DEPARTMENT OF FOOD SCIENCE
FACULTY OF LIFE SCIENCES
UNIVERSITY OF COPENHAGEN

Male chicken thigh meat quality from fast and slow growing breeds from an organic free-range system

Anders H. Karlsson*[1], Klaus Horsted[2], and Aleš Dufek[3]

[1]Dept. of Food Science, University of Copenhagen, Rolighedsvej 30, 1958 Frederiksberg C, Denmark

[2]Dept. Agroecology and Environment, Aarhus University, Foulum, P.O. Box 50, 8830 Tjele, Denmark

[3]Agriresearch Rapotin Ltd., Vikyrovice 267, 788 13, Czech Republic

* E-mail: ahka@life.ku.dk

OBJECTIVES

To test for distinct differences in meat quality attributes of male chicken thigh meat from a dual-purpose breed and from a relatively fast growing broiler hybrid, and whether this was influenced by feed type and age at slaughter.

INTRODUCTION

To some degree, the organic poultry production is based on the same rationale as the conventional poultry industry, to obtain a satisfactory economic output. However, the killing of one day old male chickens in the egg production is considered as a huge image problem and can lead to less consumer support for organically produced poultry products. A niche production based on breeds where the male chicken can be used for meat production and females for egg production might be considered.

MATERIALS AND METHODS

Breeds and feeding

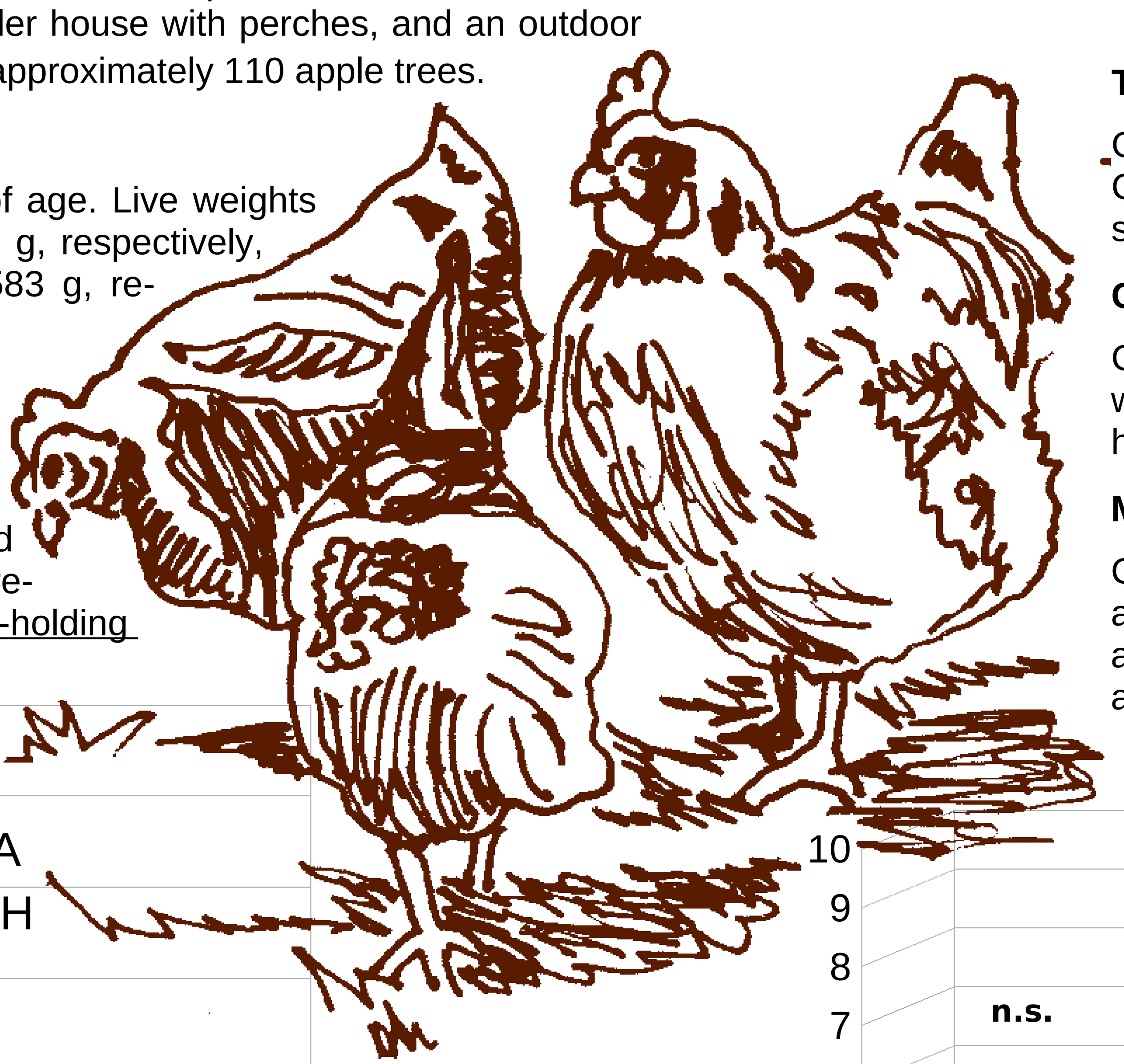
New Hampshire dual-purpose breed (NH) and a commercial broiler hybrid (JA757) were reared in the same flock until 39 days of age, thereafter divided into 12 flocks of 47 chickens. Within each breed three flocks were given fed with crude protein content of 19.2 and 18.2%, respectively. All flocks had access to a broiler house with perches, and an outdoor area at 9.5 m^2 per animal and each pen contained approximately 110 apple trees.

