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EVALUATION OF DRIED SALTED PORK HAM AND NECK QUALITY

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ABSTRACT

The aim of the present study was analysed chemical and physical parameters of dried salted pork ham and neck. Dry-cured meat is a traditional dry-cured product obtained after 12 – 24 months of ripening under controlled environmental conditions. Ham and neck was salted by nitrite salt mixture during 1 week. Salted meat products were dried at 4 °C and relative humidity 85% 1 week after salting. The quality of dry-cured meat is influenced by the processing technology, for example length of drying and ripening period. The average moisture of dried salted pork ham was 63.77% and dried salted pork neck was 59.26%. The protein content was 24.87% in dried salted pork ham and significantly lower (20.51%) in dried salted pork neck. The value of intramuscular fat in dried salted pork ham was 4.97% and 14.40% in dried salted pork neck. The salt content was 5.39% in dried salted pork ham and 4.83% in dried salted pork neck. The cholesterol content was 1.36 $g.kg^{-1}$ in dried salted pork ham and significant lower in dried salted pork neck (0.60 $g.kg^{-1}$). The value of lightness was 44.36 CIE L* in dried salted pork ham and significantly lower in dried salted pork neck (40.74 CIE L*). The pH value was 5.84 in dried salted pork ham and 5.80 in dried salted pork neck. The shear work was 9.99 $kg.s^{-1}$ in dried salted pork ham and 6.34 in dried salted pork neck. The value of water activity (a_w) was 0.929 in dried salted pork ham and similar 0.921 in dried salted pork neck.

Keywords: chemical and physical parameters; cholesterol content; color; water activity; dried meat

INTRODUCTION

Variation in technological properties of meat largely depends on the productive conditions of pig (including genetics and feeding) and processes of muscle conversion into meat **(Čandek-Potokar and Skrlep, 2011)** and it is an important drawback in the commercial setting.

The pork meat quality is defined as a combination of different characteristics of raw and processed meat **(Joo et al., 2013)**. These characteristics relate to acceptability for technological and consumers' aspects, such as color, water-holding capacity (WHC) and texture. Biochemical processes take place in the muscle *post mortem* affect all of these characteristics. The result of these biochemical changes is influenced by pH value, which is considered as one of the most important factors determining the meat quality **(Van der Wal et al., 1997)**.

The demand for livestock products has rapidly increased in recent times as a result of the income and population growths, as well as along with changing food preferences **(FAO, 2013)**. However, consumers' demands meat products with high quality, safety, health benefits, palatability and convenience.

However, processing of the muscle into final products for instance, ready-to-eat products with high nutritional value, typical palpability and convenience to use is necessary to add value to this muscle far beyond its usual profitability. So far, dry-cured meat is one of the most popular meat products processed mainly from pork muscle, and has been received considerable attention by consumers due its palatability and typical flavour **(Muriel et al., 2004a; Ventanas et al., 2007)**. The dry-cured meat is produced by salting a mixture of curing agents (salt and nitrite) and other additives, drying and ripening. The ripening process product becomes partially dried and develops its typical aroma and taste characteristics due to the biochemical changes. The quality characteristics of dry-cured meat products as a whole are greatly affected by a number of factors related to the raw material and processing technology **(Andres et al., 2004; Jurado et al., 2007)**.

The ripening process of dry-cured meat products involves complex chemical and biochemical changes in the main components of raw meat (proteins and lipids) which lead to the generation of volatile compounds with olfaction thresholds and distinct aromatic notes **(Ruiz et al., 2002)**.

The acceptance of dry-cured meat by consumers is mainly determinated by their sensory properties. The flavour is probably the most important quality parameter and it is affected by raw material, processing techniques, and ripening time **(Sánchez-Peña et al., 2005)**. Processing has an important influence on the final flavour of dry-cured meat. The ripening and drying phases involve complex chemical and biochemical changes in the main components of the raw meat (proteins and lipids) leading to the generation of volatile compounds, which are mainly esters and sulphide compounds **(Lorenzo, 2014a; Muriel et al., 2004b)**. These compounds are responsible of the characteristic flavour of these products and they have influence on the consumer acceptance **(Ruiz et al., 2002)**.

