



Quality parameters of thermally treated chickens of two provenances and free range keeping

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ABSTRACT

The aim of the research was to study the influence of two rearing methods (free range and indoors) for chickens of two provenances on some quality parameters of thermally treated chickens. The trial involved 48 chickens (24 Ross and 24 Prelux-bro). All the birds were raised in deep litter house for the first 4 weeks. Then they were divided into 2 groups, the free range chicken group having free access to pasture ground. Both the pasture-raised and the indoor-raised groups were slaughtered at the age of 56 days. After slaughter and chilling the chickens were thermally treated at 190°C, reaching the central temperature in the breast, $T_s=85^\circ\text{C}$. Thawing weight loss and thermal treatment weight loss were calculated, basic chemical composition was analysed and after thermal treatment instrument-based analysis of texture and sensory parameters was performed. The results showed that the method of raising affected the instrument-measured traits of texture and the chemical composition of the thermally treated muscles. Sensory quality (overall acceptance) of chicken meat was not influenced significantly by method of raising or provenance, but an influence of the part of chicken (thigh versus breast) on the most of the sensory traits was established.

(Keywords: broilers, free range, meat, thermal treatment, quality parameters)

ZUSAMMENFASSUNG

Qualitätsparameter thermisch behandelter Broiler zweier Genotypen aus der Freilandhaltung

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Das Ziel der vorliegenden Untersuchung war festzustellen, welchen Einfluß die Zuchtbedingungen (Freilandhaltung und Zuchtort) und die zwei Genotypen (Ross und Prelux-bro) auf einige Qualitätsparameter der thermisch behandelten Broiler haben. Im Versuch wurden 48 Broiler der zwei Genotypen (24 Ross und 24 Prelux-bro) untersucht. Alle Broiler wurden bis zum 28. Lebenstag im Hühnerstall aufgezogen und dann in zwei

Gruppen geteilt. Die Broiler aus der Bodenhaltung blieben weiterhin im Hühnerstall, während diejenigen mit Freilandhaltung einen offenen Zugang zur Weide hatten. Alle Broiler wurden am 56. Tag geschlachtet. Nach dem Schlachten und Gefrieren wurden die Broiler bei 190 °C bis $T_c=85$ °C im Zentrum des Filets thermisch (durch Braten) behandelt. Die Gewichtsverluste beim Auftauen und bei der thermischen Behandlung wurden gemessen. Anschließend erfolgte die Analyse der chemischen Zusammensetzung und nach der thermischen Behandlung die technische Untersuchung des Gewebes sowie die sensorische Analyse. Die Resultate beweisen, daß die Zuchtbedingungen Einfluss auf die instrumental gemessenen Textureigenschaften und die chemische Zusammensetzung des thermisch behandelten Muskelfleisches haben. Ein signifikanter Einfluss auf die sensorische Qualität (Gesamteindruck) konnte weder durch Zuchtbedingungen noch durch Genotypen festgestellt werden. Es war lediglich bei den meisten sensorischen Eigenschaften ein Unterschied zwischen Filet und Schenkel wahrnehmbar.

(Schlüsselwörter: Broiler, Freilandhaltung, Fleisch, Thermische Behandlung, Qualitätsparameter)

INTRODUCTION

The method of raising broilers can significantly influence the sensory quality of chicken meat alongside genotype, age, sex and certain other technological parameters before and after slaughter. Chickens raised according to various methods of less intensive free range, as set out in the regulations issued in 1991 (EEC, No. 1538/91) are preferred by some consumers due to their better sensory quality, overall acceptance, smell, flavour and texture. Less intensive methods of raising of chickens branded under particular trade marks such as *Label Rouge* and *Label Fermier* in France (Farmer et al., 1997) are strictly supervised in all phases of production, with regard to chicken genotype (i.e., slow-growing animals), food (to contain wheat), population density (free range) and age at slaughter (not less than 84 days). Such methods of raising bear a significant effect on texture, tenderness and juiciness, which deteriorate, while the smell and flavour of the meat do not, and may even improve. Better or changed sensory traits of chicken meat from less intensive raising are different in white meat (breast) compared with dark meat (thigh) (Farmer et al., 1997), and also depending on sex (Ristić, 1990). Free range keeping changes the chemical composition of meat: the lipid and protein content increase while water content decreases. The pH value and WHC increase, as does shear force (Mahapatra et al., 1989). The aim of this research was to study the influence of two methods of raising (free range and indoor) and two provenances (Ross and Prelux-bro) on the chemical composition and sensory quality parameters of broilers after thermal treatment.

