Sensory properties and consumer's acceptance of Parma, San Daniele and Toscano dry-cured hams: effect of familiarity and processing technology

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Abstract

BACKGROUND

This study investigated sensory properties and acceptability of dry-cured hams labeled with different PDOs (Protected Designation of Origin). For each PDO, two genotypes were considered: ILxLW cross (reference hybrid) and Goland cross (commercial hybrid).

RESULTS

According to descriptive analysis, genetic variance did not affect the sensory quality of Toscano and San Daniele hams. The commercial hybrid Parma ham was distinct from the traditional one. Goland genotype was significantly higher in red color, saltiness, dryness and hardness and showed a lower intensity of pork-meat odor/flavor and sweetness than the ILxLW genotype. Consumer's acceptance was influenced by the PDO but not by genetic type. PCR analysis revealed that Toscano ham was the preferred sample. Considering that the consumers involved were from Florence (Tuscany region), it is likely that Toscano ham was the preferred product according to a higher familiarity with this product.

CONCLUSION

This study revealed that genetic type played a marginal role on dry-cured ham sensory quality and acceptability. Hams considered are better discriminated according to the denomination of origin, and thus according to the different technology process. One of the main finding of the study was that familiarity with the product was the best driver of dry-cured ham preference.

Keywords: Dry-cured ham; Crossbreeding; Protected Denomination of Origin; Acceptability; Familiarity

1. Introduction

Dry-cured ham is an important product category throughout Europe, representing a typical traditional product seen from the consumer's perspective[1,2]. This product represents a key element in the daily food intake, reflecting cultural inheritance and having left its imprint on contemporary dietary patterns in Europe[3]. Dry-cured ham is one of the essential components of the Mediterranean diet and, although the risks and benefits of the consumption of processed meat products are still under discussion[4], moderate consumption of dry-cured ham has commonly been included as part of a balanced diet, especially for teenagers and elderly people[5].

Dry-cured hams may receive different labels in the European Union area, such as Protected Designation of Origin (PDO), Protected Geographical Indication (PGI), or Traditional Specialty Guaranteed (TSG), depending on the specific region and particular regulation[6].

Italy has a large amount of food and agriculture resources, as well as the highest number of PDO and PGI labeled products in Europe. The meat-products segment corresponds to about 16% of Italian PDOs/PGIs; this product category also includes dry-cured hams, which represent 7% of Italian PDOs[7]. In this context, Parma, San Daniele and Toscano hams are the three most important Italian consortia for the production of PDO dry-cured hams.

Considering the manufacturing protocols, Parma, San Daniele and Toscano hams share a similar process technology, but differ in some aspects such as: a) the trimming process, which endows the ham with its typical shape (a guitar-like shape for San Daniele ham, a chicken-thigh-like shape for Parma ham and a round shape for Toscano ham); b) the salting phase, which varies between the various DPO for both the method of salting, type of salt used, time and temperature storage (for Toscano this phase is much longer than the other); c) the pressing phase, which is typical of San Daniele, and contributes to give the ham its typical shape; d) the ripening phase, which corresponds to minimum 12 months for Parma and Toscano hams and 13 months for San Daniele ham. According to PDO specifications, final products are mainly distinguished by NaCl content, which can vary from minimum 4.5-4.9% to maximum 6.4-6.9% in Parma and San Daniele hams, while a maximum value of 8.3% is established for Toscano ham[8-10].

The wide variety of processing technologies (e.g., different drying and ripening conditions) as well as raw material (e.g., genetic type, animal feed, rearing system) contribute to hams' quality variation, especially sensory characteristics[6]. Taste is one of the main determinants of overall consumer's satisfaction, hence, producers are recommended to focus on matching sensory acceptability of dry-cured ham to have a successful product[11].

With regard to genetics, breed has been reported to have a marked effect on dry-cured ham characteristics[12]. In fact, when processing is standardized, the quality of the final dry-cured product is primarily determined by the quality of the meat before curing[13]. Italian pig farming has undergone significant changes in the past 20 years. The so-called ''traditional'' pigs, mainly Large White (LW), Landrace (L) and Duroc (D) breeds or deriving from their crosses, which have always been used in heavy pig production and the related pork-processing industry, have been joined by more recent genetic types, mainly commercial hybrids with better farm performance and leaner carcasses. These changes have inevitably led to modifications in the characteristics of lipids, which have gradually become richer in unsaturated fatty acids and therefore more subject to oxidative phenomena[14], with marked consequences on sensory quality. Several authors have investigated the effect of genetic type on meat quality destined to dry-cured ham production[12,14-16,17-21] but to our knowledge no studies have attempted to investigate how genetic origin can influence consumer's perception of the three main Italian PDOs.

The aim of the present study was to investigate the influence of pig's genetic type on sensory properties and consumer's acceptance of dry-cured hams labeled with different PDOs. Parma, San Daniele and Toscano dry-cured hams were selected for the study. For each PDO, two genotypes were considered: Italian Landrace x Italian Large White cross and Goland. A panel of trained assessors was involved in order to see whether Parma, San Daniele and Toscano hams deriving from the two different genotypes showed differences in their sensory profile. A larger, separate group of consumers was then involved in order to see whether genetic type can influence consumers' acceptance and, if so, which are the sensory descriptors that contribute to explain preference.