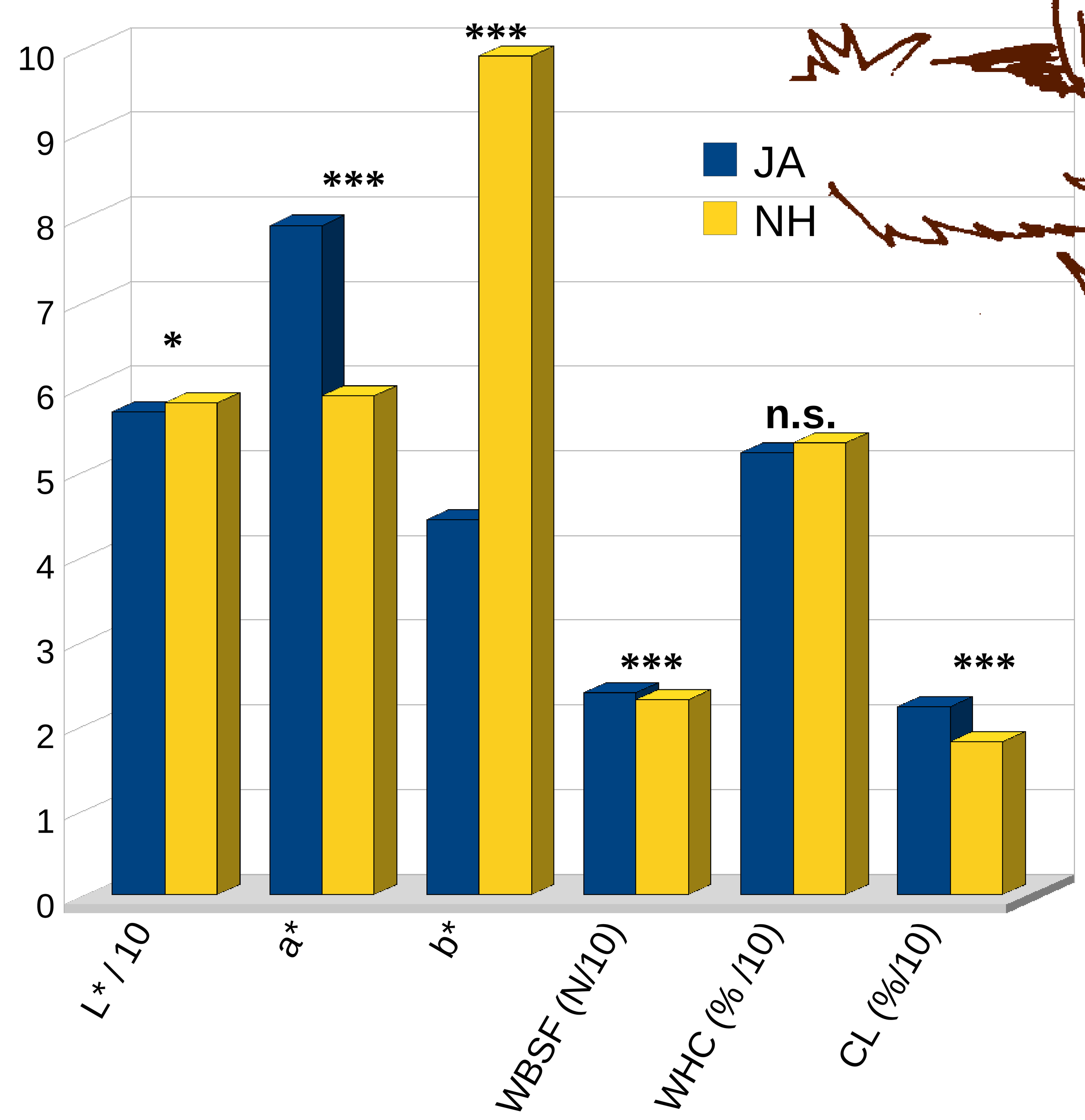
Slaughtering

The broilers were slaughtered at 82 or 110 days of age. Live weights for NH males at slaughtering were 1784 and 2828 g, respectively, and live weights for JA males were 4339 and 5583 g, respectively.

