian ham, while Dalmatian ham had higher moisture content. Calcium (Ca) and magnesium (Mg) content did not differ between ham types. The variability of moisture, ash, NaCl, Na, P, Mg, and Ca content can be regarded as low, while the variability of K, Zn, Fe, Cu, and Mn content should be considered as high. It was observed that mineral content variability within ham type was more often lower than overall variability. Intake of Na by consumption of 100 g of dry-cured ham is between 2350.54 mg in Dalmatian ham and 3148.33 mg in Istrian ham, respectively, thus exceeding recommended daily limitation. Therefore, more efforts in ham manufacturing have to be done to lower Na content. Average contribution of K, P, and Zn to the RDI values were 31.89 %, 40.14 %, and 50.80 %, respectively. Considering that, dry-cured ham could be regarded as a source of a significant amount of these minerals. Contribution of Fe and Cu should be carefully considered because of high variability between ham types. Contribution of Mg, Ca, and Mn to RDI values were lower than 10 %.

**Keywords:** mineral content, reference daily intake, sodium, dry-cured ham, nutritional aspect

## Introduction

The manufacture of dry-cured ham is mostly based on the addition of salt (NaCl) and the dehydration process of pork leg, aimed to produce a sensory distinctive and stable meat

product at room temperature. Dry-cured ham consumption is very popular in all Mediterranean countries, although there are frequent questions about health impact and benefits of its nutritive

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value. This is partly a result of nutritive recommendations which limit intake of calories, cholesterol, and sodium (Na), and advise intake of specific fatty acids (WHO, 2003). On a positive side, dry-cured hams are rich in minerals, so they are a good source of iron (Fe) and zinc (Zn), and have significant amount of phosphorus (P), potassium (K), magnesium (Mg), and selenium (Se) (Chen et al., 1997; Jiménez-Colmenero et al., 2010.). All this is further emphasised with higher mineral bioavailability, especially for Fe and Zn.

Mineral content of fresh pork meat is mainly influenced by genetic line, sex, body weight (Wiseman and Mahan, 2010), diet and muscle location (Purchas et al., 2009). Fresh meat has less than 100 mg of Na per 100 g, but addition of salt (NaCl), as one of the key steps in manufacturing of dry-cured products, causes high increase of NaCl and consequently Na content. Additionally, drying procedures applied during manufacturing process increase content of all minerals over time (Lorenzo et al., 2003). Previous research was mainly focused on salt content because of its influence on raising blood pressure and occurrence of cardiovascular diseases. One of the studies was presented by Karolyi (2006) who observed that salt content in Istrian ham was 6.45 %, while Božac et al. (2011) reported higher values of salt content in Istrian ham from 7.35 to 7.83 %. Salt content in Dalmatian ham was 6.20 -7.09 % according to the results given by Kos et al. (2014). Similarly, Pleadin et al. (2015) showed that dry-cured ham from Istria and Dalmatia region had 5.93 - 7.18 % salt. Research on Slavonian ham performed by Kovačević et al. (2017) presented higher range of salt content from 5.31 to 7.73 %. These researches showed that salt content in dry-cured hams is being very variable because most curing techniques are still based on addition of unweighted salt amounts as stated by Virgili et al. (1999).

Currently, the daily Na intake per person is approximately three times the recommended daily limitation, which was the reason for numerous studies on Na reduction in food (Albarracín et al., 2011; Desmond, 2006) and especially in dry-cured hams (Armenteros et al., 2012). Despite these disadvantages, studies show that dry-cured ham has a well-balanced nutritional profile and is suitable, in appropriate amounts, for consumption even 2–3 times per week in healthy individuals as part of a balanced diet (Jiménez-Colmenero

et al., 2010). Because of a need for better understanding of the role of dry-cured ham in human diet, the aim of this paper was to determine mineral content variability and their contribution to the reference daily intake (RDI) as defined in Regulation (EU) No 1169/2011 (EU, 2011).

## Material and Methods

### Ham processing

For the purpose of this research, two types of dry-cured hams were produced, namely Istrian and Dalmatian. In the manufacture of Dalmatian ham, raw hams (n=40) were trimmed according to Kos et al. (2009), dry-salted with mixture of coarse and finely ground sea salt (70:30 %) and kept at 2-4 °C and relative humidity of 85-90 % for 18 days. After that, the hams were kept under pressure of 300 kg/m<sup>2</sup> for three days followed by washing, draining, and smoking for 14 days at 13-15 °C and relative humidity of 70 %. During the drying and ripening period, the temperature and relative humidity were kept at 12-15 °C and 65-75 % for 11 months.

