Influence of age, strain and breeding method on the eating quality of broiler chickens

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SUMMARY

ROSS and COU NU d'Aquitaine broiler chickens grown on pasture and in confinement. The feeding was the same for both groups.

The chickens were commercially killed at three ages : 6 weeks, 9 weeks and 12 weeks.

They were frozen for at least 2 weeks at - 20°C. The breast meat and leg meat was analysed for the chemical composition, the juice losses, the color and the tenderness assessed by the shear forces and by a taste panel.

Results obtained indicate that :

1. The age has a great influence on the juice losses and the tenderness.
2. The strain has a great influence on the growing rate and on the yield of meat.

After 9 weeks the growing of the ROSS strain isn't, economically, interesting anymore.

3. The growing on pasture doesn't improve the eating quality of broiler chickens.

INTRODUCTION

In West Europe, most of the people are convinced that a chicken growing on pasture gives a better meat. On the other hand, the breeder looks for the best yield, with high growing rates and low consumption index. The purpose of our study was to compare the eating quality of chickens growing in freedom and in "cloistering", all the other criteria being identical.

Those comparisons were carried out with two strains (ROSS and COU NU d'Aquitaine) and for three slaughtering ages (6-9 and 12 weeks of age).

MATERIALS and METHODS

We have used a strain with rapid growth (ROSS) and a strain with slow growth (COU NU d'Aquitaine). The chickens of each strain were divided in two groups. Both group of 50 chickens disposed of an indoor space of 6.50 m^2 (7.7 chickens/m^2) but only one of them had an access to an outdoor run of 100 m^2 (2 m^2/chicken).

The feeding had the following characteristics.

age	0-5 weeks	5-10 weeks	10-12 weeks
Crude protein (%)	20.70	18.40	16.30
Metab energy (Kcal/Kg)	2920	2920	3000

The chickens were commercially killed, eviscerated and frozen at - 20°C for two weeks at least 12 chickens of each group were kept for the laboratory analyses.

Sample preparation

After thawing at 4°C for 24 H, the chickens were dissected in order to estimate the yield of meat, skin, bone and abdominal fat (ARNAUD et al, 1975).

Eight chickens were used for the laboratory determinations. The physico-chemical determinations were carried out on the rightside and the shear forces measurements, on the left side. Four chickens of each group, aged of 12 weeks, were selected for the taste panel.

Physi-cochemical determinations

The breast meat and leg meat were first ground with a house grinder during 20 seconds. The following determinations were made on this ground meat :

- the dry matter, obtained by weighting of 5 g of meat before and after drying at 105°C during 96 H.
- the metmyoglobine content determined with the method of HARRISON (1980)
- the total protein content (total nitrogen content x 6.25)
- the total collagen content (total hydroxyprolin content x 8)
- the total lipids
- the juice losses determined by weighting before and after centrifugation at 35.000 g during 30 minutes.

Shear forces evaluation

The breast meat and leg meat were vacuum packed and cooked at 75°C during 60 min. After chilling at room temperature, 1 cm cores were cutted parallel with the fibers. Each sample was sheared across the fibers using the Warner-Bratzler Meat Shear on the Universal Testing Machine, model 1140 (Instron Ltd).

Crosshead speed and chart speed were 50 mm/min and 100 mm/min respectively.

Sensory evaluation

A trained panel of 8 members of the Departement of Food Technology evaluated the tenderness of breast meat and leg meat (0 = very tender, 10 = very tough).

The samples were cooked and cutted as for the shear forces evaluation.

Statistical analysis

Data were analysed statistically by a three-way analysis of variance to determine the significance of difference among age, strain and breeding method.

RESULTS and DISCUSSION

Carcass characteristics

The tables 1 et 2 show that the breeding method has no influence on the carcass weight and on the yields.

Table 1 : Carcass characteristics : results

		COU NU		ROSS	
		Pasture	Cloistering	Pasture	Cloistering
Carcass Weight (g)	6w	492,25	456,38	722,00	566,75
	9 w	1034,25	879,25	1505,00	1461,50
	12 w	1235,62	1320,38	1686,50	1926,62
Meat (%)	6 w	57,95	56,33	56,62	56,16
	9 w	61,12	59,60	62,62	63,68
	12 w	63,16	63,63	62,40	64,62
Abdominal Fat (%)	6 w	0,95	0,94	1,58	1,45
	9 w	1,46	1,26	2,18	2,05
	12 w	1,23	1,23	2,91	3,00

The weight of the COU NU strain regulary increases since 6 weeks for 12 weeks. Between 6 and 9 weeks, the ROSS strain has a faster growth whereas the growing rate slows down after 9 weeks.