Meat quality measurements

M.iliothibialis from the right and left thigh were used. Meat colour was measured using a Minolta spectrophotometer: L* (lightness), a* (redness), and b* (yellowness) values.; an average of 3 measurements across the meat surface was used. For water-holding (WHC), two 5 gram pieces was taken. and pressed between two filter papers and two acrylic glass plates, and measured as the weight difference of the papers before and after pressing. Tenderness. From each muscle, 2 strips were sheared perpendicular to the fibre axis using an Instron Texture Analyser equipped with a rectangular WB blade. Nine registrations per animal were performed. Cooking loss (CL) was registered as the weight loss of the samples before and after cooking and cooling. Statistical analyses were performed using the R package [10, 11], calculating least-squares means and standard errors for the systematic effects: Genotype (JA vs. NH), Age at slaughter (82days vs. 110days), Feed Protein content (16,2 % vs.. 19,2 %) and their interactions, followed by stepwise selection (add-drop) by AIC to find out the best fitted models.





Effect of genotype (JA vs. NH) on meat quality attributes (Meat colour: lightness-L*, redness-a* and yellowness-b*), Instrumental tenderness: Warner-Bratzler Shear force (WBSF, N), Water-holding capacity (WHC, %) and Cooking loss (CL, %).

CONCLUSIONS

Significant effects of Genotype and Age on several of the technological meat quality attributes measured were found. In general, the meat from fast growing birds (JA) was darker, more tender, had a higher water-binding but a higher cooking loss. Birds with a higher age at slaughter was more red, less tender and had a higher cooking loss. Regarding the protein concentration of the feed, no significant effects could be found on meat quality attributes, however a high protein concentration in the feed showed a tendency towards more tender meat.

RESULTS

Tenderness

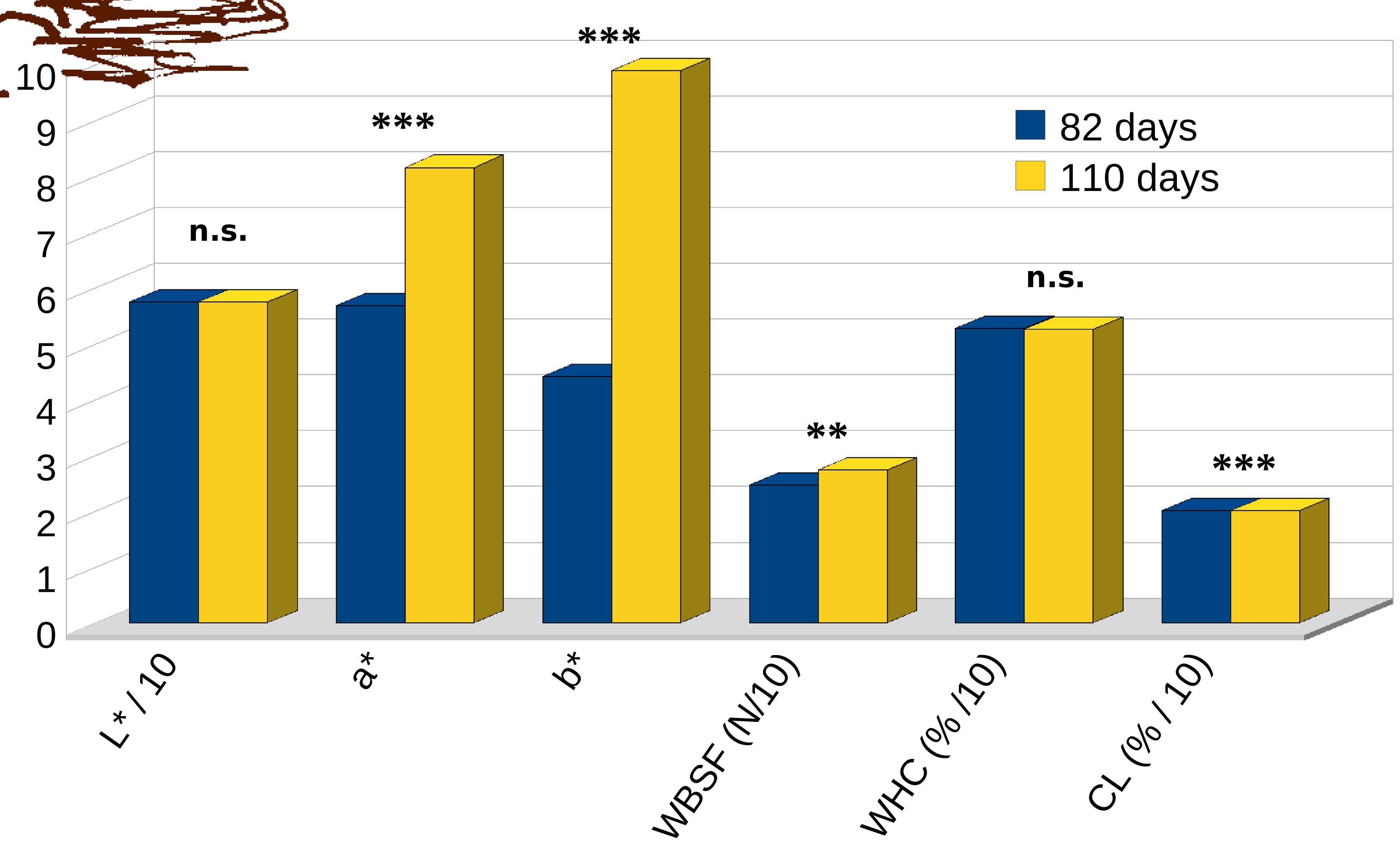
Genotype NH had less tender meat after cooking, compared with JA. Compared with an slaughter age of 82 days at slaughter, animals slaughtered at 110 days of age had less tender meat.