In the manufacture of Istrian ham, raw hams (n=50) were prepared according Božac et al (2011), dry-salted at 2-4 °C and relative humidity of 85-90 % for 21 days with a mixture of coarse and finely ground sea salt (70:30 %), 2 % of black pepper (*Piper nigrum* L.) and 1.5 % of garlic powder (*Allium sativum* L.). Then hams were washed with cold water, drained, and rubbed with ground pepper, and kept under pressure of 100 kg/m<sup>2</sup> for seven days. The drying and ripening period lasted for 12 months at the temperature of 14–15 °C, relative humidity of 70–75 % and air circulation of 10 cm/s.

### Chemical analysis

Samples for chemical analysis were prepared from ripened dry-cured hams from *m. semimembranosus* and *m. biceps femoris* without visible fat tissue. A total of 20 of Dalmatian ham, and 30 samples of Istrian ham were prepared. Moisture content was determined according to the AOAC method 950.46 (AOAC, 1998) by drying at 102 °C to a constant weight. Ash content was determined according to the AOAC method 923.03 (AOAC, 1998) by burning at 550 °C until constant weight. NaCl content (salt) was determined by

the AOAC method 935.47 (AOAC, 1998) as chloride content. Moisture, ash, and NaCl content were expressed as percentage. Determination of minerals was performed according to the AOAC methods 975.03 and 968.08 (AOAC, 1998) by flame atomic absorption spectroscopy (Perkin-Elmer, model 2380, USA) at 422.7 nm for Ca, 285.2 nm for Mg, 766.5 nm for K, 589.0 nm for Na, 248.3 nm for Fe, 213.9 nm for Zn, 279.5 nm for manganese (Mn) and 324.7 nm for copper (Cu). P content was determined according to the AOAC method 991.27 (AOAC, 1998) at 890.0 nm. Mineral content was expressed as mg/100 g.

### Statistical analysis

The data obtained were analysed by statistical program SAS Studio University Edition ver. 3.71 (SAS Institute, 2018) using GLM procedure with Tukey test for ham type comparison at level  $P < 0.05$ .

## Results and Discussion

Descriptive statistics on moisture, ash and NaCl (salt) content of dry-cured hams is shown in Table 1. The moisture content of Dalmatian and Istrian hams was 46.58 and 44.48 % ( $P < 0.05$ ), respectively. These result are similar to previously reported values by Kos et al. (2014) in Dalmatian ham, and Božac et al. (2011) in Istrian ham. Contrary to this, Karolyi (2006) established that moisture content of Istrian ham had lower values (33.99 %). This difference is most likely the result of different fresh ham trimming in which Istrian ham is manufactured without skin and subcutaneous fatty tissue, leading to enhanced drying compared to Dalmatian ham.

Besides differences in production technology, final moisture content of dry-cured ham also depends on raw material (fresh ham) as stat-

ed by Virgili et al. (1999). These authors noted that moisture content was low in Corsican (45.2 %) and Iberian hams (53.3 %) as expected due to their 2-year maturation while the highest moisture content was in Italian Country-style and Parma ham (61.0 and 60.8 %, respectively). Moisture content of Dalmatian and Istrian hams was similar to Corsican and Iberian hams, although subjected to only one year-long production but characterized with higher drying rate. Similar moisture values were reported by Candek-Potokar et al. (2002) who established that the moisture content was 46.3-46.9 % in SM muscle and 57.3-58.9 % in BF muscle of Carso ham.

The average ash content of Dalmatian ham was 7.87 % while the average NaCl (salt) content was 6.64 %. Significantly higher values ( $P < 0.05$ ) of ash and NaCl content were found in Istrian ham (9.55 and 7.57 %, respectively) which can be attributed to trimming without skin and subcutaneous fatty tissue thus enabling higher salt diffusion into muscles. As it was expected, most of the ash content, namely 84 % in Dalmatian ham and 79 % in Istrian, is related to the salt content. Those data are comparable to the previously reported results by Božac et al. (2011), Kos et al. (2014), and Pleadin et al. (2015) while Karolyi (2006) reported lower salt content in Istrian ham. Virgili et al. (1999) reported high variability in salt content with the lowest values found in Iberian ham (5.3 %) and the highest in Corsican (9.2 %). Moreover, Candek-Potokar et al. (2002) established that the salt content in biceps femoris muscle of Carso ham (7.9-8.5 %) was higher than in *semimembranosus* muscle (6.3-6.7 %), reflecting high differences between these two muscles.