2. Material and methods

2.1. Dry-cured hams

A scheme of experimental plan for dry-cured hams production is reported in **Figure I**. Pigs belonged to two different genotypes: Italian Landrace x Italian Large White cross (reference hybrid, ILxLW) and Goland (commercial hybrid, GO). One-hundred thirty two pigs were reared in the same farm and fed with a standard cereals-soybean based meal. Pigs were slaughtered in the same plant. Twenty thighs for each genotype (balanced for laterality) were selected according to specifications of San Daniele, Parma and Toscano PDO consortium for raw thigh characteristics. In total 120 thighs were selected. Forty thighs (twenty per genotype) were delivered in a plant belonging to each consortium and cured according to the relevant PDO specifications. The compliance of samples to PDO specifications of each consortium was checked by consortium expert personnel at the end of processing and ten samples per each product were obtained (**Table I**). The dry cured hams were deboned, packed under vacuum in a plastic film and stored at 6 °C until evaluation. Hams were sliced immediately before evaluation (thickness 1 mm). Only anatomic parts corresponding to *M. Semimebranosous, M.*

semitendinosus, *M. Biceps femoris*, *M. Rectus femoris*, *M. Vastusmedialis* (*M. Quadriceps femoris*) were used for evaluation. For each product (PDO- genetic type), four hams were used for descriptive analysis and six for consumer test.

2.2. Methods

2.2.1. Descriptive Analysis

In order to describe hams sensory properties, the sensory profiling method was applied (ISO 13299, 2010). Twelve subjects (7 women and 5 men aged between 26 and 50) were selected. At the end of the experiment, each subject received a participation fee.

The method consisted of a first training phase to acquire familiarity with the product and the methodology, followed by a second phase focused on the sample evaluation. Subjects were trained over a period of two months (six 1-h common sessions and four sessions in individual sensory booths). During this phase, for each of the three PDO hams, several commercial products were selected and presented to the assessors in order to provide a wide range of sensory variability thus facilitating the generation of descriptors. As training progressed, descriptive terms and relevant reference standards were defined through panel discussion. Fourteen sensory descriptors were generated (**Table II**).

Once the vocabulary was set up, assessors performed four sessions in sensory booths to acquire familiarity with the scale. After the training phase, judges evaluated the six experimental hams in four replicates performed in different days. Three ham samples were evaluated by session (2 sessions per day) in order to avoid fatigue and adaptation effects. Assessors were asked not to smoke, eat or drink anything, except water, for one hour before the tasting sessions. Ham samples were served on white plastic plates coded with 3-digit numbers at room temperature in individual booths under white light. Judges rated the intensity of each sensory attribute using a 9-point scale anchored at both extremes (‘‘not at all intense’’ on the left and ‘‘very intense’’ on the right). Assessors were provided with water and unsalted crackers to rinse the mouth after the evaluation of each sample. Samples presentation order was systematically varied over assessors and replicates in order to balance the effects of serving order and carryover[22].The evaluation was performed always before lunch from 12.00 to 13.00 in a sensory laboratory designed according to ISO guidelines[23]. Data were collected using Fizz v2.31 software program (Biosystemes, Couternon, France).

2.2.2. Consumer test

2.2.2.1. Respondents

Ninety subjects, 37 males and 63 females, aged from 21 to 56 years participated in the study. Consumers were recruited in the Florence area. They had seen or received an invitation to participate in the study and volunteered based on their interest and availability. Participants had no history of disorders in oral perception and ate dry cured ham regularly (at least 2-3 times a month). Written informed consent was obtained from each subject after the description of the experiment. They were paid for their participation in the study.

2.2.2.2. Consumer test procedure

Consumer testing took place in the sensory lab and consisted of one individual evaluation session lasting 20 min. Consumer groups of 6-7 subjects were formed and asked to come to the sensory lab at 45 min time intervals from 11.00 am to 2.00 pm. Five consumer groups performed the test per day, the whole study was performed in three days. Subjects were presented with the six hams and were asked to rate their liking on a fully anchored 9-point category scale ranging from 1 (“dislike extremely”) to 9 (“like extremely”) with a neutral point at 5 (“neither like nor dislike”)[24]. To take in to account sample variability within the same product one different ham was evaluated every 15 subjects. Sample presentation and evaluation conditions are those described for descriptive analysis evaluations. After completing the liking test, respondents were presented with the PDO names and were asked to rate their familiarity with the relevant products using a five option scale: 1 ‘‘I do not recognize this type of ham’’, 2 ‘‘I recognize this type of ham, but I have not tasted it’’, 3 ‘‘I have tasted this type of ham, but I do not use it’’, 4 ‘‘I occasionally use this type of ham and 5 ‘‘I regularly use this type of ham”[25].

A computerized system (FIZZ Version 2.47B, Biosystèmes, Couternon, France) was used for data recording.

2.3. Data analysis

In order to check panel reliability, sensory profiling data were analyzed according to[26]. Once panel reliability has been assessed, sensory profiling data were averaged across judges and replicates. Mean intensity data of each PDO were independently submitted to a Student t-test in order to assess the effect of genetic type on hams’ sensory properties. PDO was not considered as a factor for sensory profiling data at this stage because previous findings reported marked differences between Parma, Sand Daniele and Toscano hams sensory properties[26] that might blur differences due to genetic type.

Liking ratings were submitted to a mixed ANOVA model considering *PDO, Genetic type* and their interaction as fixed factors and *Subjects* as random factor. When a significant effect ($p<0.05$) was found, the Least significant difference (LSD) was used as a multiple comparison test.

Individual differences in consumer liking for hams and their relationship with mean intensities of sensory descriptors were analyzed by means of Principal Component Regression (PCR). For this purpose liking data were used as the X matrix and mean intensity values as the Y matrix (Internal Preference Map). Samples were included as dummy variables (down-weighted in the X data matrix) to improve the visual interpretation[27]. Mean liking scores were added to the individual ratings data in the X matrix. The full cross validation was computed to validate the interpretation of the first two components.