The yield of meat offers the same evolution. These results display that the growing of the ROSS strain isn't interesting anymore after 9 weeks.

The percentage of fat doesn't change a lot for the COU NU strain, whereas it rapidly increases after 9 weeks by the ROSS strain.

Table 2 : Carcass characteristics (Degree of Freedom : D.F.; No Significant : N.S.) : statistical analysis

Variation factors	D.F.	Carcass weight	% Meat	% Fat
Strain (S)	1	***	N.S.	***
Breeding (B)	1	N.S.	N.S.	N.S.
Age (A)	2	***	***	***
S X B	1	N.S.	N.S.	N.S.
S X A	2	***	*	**
B X A	2	*	N.S.	N.S.
S X B X A	2	***	N.S.	N.S.

Physico-chemical analysis

The table 4 shows that the breeding method doesn't affect the chemical parameters.

We can note for the 2 groups that the leg meat is fatter and contain less protein than the breast meat (Table 3).

The dry matter is similar but the collagen content is less important for the breast meat.

The ROSS strain has a stable dry matter with the slaughtering age, but it increase between 6 and 9 weeks for the COU NU strain.

The fat content of the leg meat decrease with the slaughtering age, this diminution isn't so important for the breast meat. The ROSS strain has a fatter meat than the COU NU strain.

The protein content increase more rapidly between 6 and 9 weeks for the ROSS strain.

Table 3 : Physico-chemical characteristics : results

		COU NU				ROSS			
		Pasture		Cloistering		Pasture		Cloistering	
		breast	leg	breast	leg	breast	leg	breast	leg
Dry matter (%)	6w	24,28	23,31	24,69	23,66	25,62	24,55	25,72	25,26
	9 w	26,04	23,82	25,25	23,62	25,74	24,51	25,63	24,35
	12w	25,68	23,74	25,60	23,46	26,02	24,62	25,68	24,58
Lipids (% D.M.)	6 w	4,74	11,77	4,85	12,24	4,79	15,45	4,31	17,42
	9 w	4,05	10,43	4,07	11,16	4,46	13,30	4,32	13,35
	12w	3,47	8,93	3,36	9,40	4,52	13,86	4,16	12,60
Protein (% D.M.)	6 w	96,00	87,91	95,23	86,03	94,28	83,46	95,37	81,50
	9 w	95,24	88,50	95,92	88,71	95,80	86,52	95,22	85,05
	12w	96,37	90,69	96,98	89,94	96,11	85,96	96,34	87,72
Collagen (% D.M.)	6 w	1,99	6.22	2,05	5,92	1,86	6,71	1,40	5,44
	9 w	1,80	6,45	1,94	6,84	1,65	5,57	1,65	5,20
	12w	1,94	7,01	2,06	6,25	1,72	5,60	1,70	5,98

Table 4 : Physico-chemical characteristics : statistical analysis

Variation factors	D.F.	D.M. %	Lipids/ D.M. %	Proteins/ D.M. %	Coll./ D.M.%	Metmyogl. %	Juice %
Strain (S)	1	***	***	***	**	***	N.S.
Breeding (B)	1	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Age (A)	2	**	***	***	N.S.	***	***
Part (P)	1	***	***	***	***	***	***
S X B	1	N.S.	N.S	N.S.	N.S.	N.S	N.S.
S X A	2	***	N.S.	*	N.S.	*	N.S.
B X A	2	***	N.S.	**	N.S.	N.S.	*
S X P	1	***	***	***	N.S.	N.S.	*
B X P	1	N.S.	N.S.	**	N.S.	N.S.	N.S.
A X P	2	***	***	***	N.S.	***	**

For the chickens growing in cloistering, the increase of the protein content is rapider. The protein content varies a little in breast meat, whereas it progressively increases in the leg meat with the slaughtering age.

It's interesting to note that the protein content and the fat content evolue to opposite sides.

The collagen content is higher for the COU NU chickens.

The metmyoglobine content (table5) of the bread meat doesn't vary a lot whereas it progressively increases with the slaughtering age for the leg meat.

The metmyoglobine content is higher for the ROSS strain, in fact they have a pinker meat.