Sodium chloride (NaCl) is the most important ingredient in the manufacturing process of dry-cured meat for its contribution to the water-holding capacity, prevention of microbial growth, reduction of water activity, facilitating the solubilisation of certain proteins and conferring a typical salty taste **(Lorenzo, 2014b)**. Moreover, salt affects some chemical and biochemical reactions such as proteolysis, lipolysis and lipid oxidation which contribute to the development of texture and typical flavour of dry-cured meat **(Lorenzo, 2014b)**.

In *m. longissimus dorsi* the protein content ranged from 21.23 until 22.34 g.100 g^{-1} **(Haščík et al., 2011)**.

Intramuscular fat of dry-cured hams contributes to flavour and odour perception through different mechanisms (lipid oxidation, Maillard reactions etc.) involved in volatile compounds formation **(Ruiz-Carrascal et al., 2002)**. Intramuscular fat also plays an important role in the perception of the texture of dry-cured hams, particularly in juiciness, since these products are strongly dehydrated and the contribution of moisture to the perception of this attribute is limited **(Ventanas et al., 2005)**. Fat stimulates the saliva secretion and contributes directly to juiciness by coating the tongue, teeth and other parts of the mouth acting as a lubricant agent **(Lynch et al., 1993)**.

The quality of dry-cured meat is also influenced by the processing technology (for example length of drying and ripening period). Practically, the product, after draining ripen for several months and is decreased the water activity (a_w) below 0.90 **(Soto et al., 2008)**. The ripening time may cause an increase in weight loss which affects the quality characteristics and nutritional value as well as production cost of dry-cured meat.

The color is a significant parameter of the meat quality. It is one of the most important parameter which influence evaluation of meat **(Valous et al., 2010)**. Measurement and evaluation of color can be done with determining the *L**, *a**, *b**values in CIELAB color parameter and computer image analysis **(Du and Sun, 2004)**. The most often used methods of detection of ripening meat process are pH measurement in combination with measurement of the color of meat in the CIEL*a*b* system **(Lesiów and Xiong, 2013)**. By **Scheier et al., (2013)** the color (L* - value) influences the consumers purchasing decision more than any other quality factor.

The aim of this article was to determine chemical and physical parameters of dried salted pork ham and neck.

MATERIAL AND METHODOLOGY

Ham (14 samples) and neck (14 samples) was salted by nitrite salt mixture during 1 week (dry salting). Salt mixture contains salt, dextrose, stabilizer E316, maltodextrin, taste enhancer E621, flavourings, nitrite mixture. The weight of samples was approximately 1 kg and they were dried at 4 °C and relative humidity 85% 1 week after salting.

Chemical composition analysis

The chemical composition of the neck and ham was measured (50 g) by the FT IR method using the device Nicolet 6700 (Thermo Scientific, USA). The total proteins in g.100g^{-1}, the intramuscular fat in g.100g^{-1}, total water in g.100g^{-1} and cholesterol (g.kg^{-1}) were analysed. The infra-red spectrum of the muscular homogenate analysis was carried out by the molecular spectroscopy method. The principle of this method is the absorption of the infra-red spectrum during the sample transition. There is a change of the rotary vibrating energetic conditions of the molecule depending on the changes of the dipole momentum molecule.

Determination of salt (NaCl)

Samples of approximately 2 g with 2 mL of indicator potassium chromate were titrated by solution of silver nitrate until a light orange color. The amount of silver nitrate was divided by weight of sample.

Water activity deteremination (a_w)

Water activity (a_w) of the dried ham and neck was determined at 25°C with a measuring device FA–st lab (GBX advanced technology, Switzerland). Calibration was done by using several saturated solutions of known a_w.

Colour determination

Color parameters of the salted and dried ham and neck were measured using the spectrophotometer CM-2600d Minolta Chroma Meter CR-400 (Minolta Camera Co., Ltd., Osaka, Japan). Color was expressed according to the Commission International de l'Eclairage (CIE) system and reported as CIE L* (lightness), CIE a* (redness), CIE b* (yellowness).

Shear work measurements (W – B)

Shear force was measured by device TA XT2 plus (Stable Micro Systems, United Kingdom).

Measurement of pH value

The pH value of dried ham and neck at different ripening periods was measured using a pH meter Gryf 209L (Sigma-Aldrich, Czech Republic).

Statistical analyse

The data were subjected to statistical analysis using the Statistic Analysis System (SAS) package (SAS 9.3 using of application Enterprise Guide 4.2). Differencies between groups were analysed by t-test.

