Relationships between tissue composition and sensory qualities of dry cured ham

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SUMMARY

Quality traits of odour, taste, texture and colour of dry-cured ham were investigated in relation to the contents of pigment, collagen, glycogen, lactic acid, as well as to the metabolic type and the size of the myofibres. The study was performed on the *Biceps femoris* of 26 dry-cured hams aged for 9 months. The results showed that some of the studied compositional and histological traits were related to the intensity of odour or taste, as well as to characteristics of texture and colour. The level of pigment was favourably correlated to sensory qualities, whereas glycogen and lactic acid were unfavourably related to these qualities. The level of collagen influenced favourably the flavour intensity but unfavourably the texture. Muscle tissue containing more red fibres would give hams with better sensory qualities.

INTRODUCTION

It is well established that certain compositional and structural characteristics of muscle such as : level of pigment, collagen, glycogen, lactic acid, as well as metabolic type or size of myofibres, can vary largely according to breed or age or rearing conditions. Even slaughter conditions can affect some compositional traits, e.g. glycogen and lactic acid levels. These characteristics are known to be of great importance for both sensory and technological qualities of fresh meat . But very little is known about their influence on sensory qualities of processed meat such as dry-cured ham. This work was performed in order to study the possible relationships between some compositional and structural characteristics and the sensory qualities of dry-cured ham.

MATERIAL and METHODS

Twenty-six hams, dry-salted and seasoned during 9 months following a process commonly used in French plants, were used. A slice was cut perpendicular to the femur axis, in the largest width of hams. Visual colour assessment was performed immediately by one of the authors. Tint, intensity and homogeneity were assessed following a five-point scale (0 very low ; 5 very good). Then the *Biceps femoris* muscle was removed. 300 g samples were put under vacuum in polyethylene bags and kept at -20 °C for sensory analysis. 10 g samples were minced and freeze-dried for determinations of pigment, collagen, glycogen and lactic acid. Pieces of about 1 cm^3 were cut and kept in liquid nitrogen for histochemical analyses. The contents of pigment, collagen, glycogen and lactic acid were determined using respectively the methods of HORNSEY (1956), BERGMAN & LOXLEY (1963), DALRYMPLE & HAMM (1973) and BERGMEYER (1974).

For the histochemical determinations, 10 µm thick serial sections were cut and stained for myofibrillar ATPase (GUTH & SAMAHA, 1969) and succinate dehydrogenase (NACHLAS *& al.*, 1957). To determine the metabolic and contractile types, the classification of ASHMORE & DOERR (1971) was used : αW (fast-twitch glycolytic) fibres, αR (fast-twitch glycolytic oxidative) fibres, βR (slow-twitch oxidative) fibres. The stain of MASSON (GABE, 1968) was used to determine the diameter of the fibres.

Sensory evaluation was performed by a 12-member sensory panel. The panelists evaluated each characteristic by putting a mark on a non-graduate scale, ranging from "less" to "more". Scores were given by measuring the distance between the origin of the scale and the mark. The following traits were evaluated : intensity of odour “of dry ham”, of odour “of raw meat”, of odour “of cured meat”, of odour “of fat” and of “rancid” odour ; intensity of taste “of ham”, of taste“of raw meat”, of taste “of cured meat”, of taste “of fat”, of “rancid” taste, of “salty” taste and of “acid” taste; texture : “firm”, “dry”, “mellow”, “fibrous” .

Statistical analysis was made using SPEARMAN correlations.

RESULTS

Odour and taste : the intensity of odour "of dry ham" was positively correlated ($P < 0,05$) with collagen and pigment contents and percentage of αR fibres, and negatively with percentage of αW fibres (table 1). Odour "of fat" was negatively correlated ($P < 0,01$) with fibre diameter. Odour "of meat", odour "of cured meat" and "rancid" odour were independent of the compositional traits.