Familiarity data were submitted to the Friedman Two-Way Analysis of Variance assuming PDO and subjects as factors.

All uni-variate analyses were conducted using SAS/STAT statistical software package version 9.1.3. (SAS Institute Inc., Cary, USA). PCA and PCR modeling was performed using The Unscrambler X (version 10.3, CAMO, Norway).

3. Results and Discussion

3.1. Descriptive analysis

Mean intensity ratings for the fourteen sensory attributes by genotype and PDO are reported in **Figure II** (a-c). As can be seen from Figure 2a, the two Parma genotypes show significant differences for appearance, odor, taste, flavor and texture. In particular, the GO genotype showed significantly higher values than the ILxLW genotype as regards the intensity of red color ($t= 2.78$, $p=0.05$), saltiness ($t=5.32$, $p<0.01$), dryness ($t=9.77$, $p<0.001$) and hardness ($t=3.33$, $p<0.05$) but lower values of pork-meat odor ($t=4.60$, $p=0.01$) and flavor ($t=3.41$, $p<0.05$) and sweetness ($t=5.31$, $p<0.01$). The two San Daniele genotypes differed only in terms of sweet taste and dry texture, being GO-SD significantly sweeter ($t=3.12$, $p<0.05$) and less dry ($t=2.76$, $p=0.05$) than ILxLW-P (Fig.2b). Significant differences comparing the two genotypes of Toscano hams were only found for appearance descriptors The GO–T resulted significantly more intense in red color ($t=11.68$,$p<0.001$) and brightness ($t=3.30$,$p<0.05$) and showed lower intensity in fat white color ($t=5.10$,$p<0.01$) than ILxLW-T (Fig.2c).

It has been shown in other studies that the genetic type may influence some sensory characteristics of dry-cured ham. [12]showed that genetic type had a significant impact on toasted flavor, juiciness and sweetness of Iberian ham. In another work[13] it has been shown that crossbreeding had a slight effect on bitter taste, brightness, marbling and some aroma. [17]reported that different Duroc line sires showed small variation in sensory attributes, mainly marbling and subcutaneous fat. Concerning Italian hams, [19]found that crosses of Cinta Senese with Large Withe lead to differences concerning fattiness, redness and marbling of the lean area.

3.2. Consumer test

ANOVA results revealed a significant effect only for the main factor PDO (F=21.97, p<.0001) (**Figure III**). According to the multiple range test, Toscano ham was significantly more liked (M=7.1 ±0.2), than Parma ham (M=6.5±0.2), which was in turn significantly preferred than the San Daniele ham (M=6.1±0.2). It is worth to note that all samples were rated more than 5 (neither like nor dislike) thus indicating that dry-cured ham is overall an appreciated product by Italian consumers irrespective to PDO.

3.3 Relationship between descriptive and acceptability data

In order to explore the relationship between liking and sensory profile, a principal component regression (PCR) was computed. This is an Internal Preference Map, a statistical tool commonly used to establish which sensory attributes drive consumer preference for a given set of samples. The correlation loading plot from the PCR of the fourteen significant sensory attributes for the 6 samples is presented in **Figure IV**. Individual respondents are represented on the map by points which can be considered as end-points of vectors from the origin. These vectors are not exact representations of each individual's scores, but are projections onto the preference dimension demonstrating the best fit of the original data. The direction of the vector represents the direction of increasing personal ‘preference’ for a consumer and the length (from the origin to the end-point) indicates how well that individual is represented by the dimensions that are being plotted (i.e., how much variance is explained). If a subject’s point is a long way from the origin the scores of that person are explained well by one or two ‘preference’ dimensions[28].

The first dimension indicates that consumer liking was oriented towards hams on the right side of the map (Toscano products) in opposition to samples located on the left side of the plot (Parma and San Daniele products). Thus, based on individual liking data only, the hams appear well separated in the space according to PDO. Most consumers were located on the right of the first component and their preference was mainly driven by “marbling”, “red color”, “fibrous” “dry”, “rancid”, “salty”, “hard” and “pork meat” attributes in opposition to “sweet” and “bright” attributes. Consumers were widely spread along PC2 in which Parma hams were separated from the San Daniele hams. Consumers in the upper part of the map showed a preference toward Parma hams driven by the odor attribute “cured”. While a limited number of respondents prefer hams with clear sweet notes (consumers falling in the left side of the first dimension), very few respondents tend to prefer San Daniele to other PDO hams. It seems evident that, even looking at individual differences, consumer liking is more affected by the technology than the genetic type. The two genetic types of each PDO fall very close on the map. Only Tuscan genetic types are separated along the second dimension of the internal preference map that shows a higher number of respondents orienting their liking towards the sample T-GO because the higher intensity of the “cured” attributes in this sample. This result is in agreement with findings by[17] who reported that consumer acceptability was similar across different Duroc sire lines.

The point representing the mean liking score across all respondents falls in the upper right part of the map confirming that the Toscano hams (both genetic variants) are, on average, more appreciated than Parma and San Daniele hams. Variables having a high and positive coordinate on the PC1 show a direct correlation with the mean preference score, while variables with a negative coordinate on PC1 are negatively correlated to preference. On average, liking is mainly driven by a higher red color, marbling appearance, cured flavor and salty taste. A high intensity of the texture properties and of pork-meat and rancid flavors seems to contribute as well to overall ham liking. On average San Daniele and Parma hams (both genetic variants) were perceived as sweeter and with a more bright appearance. These two types of hams were less appreciated by the consumer. These results confirm previous findings, indicating that Toscano ham shows marked differences as compared to San Daniele and Parma hams, which are in turn more similar from a sensory point of view[26]. The main difference of the three PDOs concerns the salting phase, which is longer for the Toscano ham, thus resulting in a saltier product. The salt content in this type of product is essential as it is responsible of a lower water activity and thus a harder and drier texture. Also, salt content plays a pivotal role in controlling major chemical and microbial processes. In many cases, salt acts as an essential hurdle against pathogens[29] and those spoilage organisms to which major bacterial defects have been ascribed[30].

