CHEMICAL PROPERTIES AND QUALITY OF ISTRIAN DRY-CURED HAM

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SUMMARY

Chemical properties of 18 months old Istrian dry-cured hams were analysed. The samples (n=10) of m. semimembranosus were analysed for chemical composition (water, protein, fat and ash), and NaCl content, free amino acids profile, as well as content of fatty acids in intramuscular fat. High values were found for dry matter content (40.73 % protein, 16.91 % fat and 8.37 % ash) and free amino acid content (6.264 g/100g). The average value of NaCl in dry-cured hams was 6.45%, while the cholesterol content (85.2 mg/100g) and omega-6/omega-3 fatty acid ratio (12.91) were high, as typical for pork.

Key words: *Istrian dry-cured ham, chemical composition, free amino acids, and fatty acids*

INTRODUCTION

Dry-cured ham is produced by partial dehydration and slow chemical-enzymatic transformations of dry-cured meat of pig hind leg under specific conditions of temperature, humidity and airflow. Complex changes of proteins and fats in meat, loss of water and increase of dry matter and salt (NaCl) concentrations occur in dry-cured ham during the production process. These changes are highly important for the final quality and nutritive and organoleptic properties of the final product. The traditional Istrian dry-cured ham is made of the hind leg of heavy, mature pigs, salted with sea-salt with the addition of natural spices, and then subjected to a slow process of drying and ripening in the air for over one year. Basic distinction between the Istrian and Dalmatian dry-cured ham is in the ham processing procedure; the former is usually processed with pelvic bones, skin and subcutaneous fatty tissue are removed and finally, it is not subjected to smoking.

The paper presents a review of performed chemical analyses (water, dry matter, proteins, fat, ash, NaCl content, content of free amino acids, cholesterol, and fatty acids in intramuscular fat) and also gives a description of organoleptic properties of 18 months old Istrian hams.

MATERIAL AND METHODS

Ten samples (*m. semimembranosus*) of dry-cured ham were analysed after 18 months of ripening. Dry-cured hams, originating from pigs of Swedish landrace breed, were produced in the traditional Istrian way, by application of the conventional technological procedures of ham processing, dry salting and pressing, desalting, drying and ripening. Basic chemical analysis (AOAC., 1990) was used for the determination of dry matter, moisture, protein, fat and ash content in samples. Determination of cholesterol was performed after the method of Csapó et al. (2000). Content of intramuscular fat was determined by Stoldt's method (Hungarian Standard No. 6830-66), and amino acid composition by gas chromatography HPLC (Chromopack CP 9000) (Csapó et al., 1986; 2000). Content of free amino acids was determined with the use of amino acid analyser by (LKB Model 4101 automatic AA analyser) and HPLC after the procedure developed by Csapó et al. (1986a). Results are presented as the mean value and standard deviation (x ±SD) of the analysed property in samples.

RESULTS AND DISCUSSION

Basic chemical composition and NaCl content in the 1.5-year-old Istrian dry-cured hams are presented.

In general, total loss of weight is over 40 %, and sometimes even up to 50 %, as a result of a higher

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▼ **Table 1.** Chemical composition of Istrian dry-cured ham (*m. semimembranosus*)
▼ **Tablica 1.** Kemijski sastav *m. semimembranosus* Istarskog pršuta

Chemical composition after 18 months Kemijski sastav nakon 18 mjeseci	Mean ± SD x ± SD
Water / Voda (%)	33,99 ± 1,94
Protein / Bjelančevine (%)	40,73 ± 3,55
Fat / Mast (%)	16,91 ± 4,59
Ash / Pepeo (%)	8,37 ± 0,79
Cholesterol / Kolesterol (mg/100g)	85,21 ± 8,72
NaCl (%)	6,45 ± 0,81

degree of dehydration due to the removal of the skin and subcutaneous fatty tissue, and consequentially, direct exposure of muscular tissue to ambient conditions. Consequently, water content in the Istrian dry-cured ham is usually low, while protein and lipid content (concentration) is higher. Content of NaCl is, in general, higher when a greater amount of salt is added, when salt particle size is smaller and duration of salting longer. In addition, NaCl content is higher in dry-cured hams with a larger surface of muscle tissue not covered with fat, hams of lower weight and those subjected to rapid drying. In case of analysed samples of Istrian dry-cured ham, previously salted hams were in the next phase desalted in clean water for 24 h. Average salt content at the end of ripening period amounted to 6.5 %.

