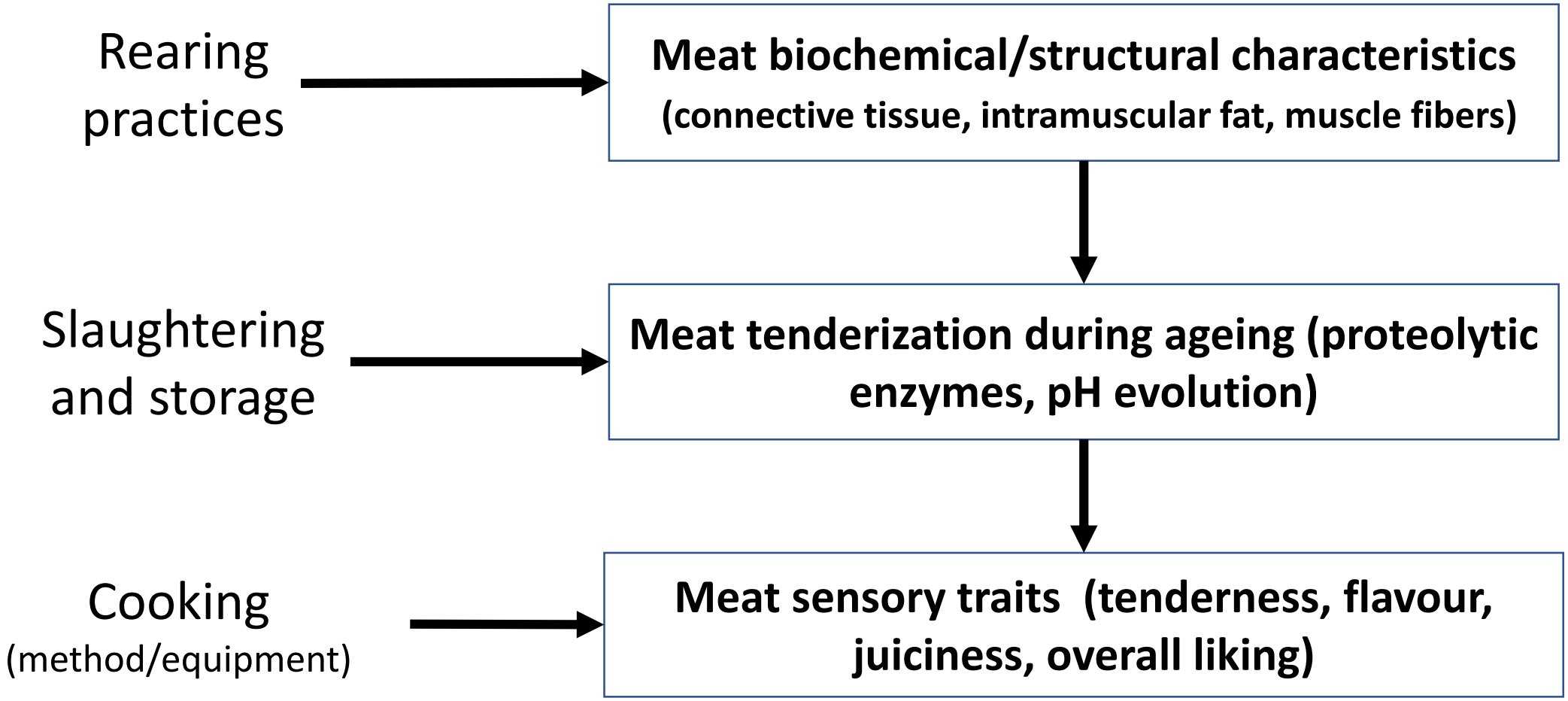
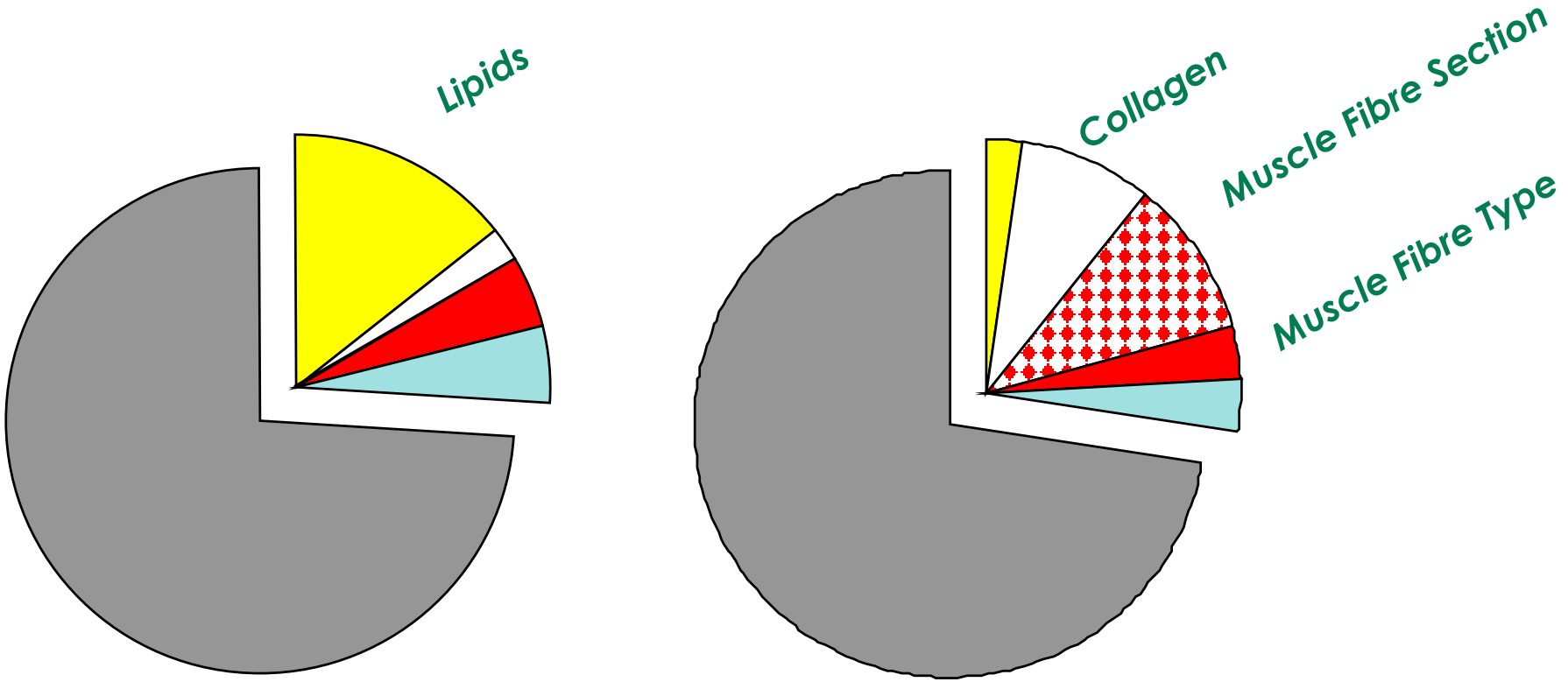
Meat tenderness and its evolution during cooking