Little research has been devoted to determine the relationship between the sensory characteristics of dry-cured ham with its acceptability. Most of the sensory studies present in literature have been carried out on Iberian hams, showing that all sensory traits including appearance, aroma, flavor and texture are important characteristics which influence overall ham quality. For instance, previous works dealing with sensory dry-cured ham quality pointed out the importance of intense aromas on the quality of ham[31,32]. The flavor of a food is a combination of its taste and smell, which are produced by non-volatile and volatile compounds, respectively. Raw meat is generally characterized as being salty, metallic and bloody tasting with a sweet aroma[33]. During the subsequent processing numerous precursors react to form the characteristic taste and aroma of dry-cured ham [34,35]. [36]reported that juiciness and cured flavor were positively correlated to acceptability for Iberian ham, whereas a more fibrous and dryer texture had a negative influence on liking. The negative influence of some textural traits like fibrousness or dryness on overall acceptability has been previously described also in cooked meat[37,38]. Fibrousness is caused both by the presence of insoluble collagen and by the aggregation of myofibrilar proteins due to the dehydration occurred during the ripening process[39]. Dryness is mainly determined by the amount of moisture retained in the ham after the processing[40]. These properties require longer mastication that can be considered unwanted by the consumer. Accordingly, [11]found that high values of the texture properties of crumbliness and softness as well as sweetness have a positive impact on Spanish consumers, while high mould odor, high saltiness and crust are valued negatively. In this context, our findings contradict literature data, since Toscano ham was preferred by consumers due to its harder and drier texture, which was mainly due to high saltiness. Considering that the consumers involved in the present study were from Florence (Tuscany region) it is likely that Toscano ham was the preferred sample because of the higher consumers' familiarity with this product. The analysis of familiarity data clearly showed that respondents were more familiar with Tuscan PDO products than Parma and San Daniele (**Table III**). Despite the ham samples were tasted by consumers in a blind condition, i.e., without having any information about the product, it seems that consumers had a good recall of the product they are used to consume, as also evidenced by[41]. Considering the structure of the consumer preference for the tested hams showed in the internal preference map, these results clearly confirm that the familiarity with a product is a strong determinant of consumers' expectations, perceptions and preference. In addition, the importance of origin information related to traditional food on consumer's appreciation has been demonstrated in several studies[42,11]. Information about products origin has been reported to have a symbolic and emotional meaning for consumers generating hedonic and sensory expectations which can lead to higher product acceptability[43,1].

Results from the present study suggest that ham appreciation and more specifically the sensory drivers of ham acceptability may vary considerably according to consumer's food culture. The results are in agreement with[2], who, in a recent cross cultural study, demonstrated that differences in familiarity and different cultural eating experiences determine a large variation in vocabulary used for description of dry-cured ham emphasizing the necessity to study and better understand how consumers of different nationalities, recognize these characteristics through their senses. This is especially relevant for a country like Italy where extremely varied food habits can be observed moving from the North to the South regions of the country. A high heterogeneity in consumer's preference for dry-cured ham has been also reported by[44], who found that, contrary to the general preference trend of the Spanish consumer, a group of consumers was more inclined towards hams characterized by crustiness, saltiness and fibrousness. Thus, it seems that consumer's segmentation is an important issue to consider when referring to dry-cured ham sensory quality, considering that matching consumers' needs is a priority in market oriented firms.

Conclusion

In conclusion, this study revealed that genetic type plays a marginal role on dry-cured ham sensory quality and acceptability. The three types of ham are actually better discriminated according to the denomination of origin, and thus according to the different technology process. One of the main finding of the study was that familiarity with the product was the best driver of dry-cured ham preference. In future studies, it would be interesting to focus more on the concepts of familiarity and origin and to look how these factors may impact dry-cured ham liking and consumption in blind, and informed conditions.

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Table I. Hams used for sensory evaluations: PDO, genotype, product code and number of hams used for Descriptive Analysis and consumer test

PDO	Genotype	Product code	Descriptive Analysis n° of hams	Consumer Test n° of hams
Parma	ILxLW	ILxLW-P	4	6
	GO	GO-P	4	6
San Daniele	ILxLW	ILxLW-SD	4	6
	GO	GO-SD	4	6
Toscano	ILxLW	ILxLW-T	4	6
	GO	GO-T	4	6

Table II. List of the sensory descriptors generated for dry-cured hams with their relevant definitions and reference standards.