MATERIALS AND METHODS

24 broilers (12 females and 12 males) from the commercial provenance Ross and 24 others (12 females and 12 males) from the commercial provenance Prelux-bro were included in this research. All chickens were housed from the time of hatching until 28 days of age in a deep litter house. At the age of 28 days the chickens were divided into two groups. The first group (12 Ross chickens and 12 Prelux-bro chickens) was raised indoors without access to pasture. The second group (12 Ross chickens and 12 Prelux-

bro chickens) had free access to pasture all day. The ground to which the chickens had access was mainly covered with various types of grasses. For the first 28 days the broilers were fed a starter diet which contained 3100 kcal/kg and 23.44% crude protein. From the 28th day until the end of fattening the broilers were given a feed mixture with 2700 kcal/kg and 14.5% crude protein. The chickens were fed ad libitum. All birds were slaughtered at the age of 8 weeks. The chicken carcasses were dressed traditionally (carcass with head, neck, lower parts of legs, giblets and abdominal fat) and ready for grilling (without the above parts). The chicken carcasses were frozen at -20°C. Before the analyses began the frozen chickens were thawed for 24 hours at T=0 to +4°C and thawing weight loss was calculated. The thawed carcasses were thermally treated by roasting in a steam convection oven at 190°C, adding steam until the central temperature in the breast at the breastbone reached T_s=85°C. Thermal treatment weight loss was then calculated. With the use of basic chemical analyses for thermally treated breast muscle the water content was determined by a method of drying to constant mass at 105°C, fat content by Soxhlet's method, and ash content by dry burning of the samples at 550°C. Instrument-based analysis of texture (cutting values across and along the direction of muscular fibres with a 1 cm long blade) was performed on *m. pectoralis superficialis* and on *m. biceps femoris* using INSTRON universal test apparatus, desk type 1111. The sensory parameters were determined by a three-member committee according to the system of non-structured score scale from the group of descriptive analytical tests (SEG, 1980). The shape and overall acceptance of the whole thermally treated chicken was assessed. Colour, texture, fatness and flavour were assessed for the skin, while colour, smell, flavour, juiciness, fatness, tenderness and mouth feeling were evaluated for the breast and thigh muscle. Tenderness was assessed using the 1-4-7 score system, where the mean value denotes optimal tenderness, a lower score that the muscle is too firm and a higher score that it is too soft. All other sensory traits were assessed using the 1-7 score system, where the highest score denotes a more expressed trait. Statistical analysis of the data was performed by means of the GLM procedure of the SAS/STAT programme package (SAS/STAT User's Guide, 1990).

RESULTS AND DISCUSSION

Table 1 shows the basic statistical parameters for all the chicken traits analysed.

Table 2 shows the parameters (method of raising, provenance, part of chicken and parallel/assessor) which cause the variability of values for some traits. The calculated P value shows the strength of influence of single parameter on each trait.

Technological parameters, chemical composition and instrument-based values of texture of parallel did not have any influence while assessor significantly and highly significantly affected most of the sensory traits analysed. The other three effects (method of raising, provenance and part of chicken) are described in detail in *Table 3*.