J.-F. HOCQUETTE and A. KONDJOYAN

Main factors affecting meat sensory traits for consumers.

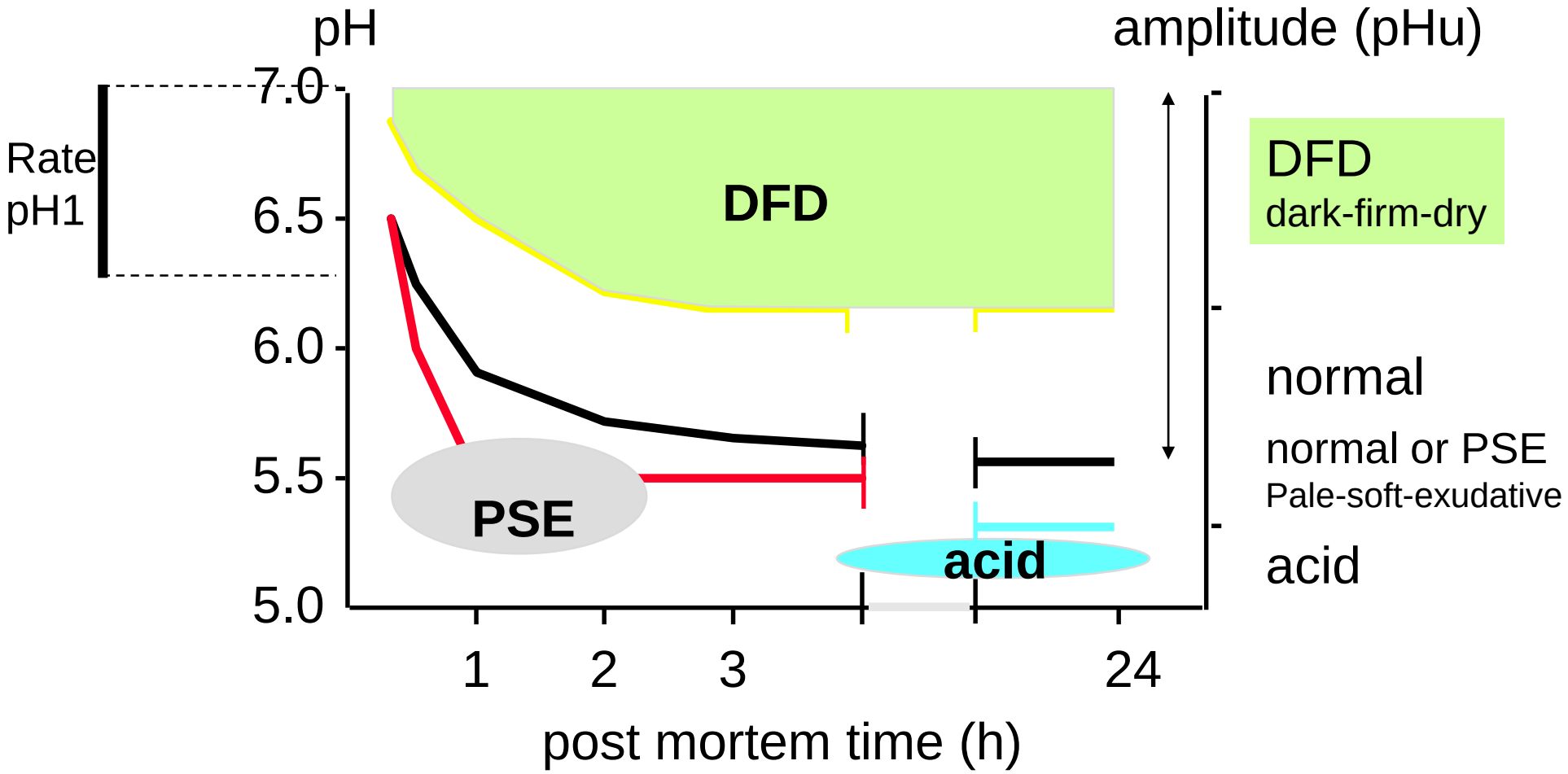


Relationships between Meat Quality attributes and Muscle Characteristics



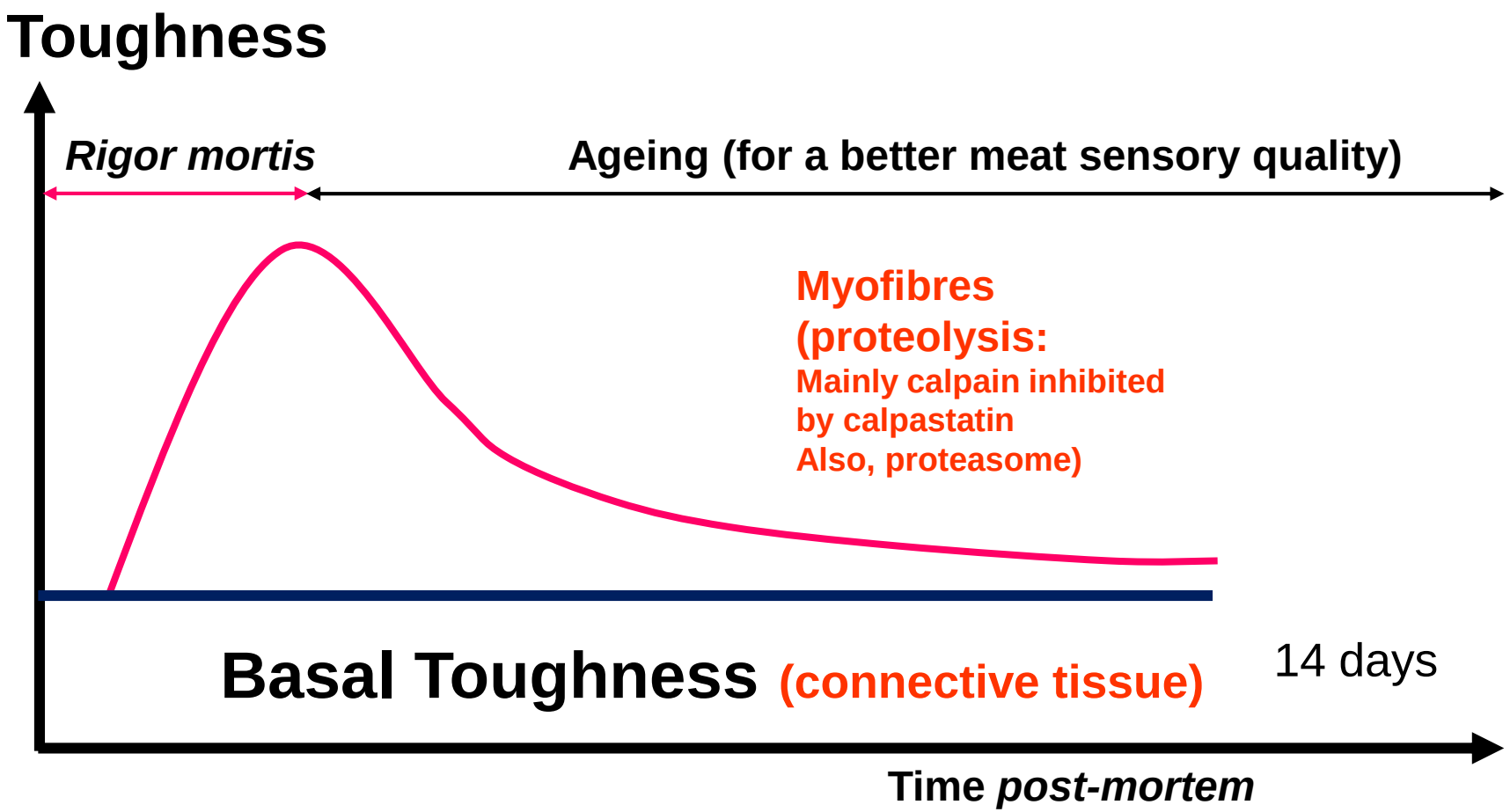
** Cooking temperature = 55 °C*

Evolution of *post-mortem* pH

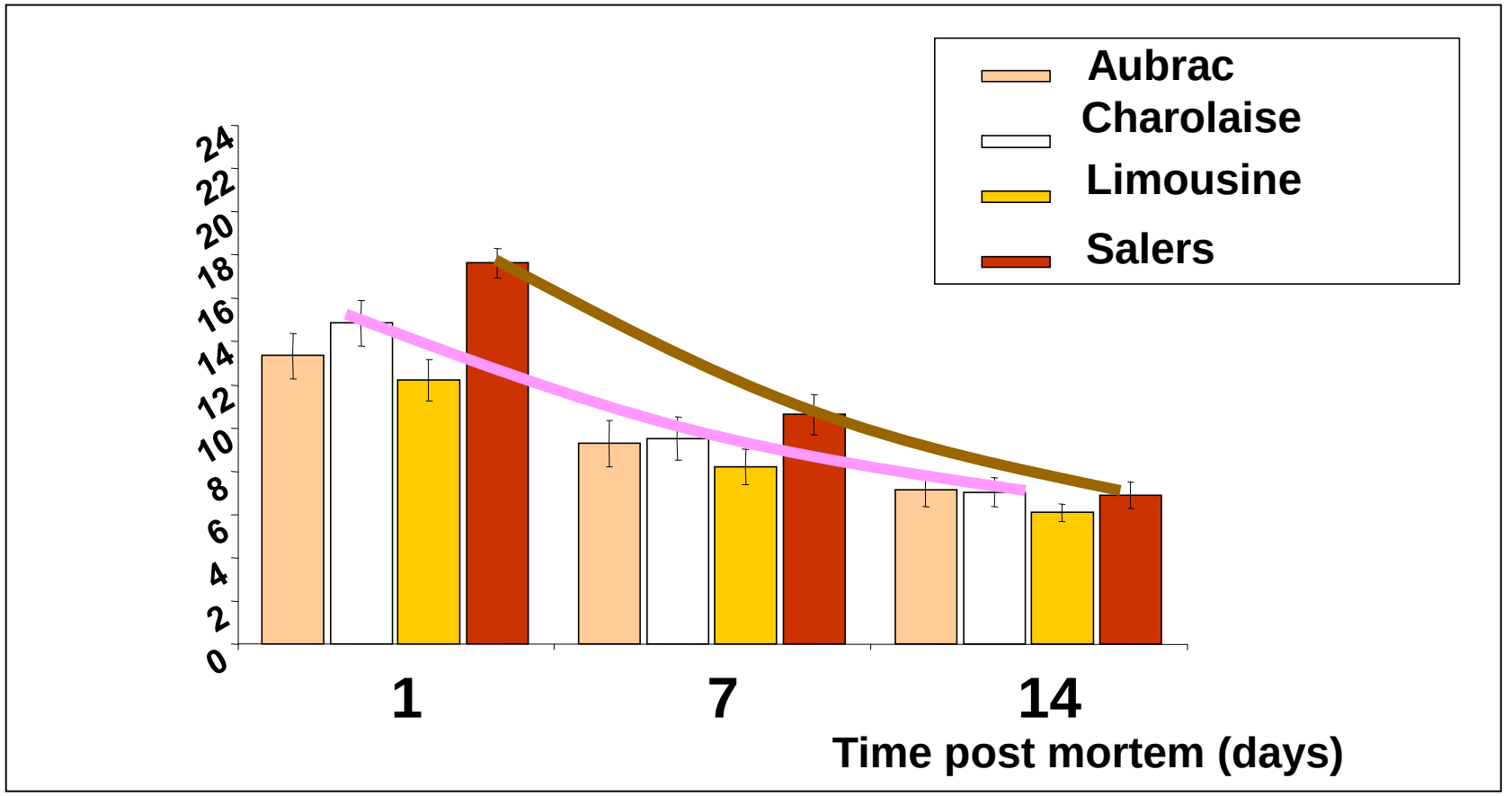