Sensorydescriptor	Definition	Reference standard
Appearance		
1. Marbling	Presence of visible intramuscular fat	Picture of a ham slice with a high presence of intramuscular fat
2. Red color	Intensity of red color of the lean area	Slice of "Breasola della Valtellina" (0.8-mm of thickness)
3. White color	Intensity of white color of the fat area	Slice of lard (1-mm of thickness)
4. Brightness	Intensity of brightness of the slice of ham (lean area)	Picture of a slice of Parma ham (0.8-mm of thickness) extremely bright
Odor		
5. Pork-meat	Characteristic odor of pork meat perceived orthonasally	Slice of Toscano ham (0.8-mm of thickness)
6. Cured	Characteristic odor perceived orthonasally associated to the perception of volatile, aromatic compounds generating from curing	Slice of Parma ham cured for 24 months (0.8-mm of thickness)
7. Rancid	Characteristic odor perceived orthonasally associated to fat oxidation	Slice of lard (1-mm of thickness) left at open air and room temperature for
Taste		
8. Sweet	One of the basic tastes, caused by sweet compounds perceived in the oral cavity	Slice of Parma ham cured for 24 months (0.8-mm of thickness)
9. Salty	One of the basic tastes, caused by salty compounds perceived in the oral cavity	Slice of Toscano ham (0.8-mm of thickness)
Flavor		
10. Pork-meat	Characteristic odor of pork meat perceived in the oral cavity during	Slice of Toscano ham (0.8-mm of thickness)
11. Cured	Characteristic odor of cured ham perceived in the oral cavity during	Slice of Parma ham cured for 24 months (0.8-mm of thickness)
Texture		
12. Fibrous	Amount of fibers/strands perceived during chewing	Slice of boiled beef meat (25-mm of thickness)
13. Dry	Dryness sensation due to the reduced amount of sample moisture perceived during the chewing process	Fibers of dried horse meat (F.lli Sibilla S.r.l.)
14. Hard	Effort required to bite the sample with molars	"Breasola della Valtellina" cubes (10-mm of thickness)

Table III. Friedman Two-Way Analysis of Variance on Familiarity ratings for Toscano, Parma and San Daniele PDOs (N=270; Friedman Test Statistic=19,473; p=0.000 assuming chi-square distribution with df=2).

PDO	Rank SUM	Friedman Multiple Comparisons (p values)		
		Toscano	Parma	San Daniele
Toscano	204	-	0.043	0.000
Parma	182	0.043	-	0.010
San Daniele	154	0.000	0.010	-

505 Figure I. Experimental plan for dry-cured hams production

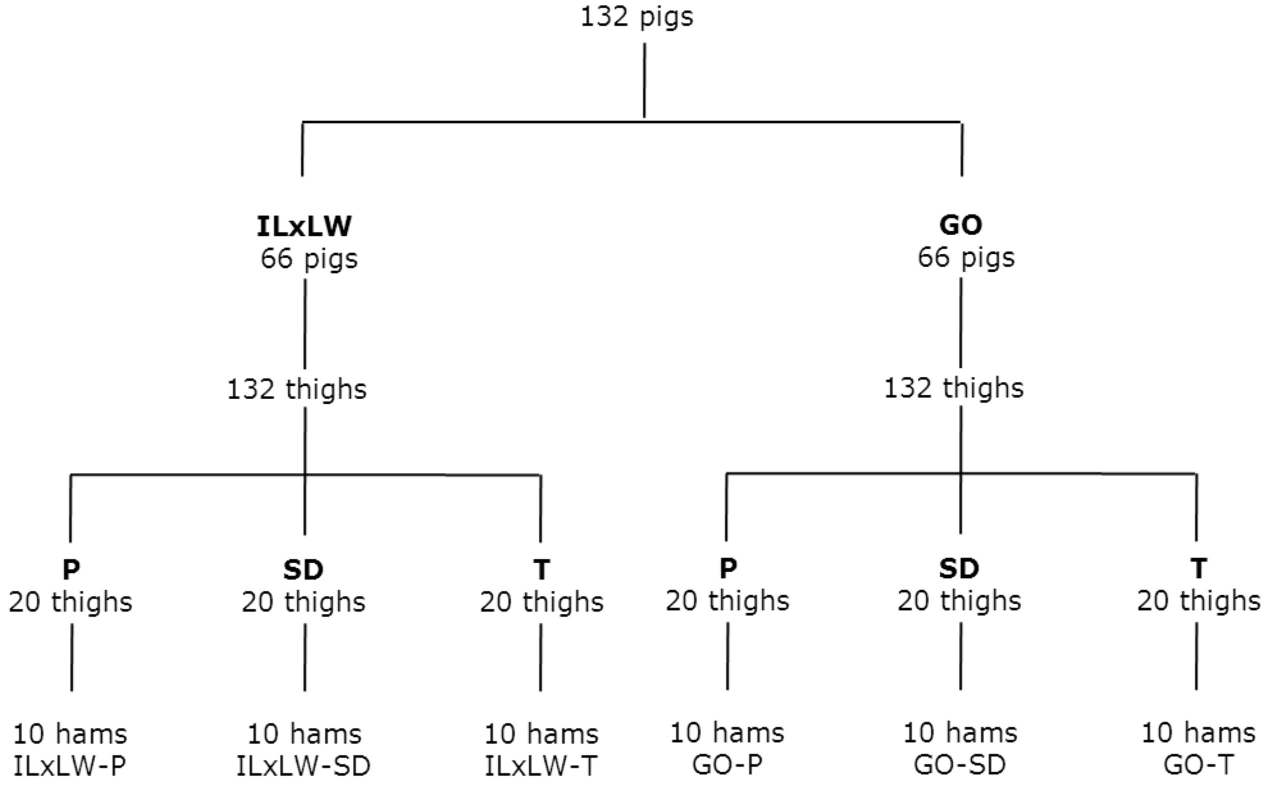
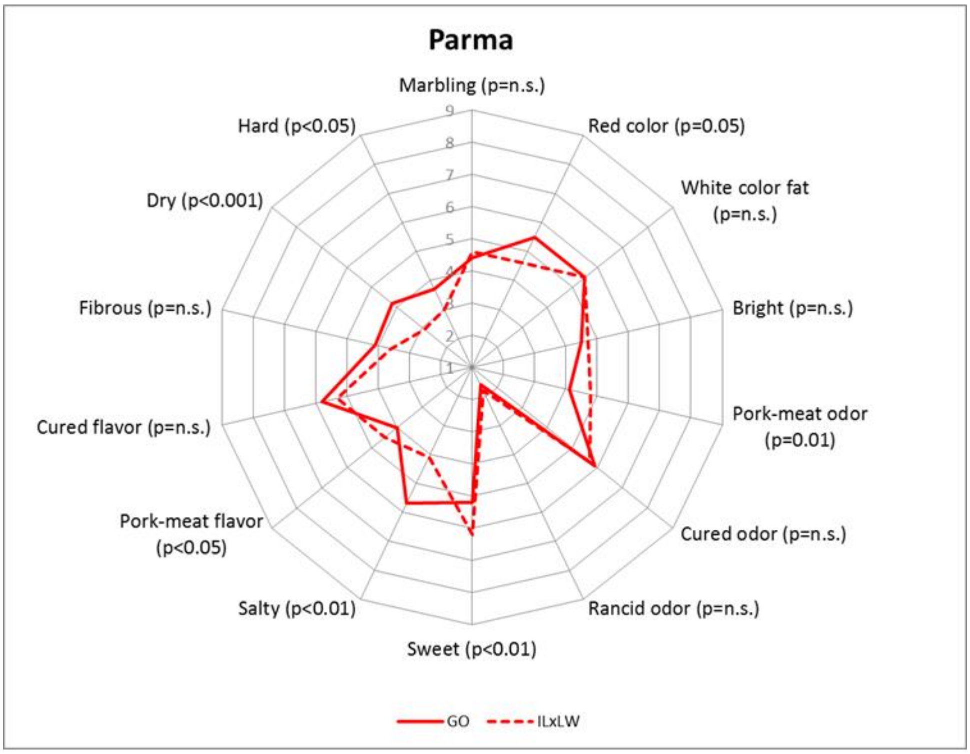