Table 1 : Correlations between compositional and histochemical traits and odour characteristics of dry ham.

Odour	Pigment	Collagen	Glycogen	Lactic acid	Fibre diam.	% βR	% αR	% αW
Ham	**0,45***	**0,46***	-0,07	-0,39	-0,19	0,07	**0,42***	**-0,49***
Raw meat	-0,06	-0,21	-0,30	-0,37	-0,13	0,21	0,25	-0,32
Fat	-0,05	**-0,44***	-0,37	-0,24	**-0,50****	0,25	0,13	-0,35
Cured meat	0,13	0,16	0,00	-0,13	-0,12	-0,36	0,25	-0,05
Rancid	-0,29	-0,34	-0,28	-0,09	0,09	0,18	-0,14	0,13

* : $P < 0,05$ ** : $P < 0,01$

The intensity of taste "of dry ham" was positively correlated ($P < 0,05$) with collagen and glycogen contents (table 2). Taste "of cured meat" was negatively correlated ($P < 0,05$) with percentage of βR fibres and positively with percentage of αR ones. Taste "of raw meat", taste "of fat" and "rancid" taste were independent of the ham compositional traits. "Salty" taste was positively correlated ($P < 0,05$) with glycogen and lactic acid contents. "Acid" taste was positively correlated ($P < 0,01$) with glycogen and lactic acid contents, and negatively ($P < 0,05$) with pigment content and percentage of βR fibres.

Table 2 : Correlations between compositional and histochemical traits and taste characteristics of dry ham.

Taste	Pigment	Collagen	Glycogen	Lactic acid	Fibre diam.	% βR	% αR	% αW
Ham	0,16	**0,41***	**0,48***	0,22	-0,04	-0,27	0,21	-0,05
Raw meat	-0,07	0,06	0,03	-0,10	-0,02	0,25	0,11	-0,22
Fat	-0,24	-0,29	-0,33	-0,32	-0,30	0,36	0,02	-0,26
Cured meat	0,08	0,34	0,35	0,15	0,05	**-0,39***	**0,04***	-0,10
Rancid	0,00	0,02	-0,13	-0,13	0,16	-0,08	-0,04	0,18
Salt	-0,17	0,033	**0,49***	**0,43***	0,04	-0,23	-0,08	0,16
Acid	**-0,39***	0,088	**0,54****	**0,52****	0,24	**-0,43***	-0,04	0,33

* : $P < 0,05$ ** : $P < 0,01$

Texture : firmness was positively correlated ($P < 0,05$) with collagen content, and dryness with lactic acid content (table 3). Mellow and fibrous textures showed no relationship with any compositional trait.

Colour : colour homogeneity was negatively correlated ($P < 0,05$) with lactic acid content and percentage of αW fibres (table 4).

Table 3 : Correlations between compositional and histochemical traits and texture characteristics of dry ham.

Texture	Pigment	Collagen	Glycogen	Lactic acid	Fibre diam.	% βR	% αR	% αW
Firm	0,13	**0,46***	0,15	0,18	0,12	-0,10	-0,19	0,32
Dry	0,07	0,302	0,38	**0,41***	0,31	-0,35	0,03	-0,34
Mellow	-0.07	-0.34	-0.06	-0.13	-0.11	0.07	0.27	-0.34
Fibrous	0,06	0,277	-0,09	-0,04	-0,13	-0,06	-0,28	0,28

* : P < 0,05 ** : P < 0,01

Table 4 : Correlations between compositional and histochemical traits and colour characteristics of dry ham.