Reviewed by Hocquette et al., 1996. Viandes Prod. Carnés, 17, 217-230.

Beef ageing is a major factor determining beef tenderness



Beef ageing differ between breeds



Compression value of raw beef differs between breeds at day1 but not at day14.

This indicates different ageing rates.

Picard *et al.*, 2002

Variety of domestic and cattering heat sources

Static Oven or Fan Assisted Oven, Steam Injection

« Microwaves»

Le fourneau Cluny de **Lacanche**
le matériel professionnel
destiné au particlier

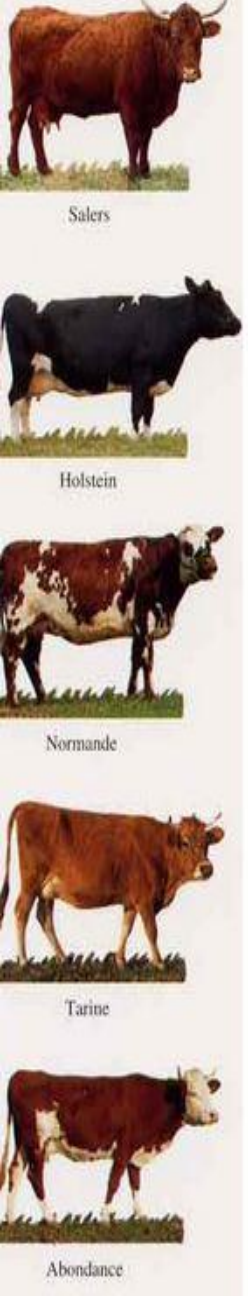
French Restaurant « the piano »

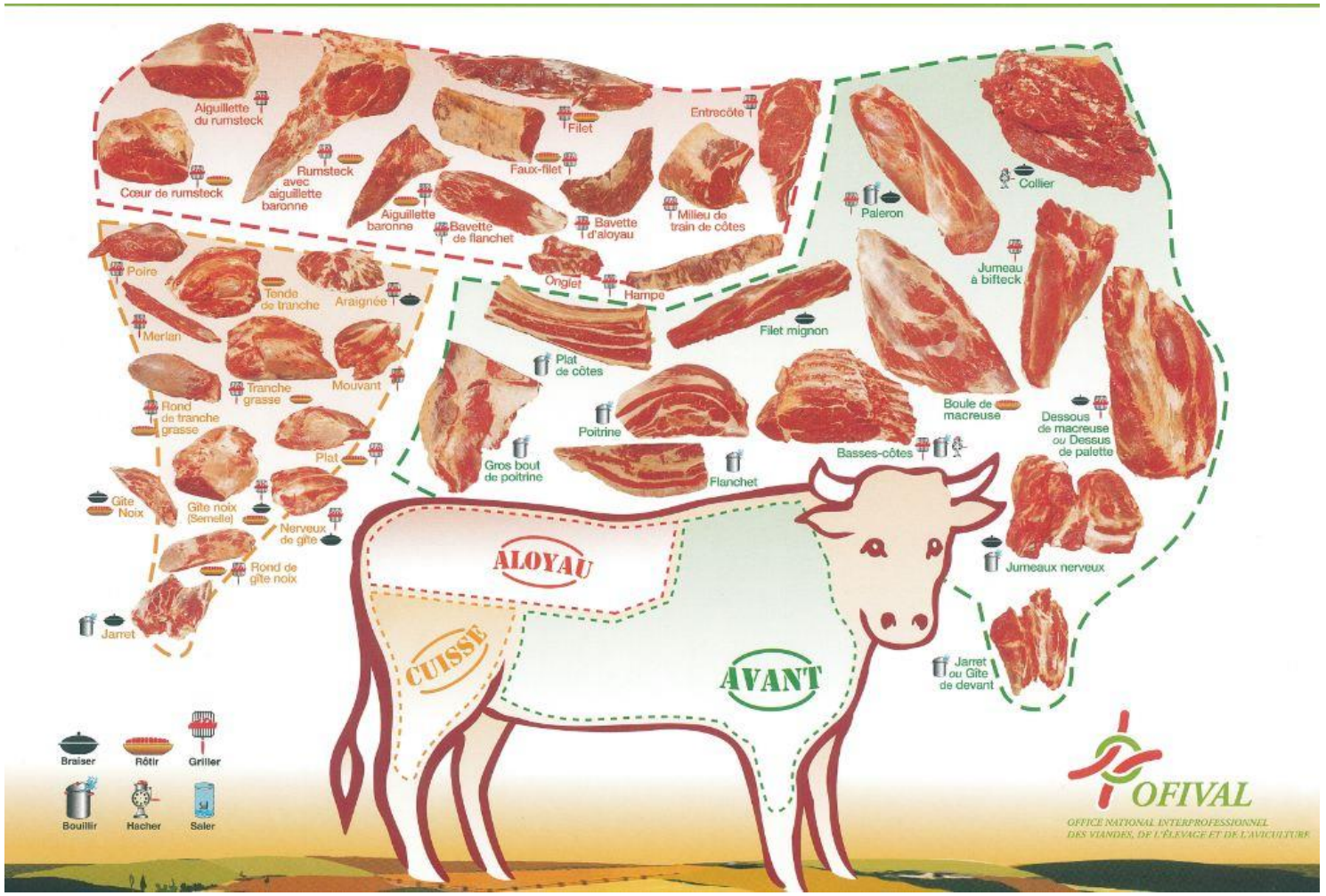
« Electrical Grills or Charcoal Grills »