From the point of view of human nutrition, of special interest is amino acid and fatty acid composition of lipids of a dry-cured ham. Its content of free amino acids is significantly higher in comparison with fresh meat, because of proteolytic changes occurring during ripening (Toldrà et al., 1992; Toldrà and Aristoy 1993). In the analysed samples of Istrian dry-cured ham, content of free amino acids and ammonia was on an average 6,264 g in a 100-g sample (Table 2), and there were also high levels of free lysine, leucine, valine, arginine, phenylalanine and glutamic acid, alanine, aspartic acid and proline (Figure 1).

In intramuscular fat (*m. semimembranosus*) of Istrian dry-cured ham (Table 3), saturated fatty acids accounted for 40.51%, mono-unsaturated fatty acids

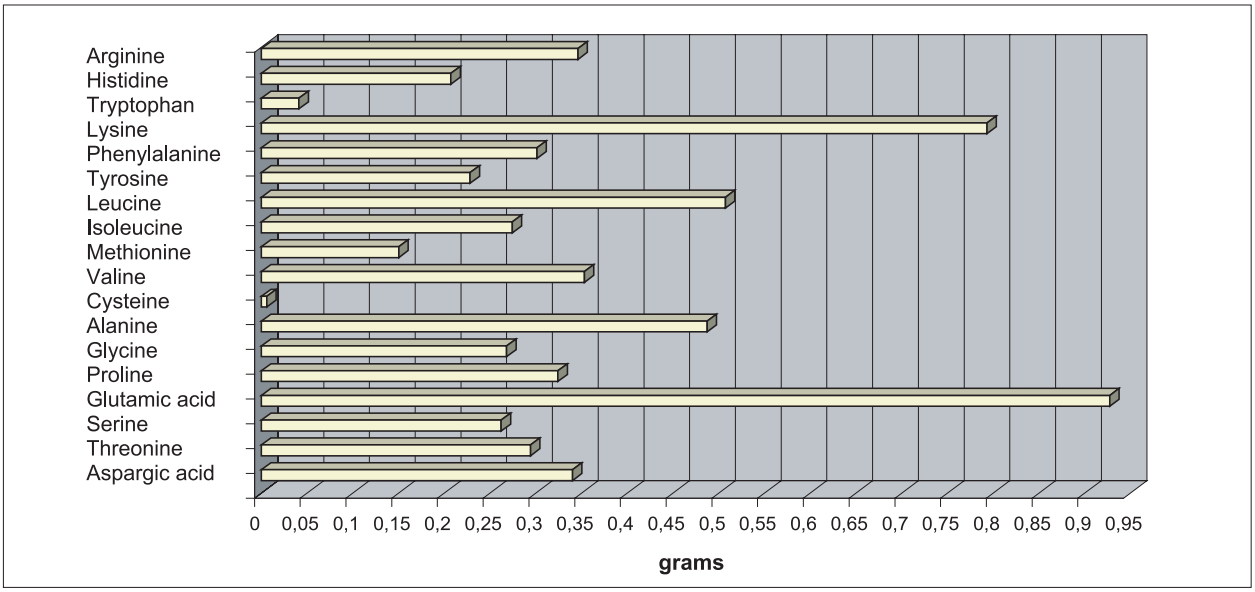
▼ **Table 2.** Content of free amino acids (g/100g muscle, *m. semimembranosus*) in Istrian dry-cured ham after 18 months
▼ **Tablica 2.** Sadržaj slobodnih aminokiselina (g/100g uzorka, *m. semimembranosus*) Istarskog pršuta starog 18 mjeseci

Amino acid Aminokiselina	Mean ±SD x ± SD
Aspargic acid / Asparginska kiselina (Asp)	0,340 ± 0,199
Threonine / Treonin* (Thr)	0,294 ± 0,093
Serine / Serin (Ser)	0,262 ± 0,077
Glutamic acid / Glutaminska kiselina (Glu)	0,927 ± 0,317
Proline / Prolin (Pro)	0,324 ± 0,105
Glycine / Glicin (Gly)	0,268 ± 0,092
Alanine / Alanin (Ala)	0,487 ± 0,173
Cystine / Cistin** (Cys)	0,006 ± 0,002
Valine / Valin* (Val)	0,353 ± 0,116
Methionine / Metionin* (Met)	0,150 ± 0,049
Isoleucine / Izoleucin* (Ile)	0,274 ± 0,092
Leucine / Leucin* (Leu)	0,507 ± 0,175
Tyrosine / Tirozin** (Tyr)	0,228 ± 0,076
Phenylalanine / Fenilalanin* (Phe)	0,301 ± 0,106
Lysine/ Lizin* (Lys)	0,793 ± 0,248
Histidine / Histidin* (His)	0,207 ± 0,085
Tryptophan / Triptofan* (Trp)	0,041 ± 0,071
Arginine / Arginin** (Arg)	0,346 ± 0,127
Ammonia / Amonijak	0,156 ± 0,077
total / ukupno	6,2636 ± 2,044