Table 1

Statistical parameters for chicken quality traits

Parameter	N	Mean	Min.	Max.	SD	CV (%)
Technological: (1)						
Thawing weight loss (%) (2)	48	0.58	0.001	3.59	0.67	116.06
Thermal treatment weight loss (%) (3)	48	35.42	24.42	44.66	4.11	11.61
Thermally treated chicken: (4)						
Chemical – breast with skin (%): (5)						
Water (6)	64	60.47	55.38	64.71	1.93	3.19
Fat (7)	64	10.43	6.13	14.43	2.01	19.24
Ash (8)	64	1.13	0.93	1.42	0.12	10.35
Instrument-based (N): (9)						
Shear strength – across (10)	384	31.62	2.5	84	15.62	49.39
Shear strength – along (11)	384	15.14	3	43	5.75	37.97
Sensory (points): (12)						
Whole chicken: (13)						
Shape (1-7) (14)	144	5.76	5.0	6.5	0.34	5.89
Overall acceptance (1-7) (15)	144	5.63	5.0	6.0	0.27	4.87
Skin: (16)						
Colour (1-7) (17)	144	5.97	5.0	7.0	0.48	7.97
Texture (1-7) (18)	144	4.24	3.5	5.5	0.41	9.77
Fatness (1-7) (19)	144	2.11	1.0	5.5	0.63	29.83
Flavour (1-7) (20)	144	5.80	5.0	6.5	0.30	5.14
Breast and thigh – mean value: (21)						
Colour (1-7) (22)	288	5.83	4.5	6.5	0.43	7.42
Smell (1-7) (23)	288	5.85	5.0	6.5	0.25	4.21
Flavour (1-7) (24)	288	5.88	5.0	6.5	0.31	5.30
Juiciness (1-7) (25)	288	5.47	4.0	6.5	0.54	9.85
Fatness (1-7) (26)	288	1.49	1.0	3.0	0.57	38.54
Tenderness (1-4-7) (27)	288	3.84	2.5	5.5	0.32	8.47
Mouth feeling (1-7) (28)	288	5.51	4.5	6.5	0.38	6.92

CV - coefficient of variability (*Variationskoeffizient*)

1. Tabelle: Statistische Parameter für Qualitätsmerkmale bei Broilern

Technologie(1), Gewichtsverlust beim Auftauen(2), Gewichtsverlust durch Erhitzen(3), Hitzebehandelte Broiler(4), Zusammensetzung von Brust mit Haut, %(5), Wasser(6), Fett(7), Asche(8), technische Analyse(9), Scherfestigkeit quer(10), Scherfestigkeit längs(11), Sensorische Analyse nach Punkten(12), Ganzer Broiler(13), Äußere Form(14), Gesamteindruck(15), Haut(16), Farbe(17), Gewebestruktur(18), Fettigkeit(19), Geschmack(20) Durchschnittswerte für Brust und Schenkel(21), Farbe(22), Geruch(23), Geschmack(24), Saftigkeit(25), Fettigkeit(26), Mürbheitsgrad(27), Mundgefühl(28)

Table 2

Sources of variability and statistical significance (p) of their effect on some quality parameters of chickens

Parameter / DF	Source of variability (p value) (29)			
	Breeding (30)	Proven. (31)	Part (32)	Parallel or Assessor
	1	1	1	2
Technological: (1)				
Thawing weight loss (%) (2)	0.0078	0.0474		1.0000
Thermal treatment weight loss (%) (3)	0.0001	0.0172		1.0000
Thermally treated chicken: (4)				
Chemical - breast with skin (%): (5)				
Water (6)	0.4585	0.7915		0.0243
Fat (7)	0.0118	0.3941		0.6227
Ash (8)	0.0018	0.4922		0.5751
Instrument-based (N): (9)				
Shear strength – across (10)	0.0001	0.8114	0.0001	0.6003
Shear strength – along (11)	0.0001	0.0683	0.0001	0.4051
Sensory (points): (12)				
Whole chicken: (13)				
Shape (1-7) (14)	0.0001	0.02899		0.4237
Overall acceptance (1-7) (15)	0.3510	0.7556		0.0059
Skin: (16)				
Colour (1-7) (17)	0.0001	0.0900		0.0397
Texture (1-7) (18)	0.0004	0.6718		0.0402
Fatness (1-7) (19)	0.0768	0.8911		0.0042
Flavour (1-7) (20)	0.6660	0.1966		0.0044
Breast and thigh – mean value: (21)				
Colour (1-7) (22)	0.2713	0.3377	0.0001	0.0177
Smell (1-7) (23)	0.1502	0.6823	0.8796	0.0001
Flavour (1-7) (24)	0.5026	0.7266	0.0001	0.0001
Juiciness (1-7) (25)	0.0013	0.9826	0.0001	0.0029
Fatness (1-7) (26)	0.0340	0.2128	0.0001	0.0172
Tenderness (1-4-7) (27)	0.7286	0.0036	0.0064	0.4084
Mouth feeling (1-7) (28)	0.0218	0.1377	0.0001	0.0145

DF - degree of freedom (*Freiheitsgrad*)