« Pans»

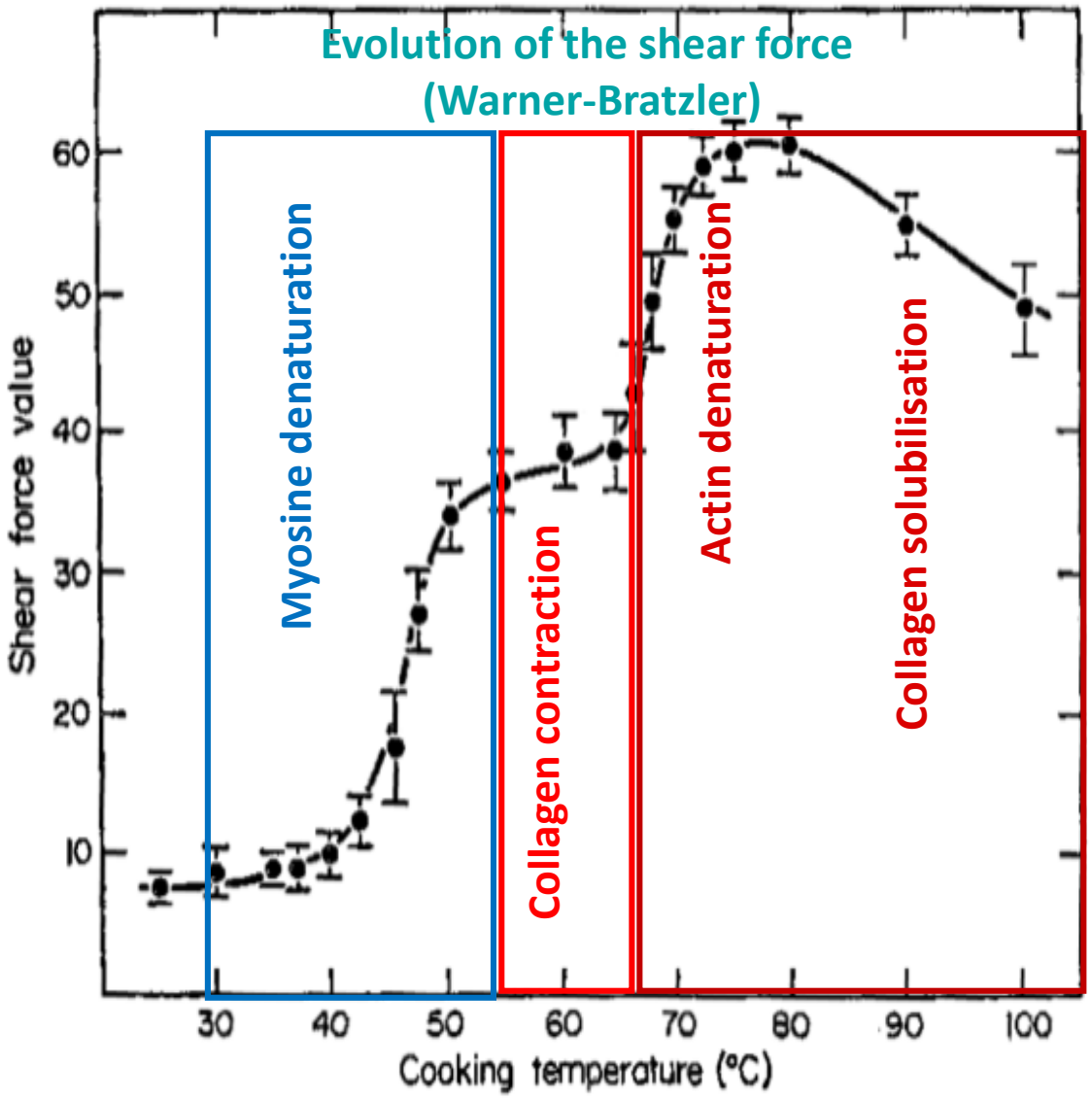
Restaurant "Controlled Oven "

Diversity of Animal Breed, Muscles and Recipes





Heating and denaturation-contraction of meat proteins



Lepetit, Grajales & Favier, Meat Science, 59, 239-250 (2000)