* Essential amino acids / esencijalne aminokiseline
** Semi-essential amino acids / poluesencijalne aminokiseline

44.67%, and poly-unsaturated fatty acids 12.50% respectively, of total identified esters of fatty acids. The PUFA/SFA ratio was 0.31. Essential non-fatty acids from the group omega - 6 (C18:2ω6 linolenic acid, C20:4ω6 and C20:2ω6) accounted for 11.83%, 0.92% of total PUFA respectively, in case of the

▼ **Figure 1.** Profile of free amino acids in Istrian dry-cured ham after 18 months (g/100g sample, *m. semimembranosus*)
▼ **Graf 1.** Profil slobodnih masnih ksielina u istarskom pršutu starom 18 mjeseci (g/100 g uzorka, *m. semimembranosus*)



group omega - 3 (C18:3ω3 linolenic acid, C20:5ω3, C22:5ω3 and C22:6ω3), with omega - 6/ omega - 3 ratio of 12.91.

In the nutritional sense, content of lipids and fatty acid profile of fat of the analysed dry-cured hams correspond to characteristic values for pork meat, with the found ratio of poly-unsaturated/saturated fatty acids slightly below the recommended values (> 0,4; Enser 2001; Wood et al., 2003; Raes et al., 2004) and typically high omega - 6/omega –3 ratio (dietary desirable values are ≤ 4; Enser 2001; Raes et al., 2004). As regards human health, cholesterol content is also important, and the average value recorded in the analysed samples of Istrian dry-cured ham amounted to 85.21 mg/100g.

CONCLUSIONS

In the course of salting, drying and ripening of a pork ham, a series of modifications occur in muscle and fatty tissue, the result of which is a product of characteristic organoleptic properties that make dry-cured ham a very attractive food product. In comparison with fresh meat, dehydration of dry-cured ham increases the content of dry matter, and consequentially also its concentration of proteins, fats and other nutritive ingredients. Protein degradation leads to significant increase of content of free amino acids, and therefore, a dry-cured ham is a concentrated source of essential amino acids. Disintegration of lipids, particularly in the intramuscular fat, and subsequent oxidation of free fatty acids results in the formation of numerous volatile compounds, such as aldehydes, alcohols, aliphatic and aromatic carbohydrates, short-chain fatty acids, esters, furan derivatives and other compounds. These compounds play an important role in the formation of characteristic flavour of a ripe dry-cured ham. Furthermore, excellent organoleptic properties of dry-cured ham should also be emphasized: pink to light red colour, without pronounced discolorations, except for the white colour in the fat tissue area, specific aroma, pleasant odour and taste, suitable consistence and resistance at chewing. Thanks to these characteristics, Istrian dry-cured ham is a valuable food product with high market demand. It should also be pointed out, that nitrite salts or other additives are not used for pickling of Istrian dry-cured ham, and it is not subjected to smoke curing, what makes it an even more valuable food product. However, it has high NaCl content, and for pork meat, also a characteristically high cholesterol content and high ratio of

▼ **Table 3.** Fatty acid composition of intramuscular fat (*m. semimembranosus*) of Istrian dry-cured ham (% of methyl esters)
▼ **Tablica 3.** Masno kiselinski sastav intramuskularne masti (*m. semimembranosus*) Istarskog pršuta (% metilnih estera)

Masna kiselina (Fatty acid)	x ± SD (Mean ±SD)
C14:0 C16:0 C18:0 Others° / Ostale	1,30 ± 0,12 24,45 ± 1,20 13,98 ± 1,08 0,79 ± 0,06
Total SFA Ukupno zasićenih	40,51 ± 2,20
C16:1 C18:1 Others[1] / Ostale	2,31 ± 0,24 41,20 ± 1,45 1,16 ± 0,15
Total MUFA / Ukupno mononezasićenih	44,67 ± 1,49
C18:2ω-6 Others[2] / Ostale Total ω-6/ Ukupno ω-6 C18:3ω-3 Others[3] / Ostale Total ω-3/ Ukupno ω-3	10,52 ± 1,65 1,32 ± 0,41 11,83 ± 1,99 0,33 ± 0,04 0,59 ± 0,14 0,92 ± 0,17
Total PUFA / Ukupno polinezasićenih	12,50 ± 2,10
ω - 6/ω - 3 PUFA/SFA - Polinezasićene/ zasićene	12,91 ± 1,07 0,31 ± 0,07