Descriptive statistics of mineral content in two ham types is shown in Table 2. Because of salting with sea salt, Na content was the highest among minerals in dry-cured hams with average

**Table 1** Content of water, ash and NaCl of two dry-cured ham types

Component	Ham type	Mean <sup>1</sup>	Min	Max	Standard error
Moisture (%)	Dalmatian	46.58 <sup>a</sup>	39.00	53.60	0.75
	Istrian	44.48 <sup>b</sup>	39.70	50.20	0.62
Ash (%)	Dalmatian	7.87 <sup>b</sup>	6.50	9.30	0.19
	Istrian	9.55 <sup>a</sup>	8.00	11.20	0.15
NaCl (%)	Dalmatian	6.64 <sup>b</sup>	5.11	8.30	0.21
	Istrian	7.57 <sup>a</sup>	6.20	9.00	0.13

<sup>1</sup> Means followed by a different letter are significantly different between ham types at level  $P < 0.05$ .

**Table 1** Mineral content of two dry-cured ham types

Component <sup>1</sup>	Ham type	Mean <sup>2</sup>	Min	Max	Standard error
Na	Dalmatian	2350.54b	1892.00	2849.00	71.71
	Istrian	3148.33a	2600.00	4200.00	63.18
K	Dalmatian	441.81b	366.00	538.80	11.55
	Istrian	833.83a	720.00	1010.20	10.35
P	Dalmatian	242.44b	195.60	276.60	5.29
	Istrian	319.47a	268.50	371.00	4.47
Mg	Dalmatian	32.33	24.00	38.00	0.68
	Istrian	32.20	20.10	39.40	0.74
Ca	Dalmatian	15.39	13.27	18.01	0.21
	Istrian	16.17	11.05	20.72	0.37
Zn	Dalmatian	2.25b	1.66	2.99	0.07
	Istrian	7.91a	6.12	10.39	0.18
Fe	Dalmatian	1.20b	0.73	3.33	0.15
	Istrian	3.27a	2.49	3.97	0.08
Cu	Dalmatian	0.10b	0.055	0.23	0.012
	Istrian	0.31a	0.21	0.92	0.02
Mn	Dalmatian	0.03b	0.012	0.043	0.002
	Istrian	0.09a	0.04	0.17	0.006

<sup>1</sup> Content of minerals expressed as mg/100 g

<sup>2</sup> Means followed by a different letter are significantly different between ham types at level  $P < 0.05$ .

value 2350.54 mg/100 g in Dalmatian ham, and significantly higher ( $P < 0.05$ ) content was found in Istrian ham (3148.33 mg/100 g). Jiménez-Colmenero et al. (2010) reported much lower values of Na content in dry-cured hams, between 1100 and 1800 mg/100 g. Similarly, Chen et al. (1997) established that the average Na content in American hams was 2100-2400 mg/100 g. Much higher differences in Na content between seven European dry-cured hams was reported by Leonardo Betiol et al. (2020). These authors reported that the lowest Na content was 1641 mg/100 g, and the highest was 2795 mg/100 g. From these reports it can be seen that Na content highly varies between various types of dry-cured hams which could be assigned to different manufacturing technology. Besides Na, Dalmatian and Istrian ham contained large amount of K (441.81 and 833.83 mg/100 g) and P (242.44 and 319.47 mg/100 g). Those minerals' content was significantly different ( $P < 0.05$ ) between ham types with higher values found in Istrian ham. Comparable K content was reported in American hams ranging from 570 to 620 mg/100 g (Chen et al., 1997). Much lower values of K and P content were reported by Jiménez-Colmenero et al. (2010) among different types of hams (153-160 mg/100 g and 157-180 mg/100 g, respectively).