Figure II a-c. Sensory descriptors mean values by PDO and genotype (ILxLW=Italian Landrace x Italian Large White cross; GO=Goland): a) Parma; b) San Daniele;c) Toscano. P-values are calculated according to t-test ($p<0.05$).

a)



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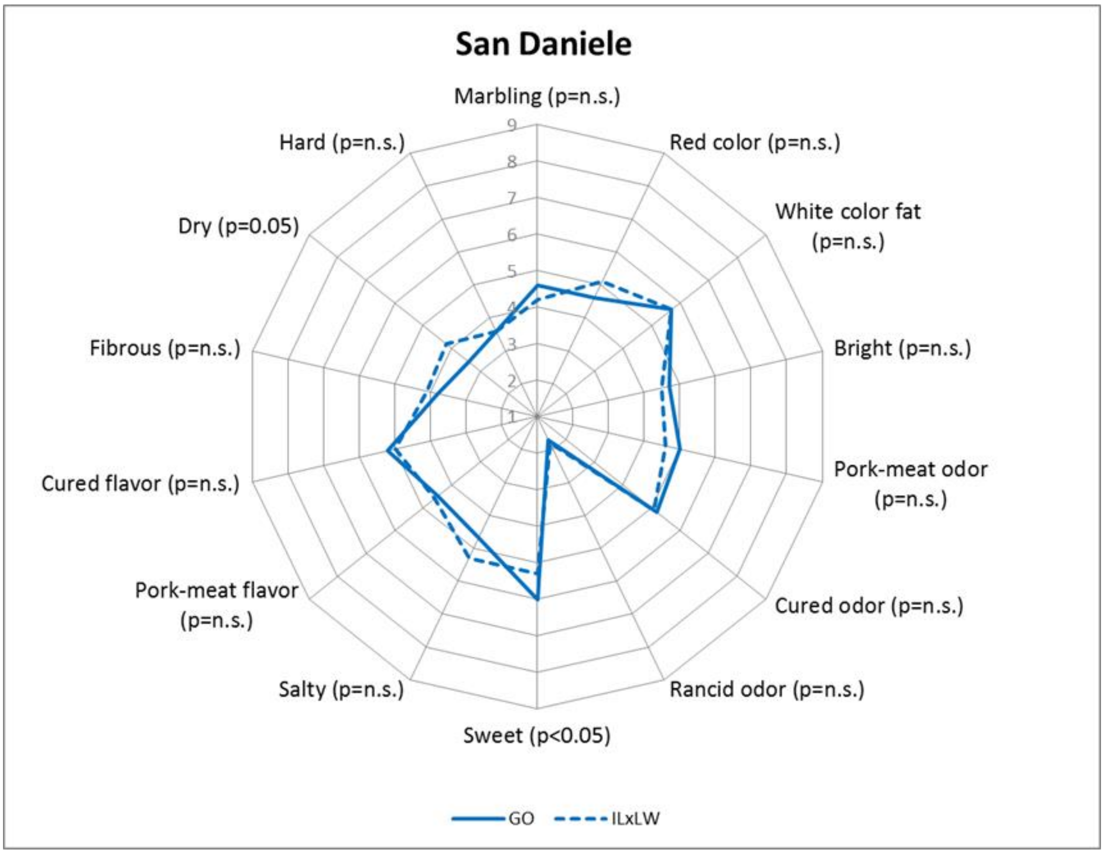
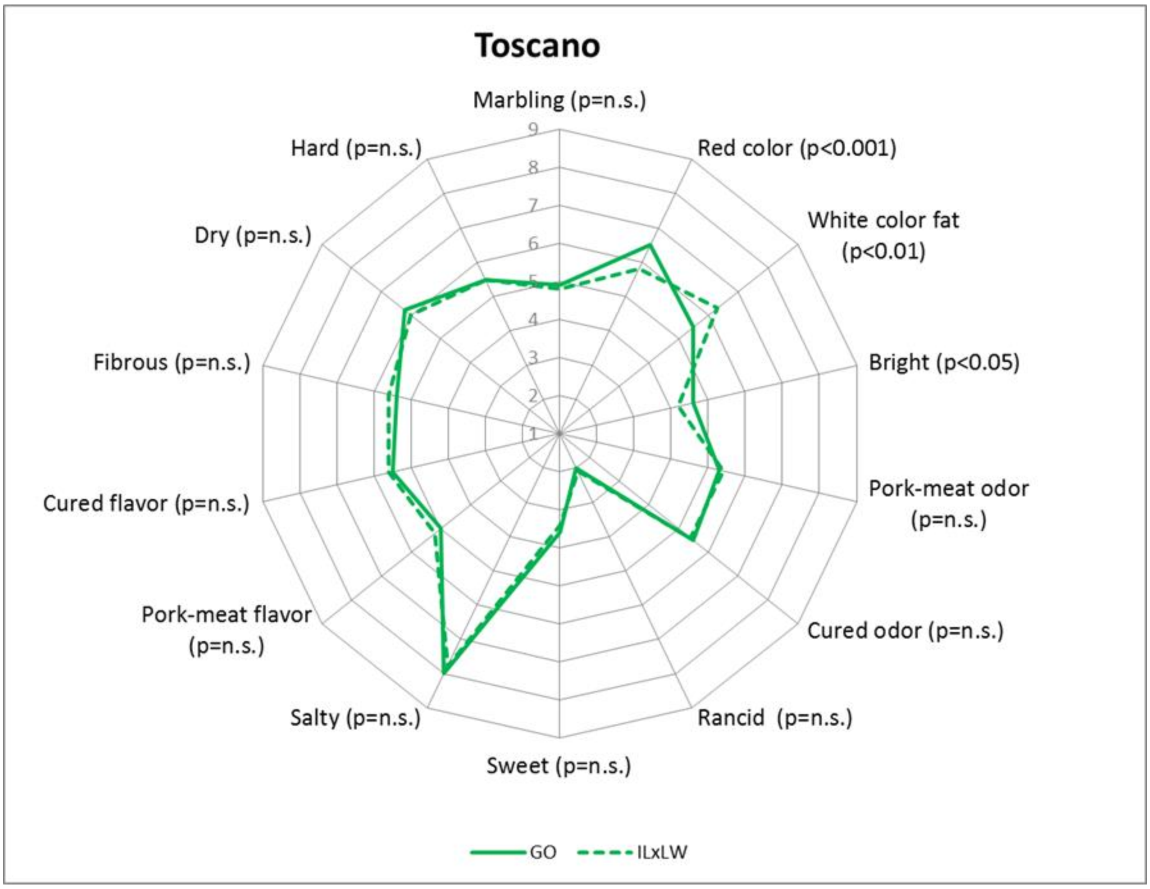