2. Tabelle: Einfluss der Variabilitätsbasis und der statistischen Signifikanz auf einige Qualitätsmerkmale der Broiler

Technologie(1), Gewichtsverlust beim Auftauen(2), Gewichtsverlust durch Erhitzen(3), Hitzebehandelte Broiler(4), Zusammensetzung von Brust mit Haut, %(5), Wasser(6), Fett(7), Asche(8), technische Analyse(9), Scherfestigkeit quer(10), Scherfestigkeit längs(11), Sensorische Analyse nach Punkten(12), Ganzer Broiler(13), Äußere Form(14), Gesamteindruck(15), Haut(16), Farbe(17), Gewebestruktur(18), Fettigkeit(19), Geschmack(20) Durchschnittswerte für Brust und Schenkel(21), Farbe(22), Geruch(23), Geschmack(24), Saftigkeit(25), Fettigkeit(26), Mürbheitsgrad(27), Mundgefühl(28), Variabilitätsbasis(29), Haltungsmethode(30), Genotyp(31), Körperteil(32)

Table 3

The influence of keeping method on some quality parameters of chickens

Parameter	Keeping method (29)				Difference between free range & indoors (32)
	Free range (30)		Indoors (31)		
	LSM	SEM	LSM	SEM	
Technological: (1)					
Thawing weight loss (%) (2)	0.45	0.07	0.71	0.07	-0.26*
Thermal treatment weight loss (%) (3)	37.87	0.35	32.96	0.35	4.91***
Thermally treated chicken: (4)					
Chemical – breast with skin (%) (5)					
Water (6)	60.67	0.26	60.92	0.26	-0.25
Fat (7)	9.91	0.28	10.94	0.28	-1.03*
Ash (8)	1.17	0.02	1.10	0.02	0.07*
Instrument-based (N): (9)					
Shear strength – across (10)	33.8	0.7	29.39	0.7	4.5***
Shear strength – along (11)	16.2	0.4	14.1	0.4	2.1***
Sensory (points): (12)					
Whole chicken: (13)					
Shape (1-7) (14)	5.90	0.03	5.63	0.03	0.26***
Overall acceptance (1-7) (15)	5.60	0.03	5.65	0.03	-0.04
Skin: (16)					
Colour (1-7) (17)	6.13	0.05	5.81	0.05	0.32***
Texture (1-7) (18)	4.12	0.05	4.35	0.05	-0.23***
Fatness (1-7) (19)	2.02	0.07	2.20	0.07	-0.18
Flavour (1-7) (20)	5.78	0.03	5.81	0.03	-0.02
Breast and thigh – mean value: (21)					
Colour (1-7) (22)	5.80	0.03	5.85	0.03	-0.05
Smell (1-7) (23)	5.83	0.02	5.86	0.02	-0.04
Flavour (1-7) (24)	5.87	0.02	5.90	0.02	-0.02
Juiciness (1-7) (25)	5.39	0.04	5.56	0.03	-0.17*
Fatness (1-7) (26)	1.45	0.02	1.53	0.02	-0.07*
Tenderness (1-4-7 (27))	3.85	0.03	3.83	0.03	0.01
Mouth feeling (1-7) (28)	5.47	0.03	5.56	0.03	-0.09

P≤0.001 *** highly stat. significant; P≤0.01 **, P≤0.05 * stat. significant;

LSM - least square mean; SEM - standard error mean

3. Tabelle: Einfluss der Haltungsmethode auf einige Qualitätsparameter der Broiler

Technologie(1), Gewichtsverlust beim Auftauen(2), Gewichtsverlust durch Erhitzen(3), Hitzebehandelte Broiler(4), Zusammensetzung von Brust mit Haut, %(5), Wasser(6), Fett(7), Asche(8), technische Analyse(9), Scherfestigkeit quer(10), Scherfestigkeit längs(11), Sensorische Analyse nach Punkten(12), Ganzer Broiler(13), Äußere Form(14), Gesamteindruck(15), Haut(16), Farbe(17), Gewebestruktur(18), Fettigkeit(19), Geschmack(20) Durchschnittswerte für Brust und Schenkel(21), Farbe(22), Geruch(23), Geschmack(24), Saftigkeit(25), Fettigkeit(26), Mürbheitsgrad(27), Mundgefühl(28), Haltungsmethode(29), Freiland(30), Stallhaltung(31), Differenz(32)