Average Mg and calcium (Ca) did not differ

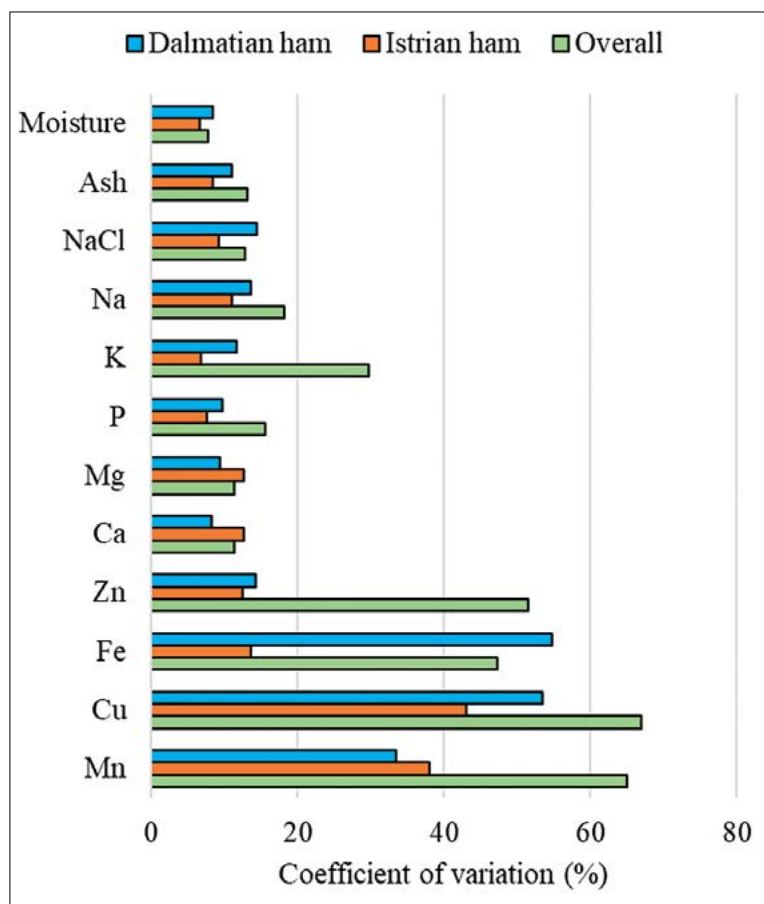
between ham types ( $P > 0.05$ ). Mg content in Dalmatian ham was 32.33 mg/100 g while its content in Istrian ham was 32.20 mg/100 g. Unlike this, Jiménez-Colmenero et al. (2010) reported much lower Mg content among various hams (17-18 mg/100 g). Ca content was two-fold lower than Mg content, namely 15.35 mg/100 g in Dalmatian ham, and 16.17 mg/100 g in Istrian. Contrary to this, Jiménez-Colmenero et al. (2010) reported that Ca was present in much wider range, from 12 to 35 mg/100 g. Likewise, Chen et al. (1997) concluded that differences of Ca content between muscles of American hams were significant, although the average Ca content in *biceps femoris* and *semimembranosus* muscle was lower than this research, 8.6 and 11 mg/100 g respectively. Previous research showed that there are significant interactions between Ca, protein and Na content in food. According to the results given by Sabto et al. (1984), 100 mmol of Na (2.3 g) takes out about 1 mmol (40 mg) of Ca. Furthermore, Nordin (1996) reported that increase of animal protein intake from 40 to 80 g/day led to increase of urinary Ca by 40 mg. Since dry-cured hams have high Na and protein content, it can be assumed that higher Ca loss will be generated with increased intake of dry-cured ham.

Within the group of microminerals, the

most abundant was Zn with the average content in Dalmatian ham of 2.25 mg/100 g and much higher ( $P < 0.05$ ) in Istrian ham, 7.91 mg/100 g. Chen et al. (1997) noted that the Zn content in American hams varied between 1.2 and 1.6 mg/100 g, while Jiménez-Colmenero et al. (2010) reported higher Zn content (2.2-3.0 mg/100 g) in various hams with values similar to the content in Dalmatian ham. Average Fe content in dry-cured ham was significantly different ( $P < 0.05$ ) between Dalmatian and Istrian ham, 1.20 and 3.27 mg/100 g, respectively. Previous research established that Fe content in American hams were between 1.1 and 1.3 mg/100 g (Chen et al., 1997), while Jiménez-Colmenero et al. (2010) reported that the Fe content in dry-cured hams varied between 1.8 and 3.3 mg/100 g, suggesting a high variability of this mineral. Average Cu and Mn contents were the lowest among investigated minerals, and both minerals had significantly different ( $P < 0.05$ ) content between ham types. Lower Cu and Mg values were found in Dalmatian (0.10 and 0.03 mg/100 g) compared to

Istrian ham (0.31 and 0.09 mg/100 g).