San Daniele
Marbling (p=n.s.)
Red color (p=n.s.)
White color fat (p=n.s.)
Bright (p=n.s.)
Pork-meat odor (p=n.s.)
Cured odor (p=n.s.)
Rancid odor (p=n.s.)
Sweet (p<0.05)
Salty (p=n.s.)
Pork-meat flavor (p=n.s.)
Cured flavor (p=n.s.)
Fibrous (p=n.s.)
Dry (p=0.05)
Hard (p=n.s.)
1
2
3
4
5
6
7
8
9
GO
ILxLW

517 c)



Toscano
Marbling (p=n.s.)
Red color (p<0.001)
White color fat (p<0.01)
Bright (p<0.05)
Pork-meat odor (p=n.s.)
Cured odor (p=n.s.)
Rancid (p=n.s.)
Sweet (p=n.s.)
Salty (p=n.s.)
Pork-meat flavor (p=n.s.)
Cured flavor (p=n.s.)
Fibrous (p=n.s.)
Dry (p=n.s.)
Hard (p=n.s.)
1
2
3
4
5
6
7
8
9
GO
ILxLW

518

519

Figure III. Mean liking ratings and relevant standard error by PDO and genotype (ILxLW=Italian Landrace x Italian Large White cross; GO=Goland).

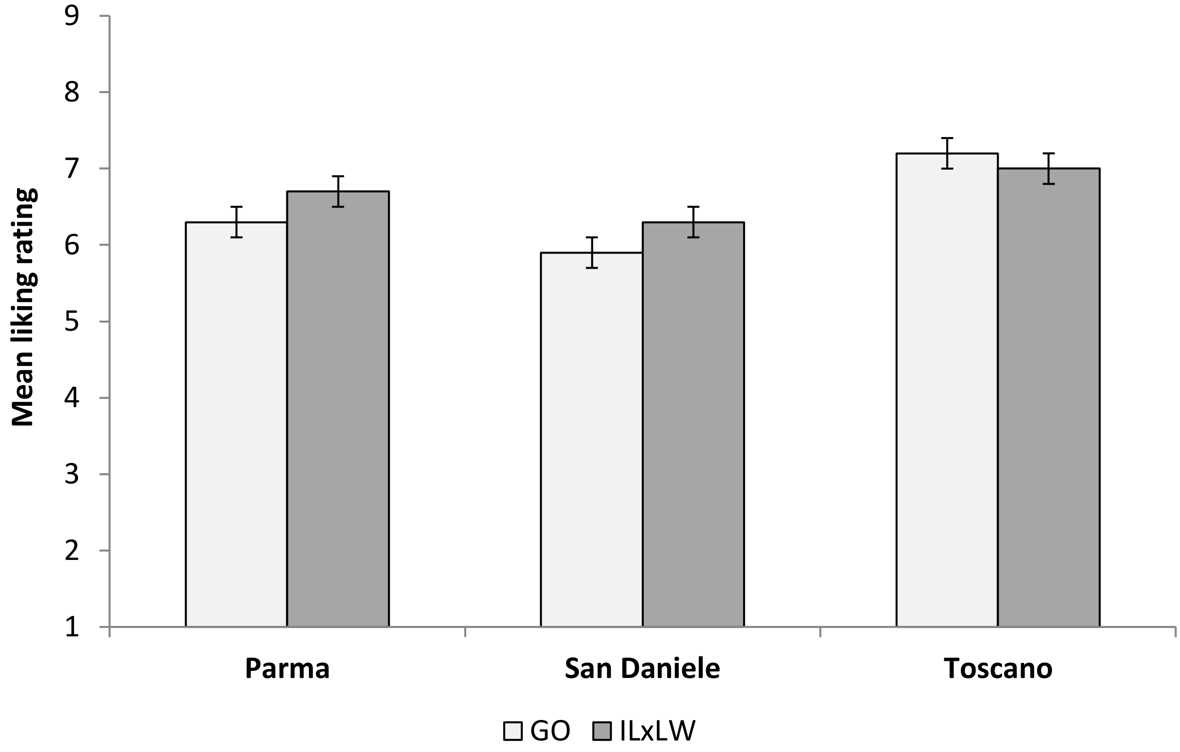
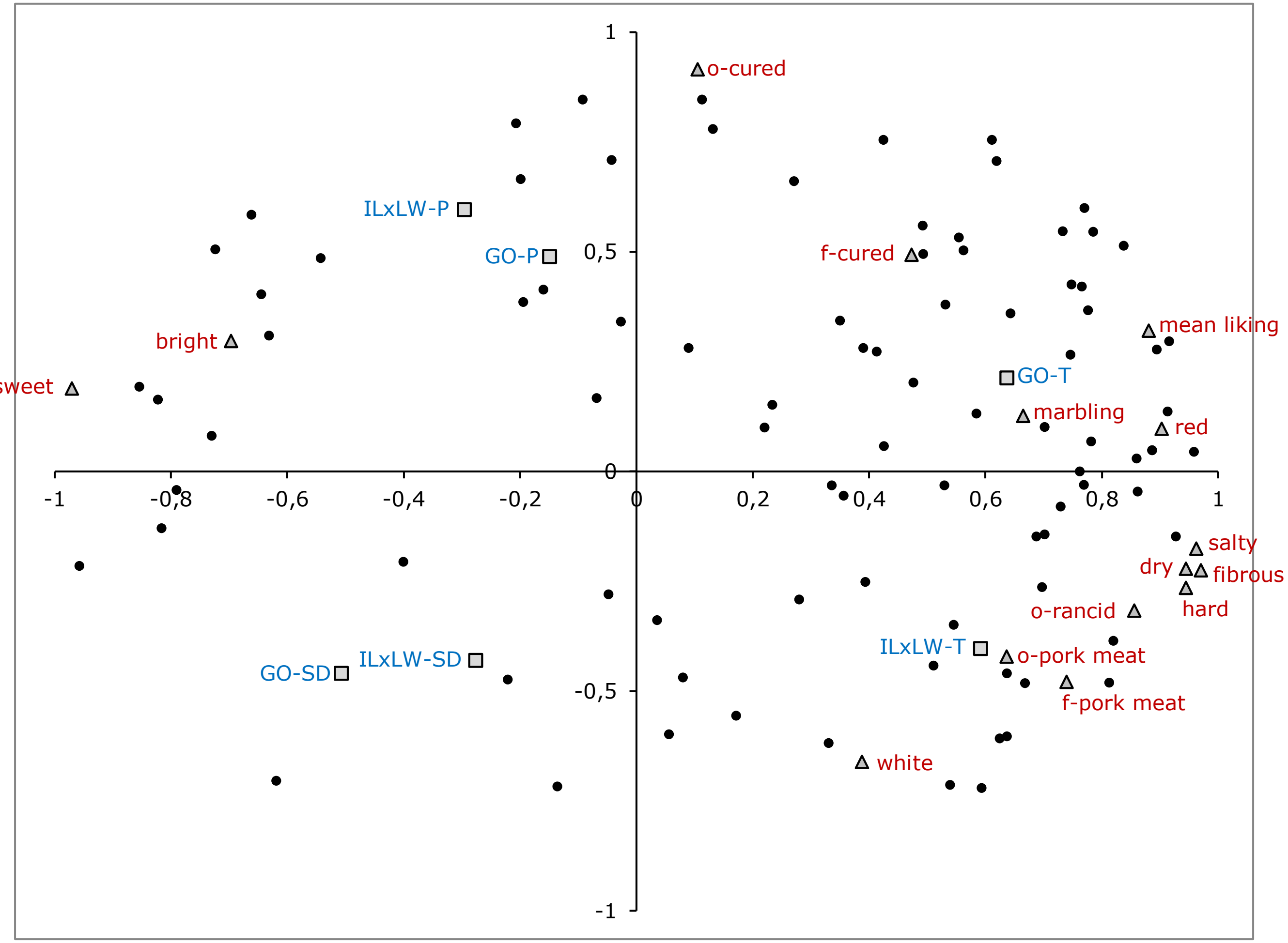


Figure IV. Correlation loading plot from PCR computed on individual liking data for the six hams (x matrix) and mean intensity values of sensory attributes (y matrix) of each product.



Explained variance: PC1 (x=40%, y=60%); PC2 (x=19%, y=17%)