RESULTS AND DISCUSSION

Dry-cured ham is a traditional dry-cured meat product obtained after 12 – 24 months of ripening under controlled environmental conditions **(Dall'asta et al., 2010)**, at present time is the tendency of shortening the aging time.

Chemical and physical parameters of dried salted pork ham and neck were analysed in this article.

The average moisture of dried salted pork ham was 63.77% and ranged from 61.06 to 67.32%. The average moisture of dried salted pork neck was 59.26% and ranged from 53.75 to 65.68% (Table 1 and Table 2). The moisture was significantly lower in neck in comparison with ham.

Benedini et al., (2012) found out opposite our results in ham lower moisture 61.2% in dried salted *biceps femoris*. The average protein content was 24.87% in dried salted pork ham and significantly lower (20.51%) in dried salted pork neck. The protein content ranged from 23.86% to

25.63% in dried salted pork ham and from 18.92 to 21.76% in dried salted pork neck.

Benedini et al., (2012) found out opposite our results protein content 27.00% in dried salted *biceps femoris*.

Lorido et al., (2015) found out opposite our results higher content of proteins (39.26%) in *semimembranosus,* but in lower moisture content (40.84%).

The average value of intramuscular fat in dried salted pork ham was 4.97% and 14.40% in dried salted pork neck. The differences between values in intramuscular fat were significant and they related to the different content of fat in the raw meat. **Lorido et al., (2015)** found out higher content of intramuscular fat (10.62%) in *semimembranosus.*

The average salt content was 5.39% in dried salted pork ham and 4.83% in dried salted pork neck. The salt content ranged from 4.50 to 5.94% in dried salted pork neck. The salt content in the dried salted pork ham was more variable (3.56 – 7.35%). **Lorido et al., (2015)** found out similar content of salt (4.38%) in *semimembranosus.* The average cholesterol content was 1.36 $g.kg^{-1}$ in dried salted pork ham and significant lower in dried salted pork neck (0.60 $g.kg^{-1}$).

The cholesterol content ranged from 0.73 to 1.93 $g.kg^{-1}$ in dried salted pork ham and from 0.38 to 1.23 $g.kg^{-1}$ in dried salted pork neck.

The average value of lightness was 44.36 CIE L* in dried salted pork ham and significantly lower in dried salted pork neck (40.74 CIE L*). The lightness in the dried salted pork ham ranged from 34.68 to 55.27 CIE L* and in dried salted pork neck ranged from 36.06 to 45.49 CIE L* (Table 3).

The average value of redness was 10.02 CIE a* in the dried salted pork ham and significantly higher in dried salted pork neck (14.45 CIE a*). The redness in the dried salted pork ham ranged from 8.08 to 12.49 CIE a* and in

Table 1 The content of moisture, dry mater and proteins in pork ham and neck.

Parameters		Moisture (%)	Dry mater (%)	Proteins (%)
ham	x	63.77	36.23	24.87
	s	2.12	2.12	0.71
	s_x	0.80	0.80	0.27
	min.	61.06	32.68	23.86
	max.	67.32	38.94	25.63
	v%	3.32	5.85	2.83
neck	x	59.26	40.74	20.51
	s	4.55	4.55	0.91
	s_x	1.72	1.72	0.34
	min.	53.75	34.32	18.92
	max.	65.68	46.25	21.76
	v%	7.67	11.16	4.43
	t-test	+	+	+++

Table 2 The content of intramuscular fat, salt and cholesterol in pork ham and neck.

Parameters		Intramuscular fat (%)	Salt (%)	Cholesterol ($g.kg^{-1}$)
ham	x	4.97	5.39	1.36
	s	2.50	1.23	0.44
	s_x	0.77	0.46	0.17
	min.	3.20	3.56	0.73
	max.	9.15	7.35	1.93
	v%	41.18	22.73	32.69
neck	x	14.40	4.83	0.60
	s	4.79	0.69	0.29
	s_x	1.81	0.26	0.11
	min.	7.89	4.50	0.38
	max.	20.92	5.94	1.23
	v%	33.29	14.29	48.09
	t-test	+++	-	++

dried salted pork neck ranged from 11.71 to 16.32 CIE a*.