Table 4

The influence of provenance on some quality parameters of chickens

Parameter	Provenance (29)				Difference between Ross & Prelux (30)
	Ross		Prelux		
	LSM	SEM	LSM	SEM	
Technological: (1)					
Thawing weight loss (%) (2)	0.48	0.07	0.68	0.07	-0.19*
Thermal treatment weight loss (%) (3)	34.82	0.35	36.01	0.35	-0.19*
Thermally treated chicken: (4)					
Chemical - breast with skin (%) (5):					
Water (6)	60.84	0.26	60.75	0.26	0.09
Fat (7)	10.60	0.28	10.26	0.28	0.34
Ash (8)	1.12	0.02	1.14	0.02	-0.02
Instrument-based (N): (9)					
Shear strength – across (10)	31.5	0.7	31.7	0.7	-0.2
Shear strength – along (11)	14.7	0.4	15.6	0.4	-0.9
Sensory (points): (12)					
Whole chicken: (13)					
Shape (1-7) (14)	5.79	0.03	5.74	0.03	0.05
Overall acceptance (1-7) (15)	5.63	0.03	5.62	0.03	0.01
Skin: (16)					
Colour (1-7) (17)	6.03	0.05	5.90	0.05	0.13
Texture (1-7) (18)	4.25	0.05	4.22	0.05	0.03
Fatness (1-7) (19)	2.12	0.07	2.10	0.07	0.01
Flavour (1-7) (20)	5.76	0.03	5.83	0.03	-0.06
Breast and thigh – mean value: (21)					
Colour (1-7) (22)	5.85	0.03	5.80	0.03	0.05
Smell (1-7) (23)	5.85	0.02	5.84	0.02	0.01
Flavour (1-7) (24)	5.88	0.02	5.89	0.02	-0.01
Juiciness (1-7) (25)	5.47	0.04	5.47	0.04	-0.00
Fatness (1-7) (26)	1.47	0.02	1.51	0.02	-0.04
Tenderness (1-4-7 (27))	3.78	0.03	3.90	0.03	-0.11*
Mouth feeling (1-7) (28)	5.49	0.03	5.54	0.03	-0.06

P≤0.001 *** highly stat. significant; P≤0.01 **, P≤0.05 * stat. significant;

LSM - least square mean; SEM - standard error mean

4. Tabelle: Einfluss des Genotyps auf einige Qualitätsmerkmale der Broiler

Technologie(1), Gewichtsverlust beim Auftauen(2), Gewichtsverlust durch Erhitzen(3), Hitzebehandelte Broiler(4), Zusammensetzung von Brust mit Haut, %(5), Wasser(6), Fett(7), Asche(8), Technische Analyse(9), Scherfestigkeit quer(10), Scherfestigkeit längs(11), Sensorische Analyse nach Punkten(12), Ganzer Broiler(13), Äußere Form(14), Gesamteindruck(15), Haut(16), Farbe(17), Gewebestruktur(18), Fettigkeit(19), Geschmack(20) Durchschnittswerte für Brust und Schenkel(21), Farbe(22), Geruch(23), Geschmack(24), Saftigkeit(25), Fettigkeit(26), Mürbheitsgrad(27), Mundgefühl(28), Genotyp(29), Differenz(30)

Table 5

The influence of part (thigh or breast) on instrument-based and sensory parameters of thermally treated chickens

Parameter	Part of meat (12)				Difference between thigh & breast (15)
	Thigh (13)		Breast (14)		
	LSM	SEM	LSM	SEM	
Instrument-based (N): (1)					
Cutting value – across (2)	19.8	0.7	43.4	0.7	-23.6***
Cutting value – along (3)	12.6	0.4	17.7	0.4	-5.2***
Sensory (points): (4)					
Colour (1-7) (5)	5.71	0.03	5.94	0.03	-0.23***
Smell (1-7) (6)	5.84	0.02	5.85	0.02	-0.00
Flavour (1-7) (7)	5.96	0.02	5.81	0.02	0.16***
Juiciness (1-7) (8)	5.78	0.04	5.17	0.04	0.61***
Fatness (1-7) (9)	1.98	0.02	1.00	0.02	0.97***
Tenderness (1-4-7) (10)	3.89	0.03	3.79	0.03	0.10*
Mouth feeling (1-7) (11)	5.70	0.03	5.33	0.03	0.38***