Variability of moisture, ash, NaCl and mineral content expressed as coefficient of variation in Dalmatian and Istrian ham, and overall content variability is shown on Figure 1. Coefficients of variation of moisture, ash, NaCl, Na, P, Mg, and Ca content were below 20 %, and this can be regarded as low variability. Interestingly, coefficients of variation of ash content (11.03 % in Dalmatian ham, and 8.46 % in Istrian) is lower than coefficients of variation of NaCl content (14.39 and 9.32 %). This difference indicates that NaCl content is more variable than ash content and therefore depends on manufacturing technology which provides opportunity for decrease of variation. According to Virgili et al. (1999) NaCl content highly varies among different ham types with coefficients of variation from 10.3 to 24.4 %, which authors attribute to the inconsistent salt absorption because most curing techniques are still based on addition of unweighted salt amounts. Besides high variability in salt content within



**Figure 1.** Variability of moisture, ash, NaCl and mineral content in Dalmatian and Istrian ham, and overall variability

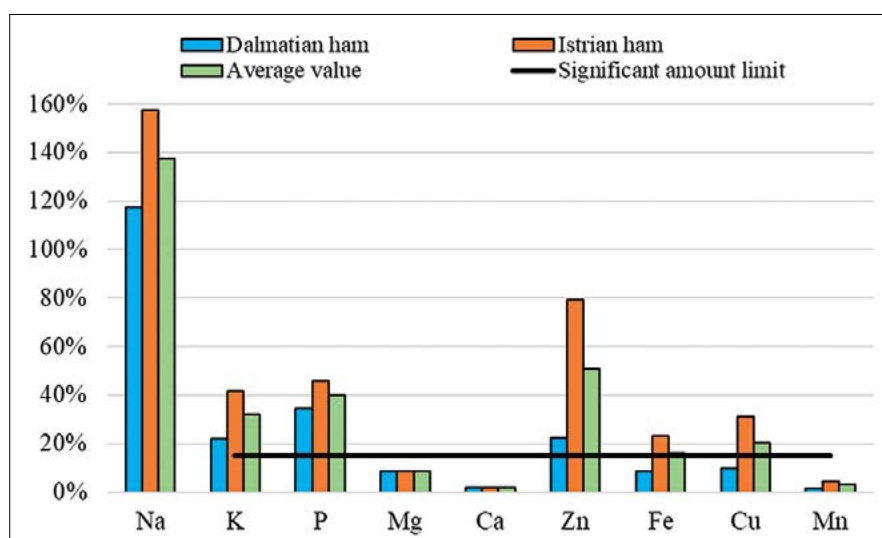
distinct types of hams, there are large differences in salt content between different ham types as determined by Leonardo Betiol et al. (2020) and Virgili et al. (1999).

The variability within ham type was usually lower than overall mineral content variability, and that was most seen in coefficients of variation of K, Zn, and Mn content. Reason for that was high difference in mineral content between studied ham types. Therefore, K and Zn content variability cannot be regarded as low, although coefficients of variation within ham types were low. Variability of Fe, Cu and Mn content within ham types was high and mostly more pronounced in overall calculation. That information should be taken in account while discussing on contribution of minerals to RDI values.

WHO (2012) stated that the minimum physiological need for Na is estimated to be 200-500 mg/day (about 0.5-1.25 g of salt per day), but average daily intakes of salt, and therefore of Na also, far exceed the minimum physiological need. In the majority of European countries, the range of intake is 7 to 12 grams of salt per day (European Commission, 2012). Most EU countries reported that apart from bread which contributed between 19.1 % and 28 %, meat and meat products were the second most important sources of salt in diet with around 10 to 20 % of the total salt intake (EFSA NDA Panel et al., 2019). Higher salt and consequently higher Na intake are associated with higher blood pres-

sure and consequently with higher risk of coronary and renal diseases. Because of that, WHO (2012) recommended Na intake in the quantity of no more than 2000 mg/day, which corresponds to the conclusions given by EFSA NDA Panel et al. (2019). Therefore, Na content in food is much more often limited, unlike other minerals. Considering the average Na content in Dalmatian ham it can be concluded that consumption of 100 g contributed to the 117.53 % of the recommended daily limitation (Figure 2). Intake of Na by consumption of 100 g of Istrian ham was even higher (157.42 %). Average intake by consumption of 100 g of dry-cured ham in this research exceeds recommendation and was 137.47 %. Therefore, efforts should be made in order to achieve lower Na content in hams through technological modifications, salt substitutions by mixtures of K, Mg and Ca chloride salts in combination with masking agents, the use of flavour enhancers, and optimisation of the physical form of salt as proposed by different authors (Albarracín et al., 2011; Armenteros et al., 2012; Desmond, 2006). On the other hand, attention must be given to the limitations of NaCl substitutions because the individual specifications of dry-cured ham production, mostly for geographically designated products, strictly prescribe the usage of sea salt.