The breast meat losses more juice than the leg meat, but the juice losses decrease with the slaughtering age.

Table 5 : Physico-chemical analysis : results

		COU NU				ROSS			
		Pasture		Cloistering		Pasture		Cloistering	
		breast	leg	breast	leg	breast	leg	breast	leg
Color	6w	8,15	19,25	9,21	20,34	9,50	18,98	8,88	20,35
	9w	6,49	20,62	7,02	11,83	7,86	22,19	8,29	20,24
	12w	7,44	21,28	7,52	22,02	8,33	23,42	11,14	23,78
Juice (%)	6w	18,05	11,64	15,16	10,44	19,37	9,72	15,20	6,06
	9w	14,47	8,96	11,83	5,74	14,01	5,61	15,85	10,28
	12w	11,29	6,83	8,81	9,87	9,61	4,76	10,56	6,04
Tend. (N) Shear Test	6w	15,17	12,68	15,82	14,35	15,24	13,08	15,12	12,50
	9w	16,20	13,62	12,52	11,12	14,91	12,41	14,49	14,51
	12w	17,48	16,02	15,63	17,97	16,86	11,97	16,62	13,77
Tend. Sens. anal.	12w	3,18	5,81	5,17	7,10	4,86	4,36	3,17	4,08

Betweeen 6 and 9 weeks, the reduction of juice losses is more important for the chickens growing on pasture.

Tenderness

a) Shear forces evaluation

It's delicate to explain this results (table 6) because there's many triple interactions. So, we must carefuly interpret.

For the breast meat, there are no difference between the two strains, but the legs of the ROSS chickens are lightly tougher.

It's suprising to note that there's no tenderness difference between the leg meat of chickens growing on pasture and in confinement. But the breasts of chickens growing on pasture is more tough.

Table 6 : Tenderness : shear force evaluation

Variation factors	D.F.	Tenderness	Variation	D.F.	Tenderness
Strain (S)	1	N.S.	BXP	1	*
Breeding (B)	1	**	AXP	2	**
Age (A)	2	***	SXBXA	2	***
Part (P)	1	***	SXBXP	1	**
SXB	1	N.S.	SXAXP	2	**
SXA	2	***	BXAXP	2	N.S.
BXA	2	***	SXBXAXP	2	*
SXP	1	*			

b) Sensory evaluation

At 12 weeks, there's a great tenderness difference between the two strains. The COU NU strain's clearly more tough than the ROSS strain.

Globally, the breeding method doesn't influence the tenderness however there's a strong interaction between the strain and the breeding method. In fact the two strains don't react alike. By the COU NU strain, the chickens bred in cloistering are clearly tougher. Whereas, by the ROSS strain, the chickens growing on pasture are tougher. The jury find the leg meat harder than the breast meat.

Table 7 - Tenderness : sensory evaluation

Variation factors	D.F.	Tenderness	Variation factors	D.F.	Tenderness
Strain (S)	1	***	BXJ	7	*
Breeding (B)	1	N.S.	PXJ	7	N.S.
Part (P)	1	***	SXBXP	1	**
Judge (J)	7	**	SXBXJ	6	***
SXB	1	***	SX PXJ	6	N.S.
SXP	1	***	BXPXJ	7	N.S.
SXJ	6	**	SXBXPXJ	6	N.S.
BXP	1	N.S.			

CONCLUSIONS

It's important to note that the growing on pasture doesn't improve eating quality of broiler chickens. In connection with that we haven't note more physical activity by the chickens with access to an outdoor run. On the other hand, the slaughtering age is a very important factor. The meat of older animals is effectively less dry (the juice losses is weaker) and firmer.

The strain's choice is primordial. If we want to keep chickens to 12 or 13 weeks, it's preferable to choise a strain with slow growth (COU NU d'Aquitaine). In fact after 9 weeks, the ROSS strain isn't economically interesting anymore.

We think that's possible to produce a high-grade chicken in standart conditions. The principal factors, who determine the meat quality, are the strain and the slaughtering age. DEROANNE et al. (1983). LYON et al. (1984) and TOURAILLE et al. (1981) have led to the same conclusions.

Finally, it's indispensable to supervise all the production from egg to the consumer's plate. Some efforts realise to steady perfect breeding conditions, can be dasked by wrong slaughtering and distribution conditions (ARNAUD M. et al, 1976).

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