P≤0.001 *** highly stat. significant; P≤0.01 **, P≤0.05 * stat. significant;
LSM - least square mean; SEM - standard error mean

5. Tabelle: Einfluss der Körperteile (Brust, Schenkel) auf die technische und sensorische Untersuchung der hitzebehandelten Broiler

Technische Analyse(1), Scherfestigkeit quer(2), Scherfestigkeit längs(3), Sensorische Analyse nach Punkten(4), Farbe(5), Geruch(6), Geschmack(7), Saftigkeit(8), Fettigkeit(9), Mürbekeitsgrad(10), Mundgefühl(11), Fleischteile(12), Schenkel(13), Brust(14), Differenz(15)

Thawing weight loss proved significantly lower in the free range chickens than in the chickens raised indoors. Thermal treatment weigh loss showed the opposite tendency, with a highly significant difference. Samples from the free range chickens contained significantly less fat and more minerals than samples from indoor-raised chickens. The instrument-measured cutting values were significantly higher in the free range chickens, which was in accordance with the findings of Mahapatra et al. (1989). The free range chickens maintained significantly better shape (i.e., with less damage) than the indoor-raised chickens, and had highly significantly mreo favourably assessed skin colour and significantly less fat in the muscles. Most of the other sensory traits of the free range chickens were assessed to be slightly less favourable than those of the indoor-raised chickens; this was also confirmed by slightly lower assessment (difference not statistically significant) of overall acceptance. Scores for flavour and tenderness of muscles for the free range chickens and the indoor-raised chickens did not differ significantly, which is not in agreement with the general belief that free range chickens have better flavour and texture (Remignon and Culioli, 1995). Absolute comparison of these findings with those in the literature is not possible, since the animals used in this

study were relatively young at slaughter (56 days), while the literature data refer to older free range chickens (80 to 90 days).

Thawing weight loss and thermal treatment weight loss were significantly lower in the chickens of Ross provenance than in those of Prelux-bro provenance. Instrument-measured cutting values proved slightly lower in the muscles of the chickens of Ross provenance than in those of Prelux-bro provenance, which is not in agreement with the fact that the tenderness of the muscles of the chickens of Ross provenance was assessed at significantly low values. Differences between the Ross and Prelux-bro provenances in the traits of overall acceptance assessed were insignificant, which shows very equal sensory quality of chickens of both provenances.

Instrument-measured cutting values for thigh muscles proved significantly lower than for breast muscles, which was in agreement with the significantly higher sensory assessment of the tenderness of thighs. The sensory trait smell was found not to vary substantially in different meat parts. The thighs were assessed at significantly lower values than the breasts with respect to colour, and at very significantly higher values for fatness, as an undesirable trait. All the other sensory traits analysed were assessed at significantly more favourable values for thigh muscle than for breast muscle. The reason for this better assessment of most sensory traits for thigh muscles is evidently the higher fat content of the thigh than of the breast.

Table 6

Coefficients of correlation between instrument-based and some sensory parameters of thermally treated chickens

	Shear strength – across (5)	Shear strength - along (6)
Juiciness (1)	-0.51***	-0.27***
Fatness (2)	-0.65***	-0.340***
Tenderness (3)	-0.17**	-0.09
Mouth feeling (4)	-0.42***	-0.21***

P≤0.001 *** highly stat. Significant, P≤0.01 ** stat. significant

6. Tabelle: Korrelationskoeffizient zwischen den technisch und sensorisch festgestellten Merkmalen der hitzebehandelten Broiler

Saftigkeit(1), Fettigkeit(2), Mürbheitsgrad(3), Mundgefühl(4), Scherfestigkeit quer(5), Scherfestigkeit längs(6)

Highly significant negative correlations between the instrument-measured cutting value across the direction of the muscle fibres and the sensory traits juiciness, fatness and mouth-feeling were established, but these were not high enough ($r < 0.7$) to be substantial.

CONCLUSIONS

Free range influences:

- chemical composition of thermally treated meat (less fat, more minerals);
- instrument-measured texture (higher cutting values).

Sensory quality (i.e., flavour and tenderness) was not affected by free range keeping.

The influence of provenance is significant only for thawing weight loss, thermal treatment weight loss and tenderness (lower weight losses and worse tenderness in chickens of Ross provenance).

All the sensory traits, except smell, colour and fatness, were assessed to be better in the thigh than in the breast muscle.

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