° C10:0 + C12:0 + C15:0 + C17:0 + C20:0 + C22:0
[1] C20:1 + C22:1ω – 9 + C24:1
[2] C20:2ω – 6 + C20:4ω – 6
[3] C20:5ω – 3 + C22:5ω – 3 + C22:6ω - 3
SFA – Saturated fatty acids
MUFA – Mono-unsaturated fatty acids
PUFA – Poly-unsaturated fatty acids

omega - 6/omega -3 poly-unsaturated fatty acids in the fat composition.

PROŠIRENI SAŽETAK

KEMIJSKI SASTAV I KAKVOĆA ISTARSKOG PRŠUTA

UVOD

Pršut nastaje djelomičnom dehidracijom i polaganim kemijsko-enzimatskim transformacijama suho salamurenog mesa svinjskog buta pod određenim uvjetima temperature, vlažnosti i strujanja zraka. Tijekom procesa proizvodnje u pršutu se dešavaju kompleksne promjene bjelančevina i masti u mesu, gubitak vode i porast koncentracije suhe tvari i soli (NaCl). Te su promjene veoma značajne za finalnu kakvoću, nutritivna i organoleptička svojstva gotovog proizvoda. Tradicionalni Istarski pršut, proizveden iz buta teških, zrelih svinja, soljen morskom soli uz dodatak prirodnih začina, nastaje polaganim sušenjem i zrenjem na zraku više od godine dana. Osnovna razlika Istarskog u odnosu na dalmatinski tip pršuta je drugačija obrada buta (but se obrađuje najčešće s zdjeličnim kostima i sa buta se skida koža i potkožno masno tkivo) i činjenica da se Istarski pršut ne podvrgava dimljenju. U radu dat je prikaz kemijskih analiza (voda, suha tvar, bjelančevine, masti, pepeo, sadržaj NaCl-a, sadržaj slobodnih aminokiselina, sadržaj kolesterola te sadržaj masnih kiselina u intramuskularnoj masti) uz opis organoleptičkih svojstava Istarskih pršuta starih 18 mjeseci.

MATERIJAL I METODE

Analizirano je 10 uzoraka (m. semimembranosus) pršuta nakon 18 mjeseci zrenja. Pršuti su proizvedeni od svinja pasmine švedski landras na tradicionalni istarski način, primjenom uobičajenih tehnoloških postupaka obrade buta, suhog soljenja i prešanja, odsoljavanja, sušenja i zrenja. Osnovnom kemijskom analizom (AOAC, 1990) u uzorcima su određeni sadržaji suhe tvari, vlage, bjelančevina, masti i pepela. Određivanje kolesterola obavljeno je prema postupku Csapó i suradnika (2000). Sadržaj intramuskularne masti određen je Stoldt metodom (Hungarian Standard No. 6830-66), a masno-kiselinski sastav određen su primjenom plinske kromatografije HPLC (Chromopack CP 9000) (Csapó i suradnici, 1986; 2000). Sadržaj slobodnih aminokiselina određen je korištenjem aminokiselinskog analizatora (LKB Model 4101 automatic AA analyser) i HPLC prema postupku kojeg su razvili Csapó i suradnici (1986a). Rezultati su prikazani kao prosječna vrijednost i standardna devijacija (x ± SD) analiziranog svojstva u uzorcima.

REZULTATI I RASPRAVA

U Tablici 1. prikazan je osnovni kemijski sastav i sadržaj NaCl-a u Istarskim pršutima starim 1,5 godinu.Kod Istarskog pršuta ukupni kalo redovito je preko 40 %, ponekad i do 50 %, zbog većeg stupnja dehidracije uslijed skidanja kože i potkožnog masnog tkiva te posljedično tome izravne izloženosti mišićnog tkiva ambijentalnim uvjetima. Zbog toga je sadržaj vode u Istarskom pršutu obično niži, pa je viši (koncentriraniji) sadržaj i bjelančevina i lipida. Sadržaj NaCl u pršutima općenito je viši što je u fazi solje-