Davey & Gilbert, J. Sci Fd Agr. 1974

Meat-Proteins contraction and juice expelling when cooking of red meats

Journal of Agricultural and Food Chemistry ARTICLE

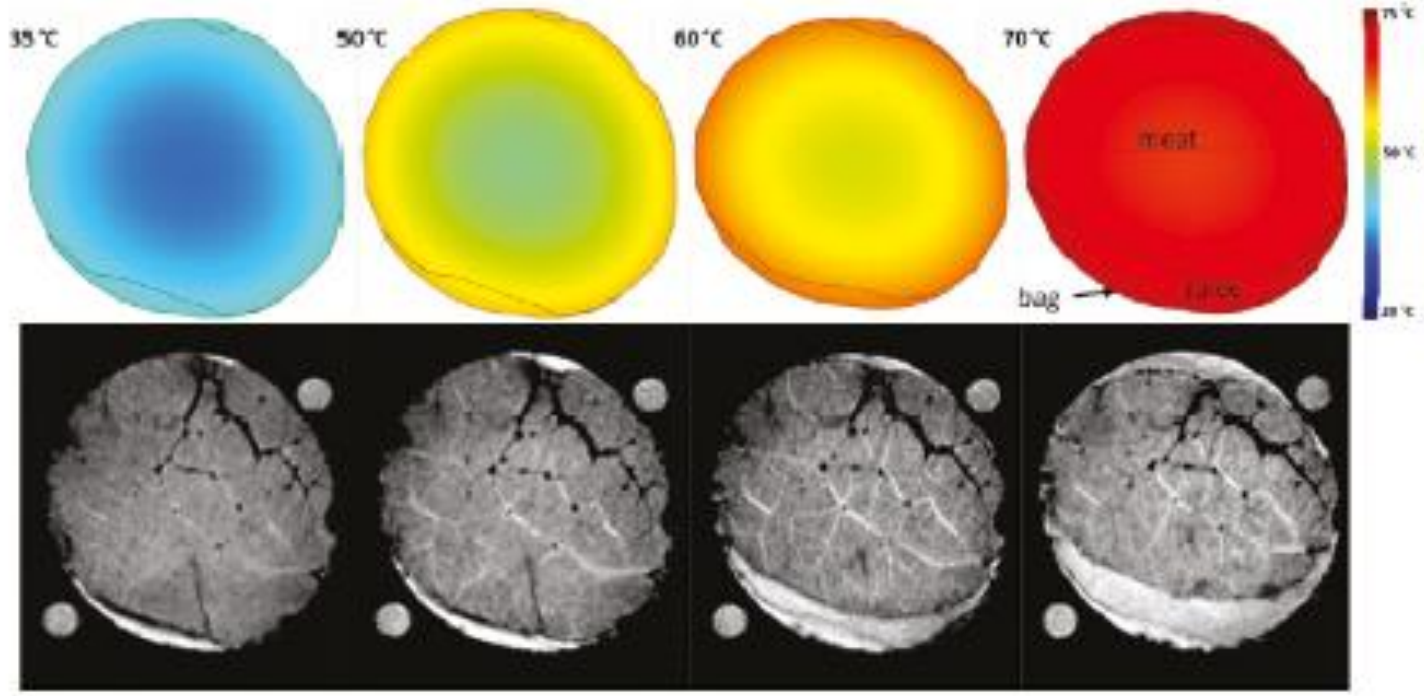


Figure 6. Temperatures mapped from our simulation, in the central section of the sample, for 4 average temperatures (35, 50, 60 and 70 °C) and the corresponding NMR images. Transfer coefficients are here considered as the same in meat and juice.

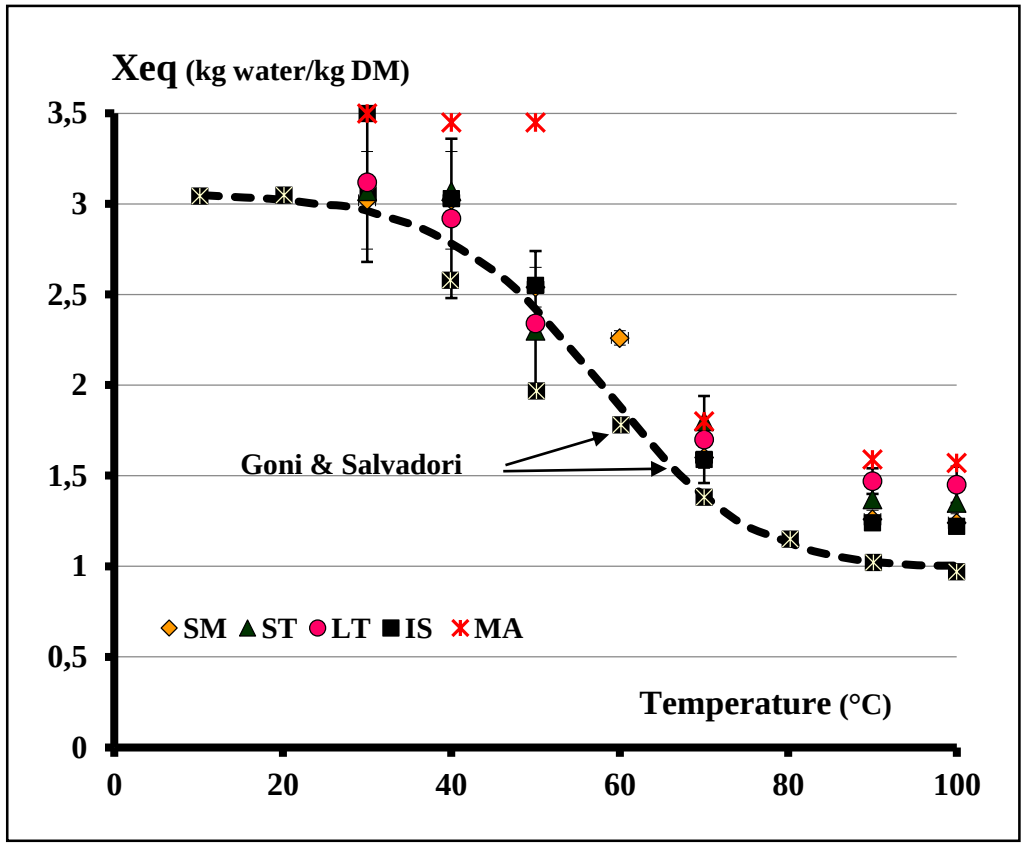
Bouhrara et al. J. Agr. Food Chem., 59, 1229-1235 (2011)

Bouhrara et al. J. Agr. Food Chem., 60, 4678-4687 (2012)

Tenderness *vs* Juiciness - Variation of the Water content in Red Meats during heating

Whatever the muscle an equilibrium water content is reached that depends on the temperature, but not on the sample size

Equilibrium Water content – f(temperature)