According to the Regulation (EU) No 1169/2011 (EU, 2011), reference daily intake of minerals is as follows: for K 2000 mg, for P 700 mg,



**Figure 2.** Contribution of minerals to the reference daily intake given by 100 g of dry-cured ham according to the Regulation (EU) No 1169/2011. Significant amount limit is defined as 15% of the specified mineral reference value

for Mg 375 mg, for Ca 800 mg, for Zn 10 mg, for Fe 14 mg, for Cu 1 mg and for Mn 2 mg. Istrian ham had generally higher mineral content compared to Dalmatian ham and therefore, consumption of Istrian ham could be described as more beneficial with highest contribution in Zn, Cu, and Fe supplementation. For the purpose of this research, average values of contribution of minerals in Dalmatian and Istrian ham will be taken for further discussion as is shown on Figure 2.

Average contribution to the RDI of K and P given by consumption of 100 g of dry-cured ham in this research was 31.89 and 40.14 %, respectively. Regulation (EU) No 1169/2011(EU, 2011) specifies statement “significant amount” under nutritional declaration, which could be applicable when 15 % of the specified mineral reference value is supplied by 100 g of food. Based on that, dry-cured ham can be regarded as a source of a significant amount of K and P. Even higher contribution to the RDI by consumption of 100 g of dry-cured ham was established for Zn with average value 50.80 %. Therefore, dry-cured ham could be also regarded as a source of significant amount of Zn.

Average contribution of dry-cured ham to the RDI of Fe was 15.96 % leading to conclusion that dry-cured ham could be regarded as a source of significant amount. However, Fe contribution showed high variability between ham types, with only 8.57 % by Dalmatian ham, but much more by Istrian ham (23.36 %). Therefore, statement “significant amount” should be carefully assigned to the contribution of dry-cured ham to the RDI of Fe. On the other hand, haem Fe from meat-containing meals has higher absorption rate, about 25 % (Hallberg et al., 1979) as opposed to non-haem Fe from plants, especially from those rich in phytates. This is especially important for diet combinations, because Fe deficiency produces anaemia, which is one of the principal public health problems affecting one quarter of the world’s population, especially pregnant women and children (Benoist, 2001). The RDI of Fe depends on its bioavailability and amounts from 9.1 mg/day at 15 % bioavailability of dietary Fe (as from food like meat) to 27.4 mg/day at 5 % bioavailability (as from food rich in phytates). Because of high differences in dietary Fe bioavailability among food sources, the RDI for Fe was set to 14 mg/day (EU, 2011).

Contribution of dry-cured ham to the

RDI of Cu appeared to be high, namely 20.50 %. However, high variability was observed between ham types with low contribution given by Dalmatian ham (10.00 %), and high contribution by Istrian ham (31.00 %), as it was found in the interpretation of the contribution of Fe to the RDI. Similarly, statement “significant amount” should be carefully assigned, and more research should be performed to confirm this observation.

Contribution of dry-cured ham to the RDI of Mg and Mn was low, 8.60 and 3 %, respectively. Even lower contribution of dry-cured ham to the RDI of Ca was found at level 1.97 %. Afore-said negative effects of Na and animal protein on Ca retention are reasons for a negative impact of increased ham consumption on Ca supplementation.

## Conclusion

Dry-cured ham is characterized by low water content and with high ash and NaCl (salt) content because of salting and drying procedures during manufacturing. This is further emphasized with high Na content which presents the main drawback of dry-cured ham consumption because Na content exceeded recommended daily limitation of 2000 mg/day.. Therefore, stronger efforts have to be done to obtain lower Na content in hams mostly by technological modifications because salt substitutions are usually not allowed according to production specification of many dry-cured hams. Significant differences of almost all components between ham types were established suggesting that nutritional contribution varies highly. This was confirmed by high variability of mineral content like Fe, Cu, and Mn so contribution of these minerals should be carefully considered and verified with more studies. On the other hand, dry-cured ham could be regarded as a source of a significant amount of K, P, and Zn because these minerals contributed more than 15 % to the RDI values.