Compared with our results, those of **Alino et al., (2010)** found lower CIE a* values (5.7 to 6.3) in dry-cured meat processed with different ripening at 60 days. In general, redness is considered as one of the most attractive color parameters of cured meat products **(Honikel, 2008)**, however, the extended ripening time up to 90 days did not improve the redness, suggesting that the ripening beyond 60 days may not be effective in improving redness of dry-cured loins.

The average value of yellowness was 9.22 CIE b* in the dried salted pork ham and 9.75 CIE b* in dried salted pork neck. The yellowness in the dried salted pork ham ranged from 7.44 to 11.90 CIE b* and in dried salted pork neck ranged from 8.05 to 10.49 CIE b*.

The average pH value was 5.84 in dried salted pork ham and 5.80 in dried salted pork neck (Table 4). The pH value ranged from 5.80 to 5.93 in dried salted pork ham and from 5.67 to 5.98 in dried salted pork neck. The pH values of both products showed that the meat has not been ripened.

Several studies have shown that pH is a good predictor of the colour and drip loss of meat. **Bednářová et al., (2014)** measured pH of *semimembranosus.* They found out pH values in range from 5.56 to 5.63. There is a high relationship between pH and moisture diffusivity and mechanical and sensory textural properties in salted or dry-cured meat **(Gou et al., 2002, Guerrero et al., 1999 and Ruiz-Ramirez et al., 2006)**.

Table 3 Color results of dried salted pork ham and neck.

Parameters		CIE L*	CIE a*	CIE b*
ham	x	44.36	10.02	9.22
	s	6.71	1.59	1.80
	s_x	2.54	0.61	0.68
	min.	34.68	8.08	7.44
	max	55.27	12.49	11.90
	v%	15.12	15.89	19.51
neck	x	40.74	14.45	9.75
	s	3.18	1.41	1.02
	s_x	1.20	0.54	0.39
	min.	36.06	11.71	8.05
	max	45.49	16.32	11.30
	v%	7.82	9.80	10.49
	t-test	+	+	-

(Note: p >0.05; + $p \leq 0.05$).

Table 4 Physical parameters of dried salted pork ham and neck.

Parameters		**pH**	**Shear work ($kg.s^{-1}$)**	**Water activity (a_w)**
ham	x	5.4	9.99	0.929
	s	0.05	6.48	0.011
	s_x	0.02	2.45	0.004
	min.	5.80	3.81	0.910
	max	5.93	20.88	0.939
	v%	0.89	64.83	1.226
neck	x	5.80	6.34	0.921
	s	0.10	1.86	0.021
	sx	0.04	0.70	0.008
	min.	5.67	4.19	0.897
	max	5.98	8.76	0.947
	v%	1.79	29.33	2.379
	t-test	-	-	-

(Note: p >0.05; + $p \leq 0.05$; ++ $p \leq 0.01$; +++ $p \leq 0.001$).

The average shear work was 9.99 kg.s^{-1} in dried salted pork ham and 6.34 in dried salted pork neck. The shear work ranged from 3.81 to 20.88 kg.s^{-1} in dried salted pork ham and from 4.19 to 8.76 kg.s^{-1} in dried salted pork neck. **Franci et al., (2007)** found out higher shear work opposite our results (ranged from 13.69 to 13.71 kg.cm^{-2}).

The average value of water activity (a_w) was 0.929 in dried salted pork ham and similar 0.921 in dried salted pork neck. The water activity value ranged from 0.91 to 0.939 in dried salted pork ham and from 0.897 to 0.947 in dried salted pork neck. **Bjarnadottir et al., (2015)** found out opposite our results lower water activity in dried ham (0.809 to 0.906 a_w).

CONCLUSION

The aim of this article was to determine chemical and physical parameters of dried salted pork ham and neck. The moisture was significantly lower in neck in comparison with ham. The protein content in dried salted pork ham was significantly higher in comparison with dried salted pork neck. The value of intramuscular fat in dried salted pork ham was significantly lower in comparison with dried salted pork neck. The content of salt was higher in dried salted pork ham compared to dried salted pork neck. The cholesterol content in dried salted pork ham was significant lower in comparison with dried salted pork neck. The lightness was significantly higher in dried salted pork ham in comparison with dried salted pork neck. The pH value was similar in dried salted pork ham as in dried salted pork neck. The shear work in dried salted pork ham was higher compared to dried salted pork neck. The value of water activity (a_w) was similar in dried salted pork ham as in dried salted pork neck.

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