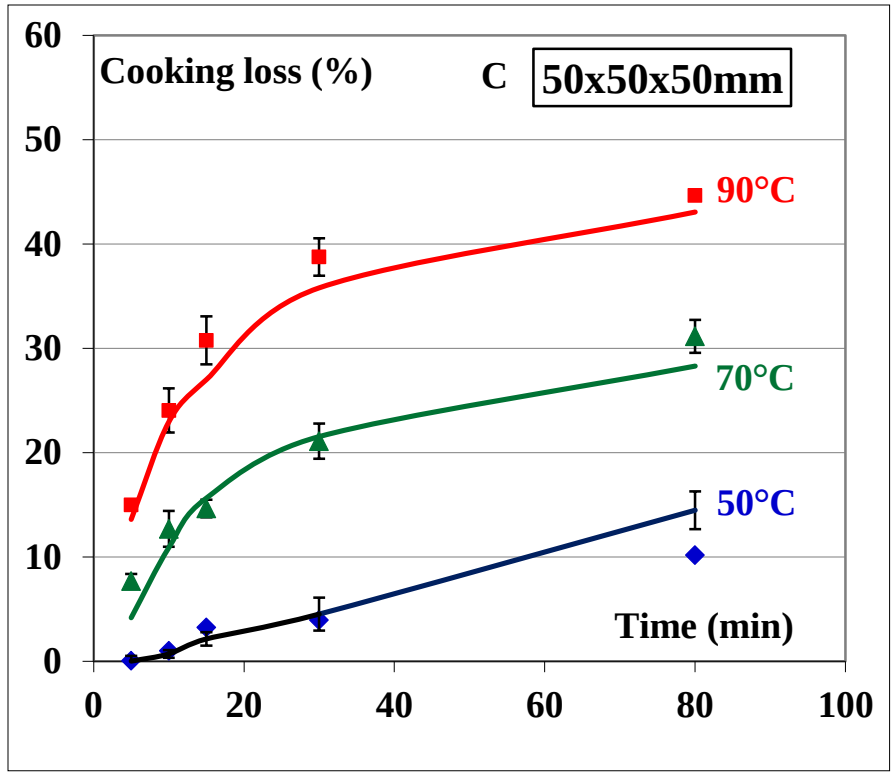


OILLIC et al. Meat Science, 88(3), 338-346 (2011)

BOMBRUN et al. Meat Science, 99, 113–122 (2015)

Modelling cooking losses or effect of cooking on proteins digestibility

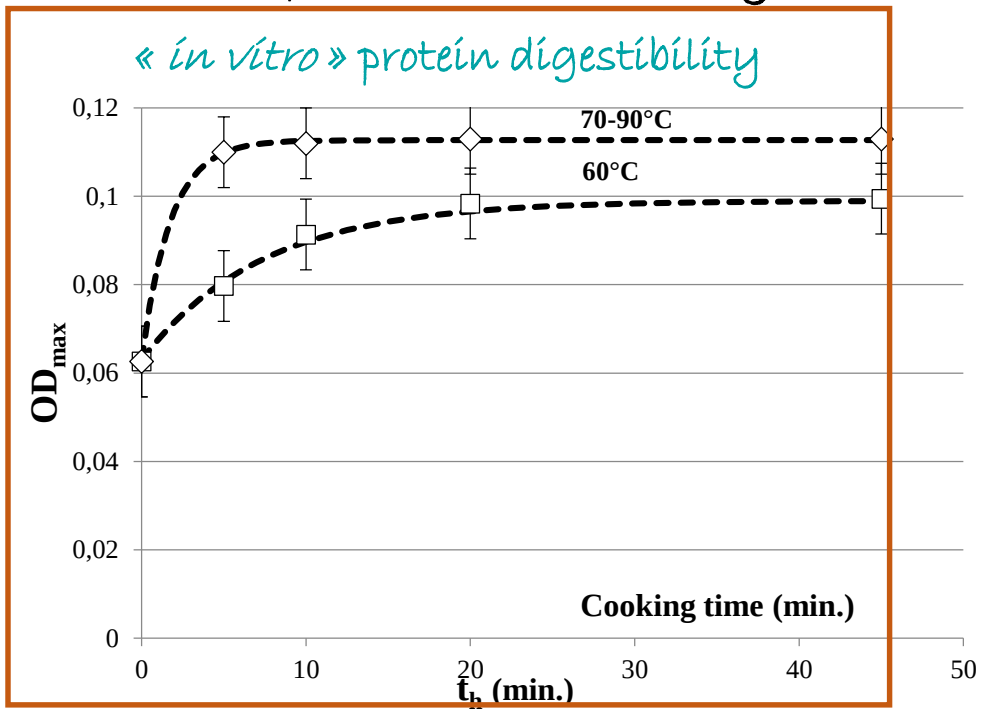
Modelling of the cooking losses



KONDJOYAN et al. Meat Science, 95(2), 336–344. (2013)
KONDJOYAN, A. et al. Meat Science, 97(3), 323–331 (2014)

BOMBRUN et al. Meat Science, 99, 113–122 (2015)

Modelling protein digestibility



KONDJOYAN et al. Food Chemistry, 172, 265–271. (2015)

Need of a quality guarantee system

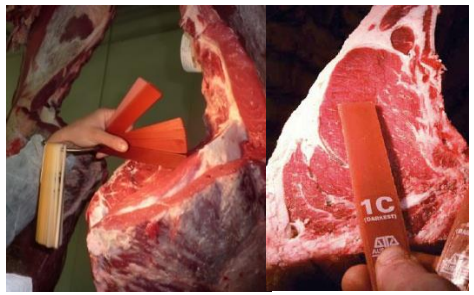
- Beef is not always meeting consumers' expectations
- No strong relationship is observed between eating quality of beef and its price as shown in France (Normand *et al.*, 2014).
- A consumer-driven prediction model of beef eating quality has been developed in Australia

Prediction using the Meat Standards Australia System

MSA2000model®

Hang (AT/TC/TS/TX)	AT
Sex (M, F)	m
Est.% Bos Indicus	0
Hump Height cms	0
Hot Std Carc Weight	200
USDA Ossification	100
Milk Fed Vealer Y/N	N
USDA Marbling	130
Days Aged (min 5)	5
Quarter Point Ribfat	5
Ultimate pH	5.40
AUSMEAT Meat Col.	2
Saleyard? (Y, N)	n
Wght/App.Maturity	1.32