Colour	Pigment	Collagen	Glycogen	Lactic acid	Fibre diam.	% βR	% αR	% αW
Tint	-0,08	0,01	-0,07	0,11	-0,17	0,18	-0,17	0,03
Intensity	-0,06	0,07	0,03	0,04	0,07	0,14	0,01	-0,13
Homogeneity	0,18	-0,03	-0,37	**-0,43****	-0,26	0,25	0,25	**-0,46****

* : P < 0,05 ** : P < 0,01

DISCUSSION

The relation between intensity of odour "of dry ham" and pigment content could result from two different mechanisms. On the one hand, pigment content increases with age of pigs. Enhanced flavour was reported in dry-cured hams from older animals (JACQUET, 1982 ; POMA, 1980). On the other hand, pigment level is positively related to content of red (αR and βR) fibres in the muscle, since these fibres contain more myoglobin than the white ones. This is in agreement with the negative relation found here between the percentage of αW fibres and the intensity of odour "of dry ham". As pointed out by ASHMORE (1974) and VALIN *& al.* (1982), metabolic type seems to be a very significant variation factor of flavour in fresh meat. It seems that muscles with higher content of βR fibres have more flavour, due to the high phospholipids level of these fibres. The negative correlation between "acid" taste and content of pigment and percentage of βR fibres could be due to the higher pH of red fibres (BEECHER *& al.*, 1965 ; LABORDE *& al.*, 1985).

To our knowledge, the few works performed on fresh pork did not show any relation between meat flavour and collagen amount (DE VOL *& al.*, 1988 ; GANDEMER *& al.*, 1990). It can be hypothetized that collagen improves the perception of flavour by increasing the firmness of ham and by the way the time of chewing. The relationship between glycogen and intensity of taste "of dry ham" is difficult to explain. The apparent relationship between glycogen and "acid" taste is probably of an indirect nature, and due to the fact that high amounts of residual glycogen are associated with high levels of lactic acid and low pH in meat. Similarly "salty" taste is positively associated with glycogen and lactic acid contents, since low pH favours salt penetration in meat (KEMP *& al.*, 1968 ; POMA, 1980 ; JACQUET, 1982).

Apart from the relation between fibre size or collagen content and odour "of fat", it is noticeable that the studied compositional criteria influence only the intensity of flavour "of dry ham" and the fundamental tastes, such as "salty" or "acid" tastes. They affect neither the flavours "of raw meat","of cured meat", "of fat" nor the "rancid" flavour in this study. Several works performed on lipolysis and proteolysis occuring during ham ageing showed indeed that the precursors of volatiles compounds involved in dry ham flavour are lipids and proteins (LILLARD & AYRES, 1969 ; MC CAIN *& al.*, 1968 ; FLORES *& al.*, 1985 ; GIOLITTI *& al.*, 1971 ; MAGGI *& al.*, 1973 ; NESTOROV *& al.*, 1981).

The total collagen content affects the texture of ham by increasing firmness. That differs from what is observed in pork, where it seems that only the solubility of collagen influences the texture of fresh meat (DE VOL *& al.*, 1988 ; GANDEMER *& al.*, 1990). It can be hypothetized that the relation between texture and collagen observed in ham is due to the proteolysis occuring during ripening : myofibrillar and sarcoplasmic proteins being largely hydrolyzed, the toughness caused by connective tissue would become relatively more perceptible.

It is noticeable that there is no relationship between the colour pattern and the pigment content. According to CANTONI *& al.* (1971), the influence of other factors is more decisive than that of pigment content on dry-cured ham colour. The intensity and the tint depend mostly on the degree of pigment denaturation and oxidation. Homogeneity depends on pigment oxidation too, which is related with pH. That explains why colour homogeneity is negatively related with lactic acid. This result agrees with those of SELLIER *& al.* (1975).

CONCLUSION

A high proportion of red fibres has some favourable effects on odour, taste and colour of dry ham. Moreover, some traits known to be associated to the red metabolic type in pig muscle, such as a high level of pigment and low levels of glycogen and lactic acid, are associated with an increase in flavour "of dry ham" and a diminution in "salty" and "acid" tastes. The collagen content has contradictory effects on sensory qualities of dry ham, since it affects favourably the flavour but unfavourably the texture.

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