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## Varijabilnost sadržaja minerala u dva tipa pršuta

### Sažetak

Cilj ovog istraživanja bio je utvrditi varijabilnost sadržaja minerala u dva tipa pršuta radi boljeg razumijevanja doprinosa minerala preporučenom unosu (PU). Ova dva tipa pršuta temeljila su se na postupku proizvodnje Istarskog i Dalmatinskog pršuta. Značajno veći ( $P < 0,05$ ) sadržaj pepela, NaCl, natrija (Na), kalija (K), fosfora (P), cinka (Zn), željeza (Fe), bakra (Cu) i mangana (Mn) pronađen je u Istarskom pršutu, dok je Dalmatinski pršut imao veći sadržaj vlage. Sadržaj Ca i Mg nije se razlikovao između pršuta. Varijabilnost sadržaja vlage, pepela, NaCl, Na, P, Mg i Ca može se smatrati niskom, dok bi varijabilnost sadržaja K, Zn, Fe, Cu i Mn mogla smatrati visokom. Uočeno je da je varijabilnost sadržaja minerala unutar tipa pršuta češće niža od ukupne varijabilnosti. Unos Na konzumacijom 100 g iznosi između 2350,54 mg u Dalmatinskom pršutu i 3148,33 mg u Istarskom pršutu, što premašuje preporučeno dnevno ograničenje. Zbog toga bi se trebalo uložiti više napora u tehnologiju proizvodnje pršuta kako bi se smanjio sadržaj Na. Prosječni doprinos K, P i Zn vrijednostima PU iznosio je 31,89 %, 40,14 % i 50,80 %. S obzirom na to, pršuti se mogu smatrati hranom koja sadrži značajne količine ovih minerala. Doprinos Fe i Cu vrijednostima PU treba pažljivo razmotriti zbog velike varijabilnosti između pršuta. Doprinos Mg, Ca i Mn vrijednostima preporučenog unosa bio je niži od 10 %.

**Cljučne riječi:** sadržaj minerala, preporučeni unos, natrij, pršut, nutritivni značaj

## Variabilität des Mineralstoffgehalts in zwei Sorten von luftgetrockneten Rohschinken

### Zusammenfassung

Das Ziel dieser Studie war es, die Variabilität des Mineralstoffgehalts von zwei luftgetrockneten Rohschinken festzustellen, um den Beitrag der Mineralstoffe zur empfohlenen täglichen Verzehrmenge (RDA) besser zu verstehen. Diese zwei Schinkensorten basieren auf dem Herstellungsprozess von istrischem und dalmatinischem Schinken. Signifikant höhere ( $P < 0,05$ ) Gehalte an Asche, NaCl, Natrium (Na), Kalium (K), Phosphor (P), Zink (Zn), Eisen (Fe), Kupfer (Cu) und Mangan (Mn) wurden in istrischem Schinken gefunden, während der dalmatinische Schinken einen höheren Feuchtigkeitsgehalt aufwies. Der Gehalt an Kalzium (Ca) und Magnesium (Mg) unterschied sich nicht zwischen den Schinkensorten. Die Variabilität des Feuchtigkeits-, Asche-, NaCl-, Na-, P-, Mg- und Ca-Gehalts kann als gering angesehen werden, während die Variabilität des K-, Zn-, Fe-, Cu- und Mn-Gehalts als hoch angesehen werden sollte. Es wurde beobachtet, dass die Variabilität des Mineralstoffgehalts innerhalb der Schinkensorte häufiger geringer war als die Gesamtvariabilität. Die Aufnahme von Na durch den Verzehr von 100 g luftgetrocknetem Rohschinken liegt zwischen 2350,54 mg bei dalmatinischem Schinken und 3148,33 mg bei istrischem Schinken und übersteigt damit die empfohlene Tagesgrenze. Daher müssen bei der Schinkenherstellung mehr Anstrengungen unternommen werden, um den Na-Gehalt zu senken. Der durchschnittliche Beitrag von K, P und Zn zu den RDA-Werten betrug 31,89 %, 40,14 % bzw. 50,80 %. In Anbetracht dessen kann der luftgetrocknete Schinken als eine Quelle von bedeutenden Mengen dieser Mineralien angesehen werden. Der Beitrag von Fe und Cu sollte aufgrund der hohen Variabilität zwischen den Schinkensorten sorgfältig betrachtet werden. Der Beitrag von Mg, Ca und Mn zu den RDA-Werten war geringer als 10 %.