nja dodano više soli, te što je sol sitnija a trajanje soljenje duže. Također, sadržaj NaCl viši je kod pršuta kod kojih je veća površina mišićnog tkiva nepokrivenog mašću, kod pršuta manje težine i brzog sušenja. Kod analiziranih uzoraka Istarskog pršuta, nakon faze soljenja primijenjen je postupak odsoljavanja u čistoj vodi tijekom 24 h. Prosječni sadržaj soli na kraju zrenja iznosio je 6,45 %. Sa stajališta ljudske prehrane, posebno je zanimljiv sadržaj slobodnih aminokiselina i masno kiselinski sastav lipida pršuta. U usporedbi sa svježim mesom, sadržaj slobodnih aminokiselina u pršutu značajno je viši zbog proteolitičkih promjena do kojih dolazi tijekom zrenja (Toldrà i sur., 1992; Toldrà i Aristoy 1993). Kod analiziranih uzoraka Istarskog pršuta (Tablica 2), sadržaj slobodnih aminokiselina i amonijaka u prosjeku je iznosio 6,264 g u 100 g uzorka, uz visoke razine slobodnog lizina, leucina, valina, arginina, fenilalanina te glutaminske kiseline, alanina, asparginske kiseline i prolina (Grafikon 1). U intramuskularnoj masti (m. semimembranosus) Istarskog pršuta (Tablica 3), na zasićene masne kiseline otpadalo je 40,51 %, na mononezasićene masne kiseline 44,67 %, a na polinezasićene masne kiseline 12,50 % od ukupno identificiranih estera masnih kiselina. Odnos polinezasićenih/zasićenih masnih kiselina iznosio je 0,31. Na esencijalne masne kiseline iz skupine "omega - 6" (C18:2ω6 linolna, C20:4ω6 i C20:2ω6) otpadalo je 11,83 %, a na skupinu "omega - 3" (C18:3ω3 linolenska, C20:5ω3, C22:5ω3 i C22:6ω3) 0,92 % od ukupnih polinezasićenih masnih kiselina, uz odnos omega - 6/ omega - 3 od 12,91. Sadržaj lipida i masno - kiselinski profil masti analiziranih pršuta, u nutritivnom smislu odgovaraju karakterističnim vrijednostima za svinjetinu uz utvrđeni odnos polinezasićenih/zasićenih masnih kiselina nešto ispod zdravstveno preporučenih vrijednosti (> 0,4; Enser 2001; Wood i sur., 2003; Raes i sur., 2004) i tipično visoki omega - 6/omega - 3 omjer (nutritivno poželjne vrijednosti iznose ≤ 4; Enser 2001; Raes i sur., 2004). Sa stajališta zdravlja, važan je i sadržaj kolesterola, koji je kod analiziranih uzoraka Istarskog pršuta iznosio u prosjeku 85,21 mg/100g.

ZAKLJUČCI

Tijekom soljenja, sušenja i zrenja svinjskog buta u mišićnom i masnom tkivu dešava se čitav niz modifikacija koje stvaraju proizvod tipičnih organoleptičkih osobina, koje pršut čine veoma atraktivnom hranom. U usporedbi sa svježim mesom, uslijed dehidracije u pršutu se povećava sadržaja suhe tvari a time i koncentracija bjelančevina, masti i drugih hranjivih sastojaka. Uslijed razgradnje bjelančevina dolazi do značajnog povećanja sadržaja slobodnih aminokiselina pa pršut predstavlja koncentrirani izvor esencijalnih aminokiselina. Razgradnja lipida, posebice unutar-mišićne masti (intramuskularne), te naknadna oksidacija slobodnih masnih kiselina vodi ka formiranju brojnih hlapivih spojeva kao što su: aldehidi, alkoholi, alifatski i aromatski ugljikovodici, kratkolančane masne kiseline, esteri, derivati furana i drugi spojevi. Navedeni spojevi imaju važnu ulogu u stvaranju karakteristične arome zrelog pršuta. Osim navedenih činjenica o kemijskom sastavu, treba istaknuti vrhunska organoleptička svojstva pršuta: ružičastu do svijetlo-crvenu boju, bez naglašenih diskoloracija osim bijele boje u području masnog tkiva, specifičnu aromu, ugodan miris i okus, povoljnu konzistenciju i otpor pri žvakanju, koja Istarski pršut čine vrlo traženim i cijenjenim proizvodom na tržištu. Također treba naglasiti da se pri salamurenju Istarskog pršuta ne koriste nitritne soli ni drugi aditivi, niti se pršut dimi što Istarski pršut, čini dodatno vrijednijom namirnicom. Manje poželjnu činjenicu, međutim, predstavlja visok sadržaj NaCl -a u pršutu, te za svinjsko meso karakteristično visoki sadržaj kolesterola i visoki omjer omega - 6/omega -3 polinezasićenih masnih kiselina u sastavu masti.

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