Meat Colour



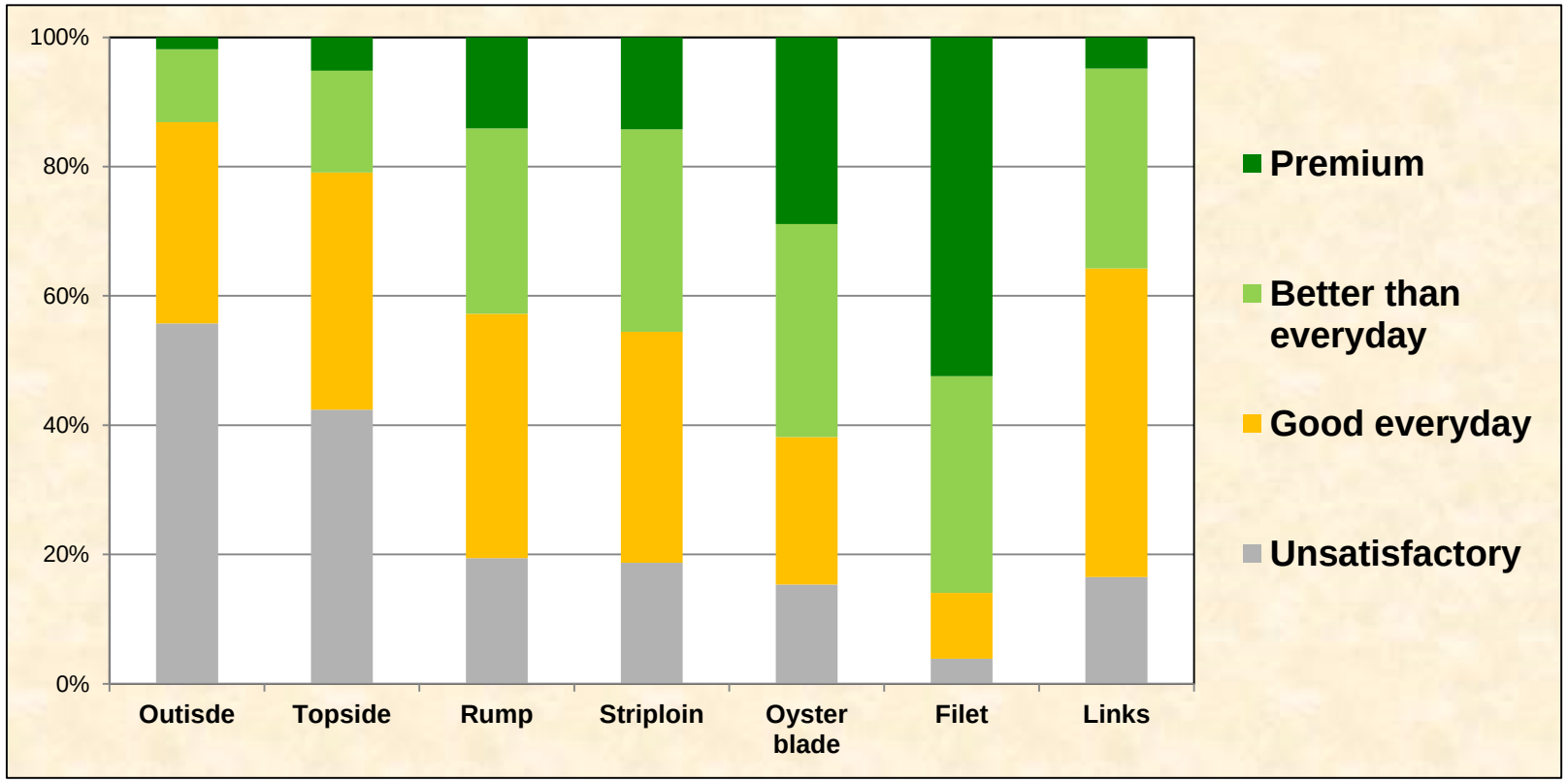
Marbling

Ossification

Cut Description	Muscle Reference	Days Aged	Grilled Steak	Roast Beef	Stir Fry	Thin Slice	Cass-erole	Corned Beef
Tenderloin	TDR062		5	4	5			
Cube Roll	CUB045		3	3	3	4		
Striploin	STR045		3	3	3	3		
Oyster Blade	OYS036		4	3	4	4		
Bolar Blade	BLD096		3	3	3	3	3	
Chuck Tender	CTR085			3	3	3	3	
Rump	RMP131		3	3	3	3		
Point End Rump	RMP231		3	3	3	4		
Knuckle	KNU099		x	3	3	3	3	
Outside Flat	OUT005			x	x	3	3	3
Eye Round	EYE075		x	3	3	3	3	x
Topside	TOP073		x	3	x	3	3	
Chuck	CHK078			3	3	3	3	
Thin Flank	TFL051				3		3	
Rib Blade	RIB041				3			
Brisket	BRI056				x	3	3	x
Shin	FQshin						3	

Prediction of sensory quality in France using the MSA system

- Considerable variability for each muscle
- But agrees visible muscle hierarchy



(data obtained with 6 muscles from 18 Australian and 18 French cattle tested by 540 French consumers)

Legrand et al., (2013). 7:3, pp 524–529

p. 15

Conclusions

- Meat tenderness, as it is perceived by consumers, results from a combination of complex mechanisms associated with animal species, muscle structure, slaughtering procedures, chilling, meat ageing, and cooking processes.
- How to control all the parameters through these steps remains a challenge. This often results in consumer dissatisfaction.
- Grading schemes like that of Meat Standards Australia are aimed at integrating all factors, from animal production to cooking methods, to predict the eating quality of beef for each combination of cut and cooking method.
- A complementary strategy is to improve the design of the equipment and methods used to cook these different combinations.