**Schlüsselwörter:** Mineralstoffgehalt, empfohlene tägliche Verzehrmenge, Natrium, luftgetrockneter Rohschinken, ernährungsphysiologischer Aspekt

## Variabilidad del contenido mineral en dos tipos de jamón

### Resumen

El objetivo de este estudio fue determinar la variabilidad del contenido mineral en dos tipos de jamón para comprender mejor la contribución de los minerales a la ingesta recomendada (IDR). Estos dos tipos de jamón se basaron en el proceso de producción del jamón de Istria y Dalmacia. Se encontró un contenido significativamente mayor ( $P < 0.05$ ) de cenizas, NaCl, sodio (Na), potasio (K), fósforo (P), zinc (Zn), hierro (Fe), cobre (Cu) y manganeso (Mn) en el jamón de Istria, mientras que el jamón de Dalmacia tenía un mayor contenido de humedad. El contenido de Ca y Mg no difirió entre los jamones. La variabilidad de los contenidos de humedad, cenizas, NaCl, Na, P, Mg y Ca puede considerarse baja, mientras que la variabilidad de los contenidos de K, Zn, Fe, Cu y Mn podría considerarse alta. Fue notado que la variabilidad del contenido mineral dentro del tipo de jamón es menor que la variabilidad total. La ingestión de Na con el consumo de 100 g del jamón de Dalmacia se sitúa entre 2350,54 mg y 148,33 mg en el jamón de Istria, lo que excede el límite diario recomendado. Por lo tanto, se deben realizar más esfuerzos en la tecnología de producción de jamón para reducir el contenido de Na. La contribución media de K, P y Zn a los valores de IDR fue 31,89 %, 40,14% y 50,80 %. Habida cuenta de esto, el jamón puede considerarse un alimento que contiene cantidades significativas de estos minerales. La contribución de Fe y Cu a los valores de IDR debe considerarse cuidadosamente debido a la gran variabilidad entre los jamones. La contribución de Mg, Ca y Mn a los valores de la ingesta recomendada fue inferior al 10 %.

**Palabras claves:** contenido mineral, ingesta recomendada, sodio, jamón, importancia nutricional

## La variabilità del contenuto di minerali in due tipi di prosciutto

### Riassunto

Il presente lavoro di ricerca è stato elaborato con lo scopo di determinare la variabilità del contenuto di minerali in due tipi di prosciutto per meglio comprendere il contributo dei minerali all'assunzione di riferimento (\*AR in croato: PU). Questi due tipi di prosciutto si sono basati sul processo produttivo del Prosciutto istriano e del Prosciutto dalmato. Significamente più alto il valore ( $P < 0,05$ ) del contenuto di ceneri, di sale (NaCl), di sodio (Na), di potassio (K), di fosforo (P), di zinco (Zn), di ferro (Fe), di rame (Cu) e di manganese (Mn) è stato trovato nel Prosciutto istriano, mentre il Prosciutto dalmato indicava un maggior contenuto di umidità. Il contenuto di Calcio (Ca) e magnesio (Mg) non ha dimostrato delle differenze tra i due tipi di prosciutto. La variabilità del contenuto di umidità, di ceneri, di sale (NaCl), di sodio (Na), di fosforo (P), di magnesio (Mg) e di Calcio (Ca) può essere considerata bassa, mentre la variabilità del contenuto di potassio (K), di zinco (Zn), di ferro (Fe), di rame (Cu) e di manganese (Mn) può essere considerata alta. È stato notato che la variabilità del contenuto di minerali nel tipo di prosciutto è spesso più bassa rispetto alla variabilità totale. L'assunzione di sodio (Na) consumando 100 g di Prosciutto dalmato è compresa tra 2350,54 mg e tra 148,33 mg nel Prosciutto istriano. Entrambi sono i valori che superano il limite giornaliero raccomandato. Di conseguenza sarebbe necessario investire maggiori sforzi nelle tecniche della produzione del prosciutto ai fini di ridurre il contenuto di sodio (Na). Il contributo medio di potassio (K), di fosforo (P) e di zinco (Zn) ai valori di AR (\*PU) importa del 31,89 %, 40,14 % e 50,80 %. Detto questo, il prosciutto può essere considerato un alimento che contiene quantità significative di questi minerali. Il contributo di ferro (Fe) e di rame (Cu) ai valori di AR (\*PU) deve essere considerato con attenzione a causa della grande variabilità tra i prosciutti. Il contributo di magnesio (Mg), di calcio (Ca) e di manganese (Mn) ai valori di AR (\*PU) è stato inferiore al 10 %.

**Parole chiave:** contenuto di minerali, assunzioni di riferimento, sodio, prosciutto, valore nutrizionale