Cooking loss

Compared with Genotype JA, NH had lower cooking loss. Compared with an slaughter age of 82 days, animals slaughtered at 110 days had higher cooking loss.

Meat colour

Compared with Genotype JA, NH had higher L*-value, lower a*-value, and higher b*-value. Compared with an slaughter age of 82 days, animals slaughtered at 110 days had no difference in the L*-value, higher a*-value and lower b*-value.



Effect of age at slaughter (82 or 110 days) on meat quality attributes (Meat colour: lightness-L*, redness-a* and yellowness-b*), Instrumental tenderness: Warner-Bratzler shear force (WBSF,N), Water-holding capacity (WHC, %) and Cooking loss (CL, %).

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Project homepage: http://ww.qemp.elr.dk/uk/

Chicken thigh meat quality from a fast growing hybrid, and a slow growing dual-purpose breed; both reared in an organic free-range system

Karlsson H. Anders[1], Horsted, Klaus[2], and Aleš Dufek[3]

Abstract

A. H. Karlsson is with the Department of Food Science, Faculty of Life Sciences, University of Copenhagen, Rolighedsvej 30, DK-1958 Frederiksberg C, Denmark (e-mail: ahka@life.ku.dk).

K. Horsted is with Aarhus University, Faculty of Agricultural Sciences, Department of Agroecology and Environment, Research Centre Foulum, P.O. Box 50, 8830 Tjele, Denmark (e-mail: Klaus.Horsted@agrsci.dk).

Aleš Dufek is with the.A. Dufek is with the Agriresearch Rapotin Ltd., Vikyrovice 267, 788 13, Czech Republic (e-mail:ales.dufek@vuchs.cz)

***Index Terms*—Chicken, Meat, Quality, Organic, Thigh.**

I. Introduction

To some degree the organic poultry production is based on the same rationale as the conventional poultry industry, i.e. highly specialized layer and broiler breeds that need to be produced in large flocks to obtain a satisfactory economic output. However, the killing of one day old male chickens in the egg production is considered as a huge image problem and can lead to less consumer support for organically produced poultry products. A niche production based on breeds where the male chicken can be used for meat production and females for egg production might be considered. However, the production costs of males from dual-purpose breeds are much higher than traditional broiler breeds, due to the slower growth and lower feed conversion rate [1]. This indicates that other quality dimensions need to be included to increase consumer attractiveness. At present the consumers show increased interest for food with distinctive characteristics and a premium-prise can be obtained for products with high added value.

The fact that slow growing broilers have proven considerably more active in the range area than fast growing broilers [2;3] indicate that they are better suited to a dual role in combination with other branches of production as e.g. pest controllers in fruit production [4;5]. Such a combined production of broilers and fruit is in accordance with the principles of organic agriculture [6] and may attract motivated consumers and lower the production costs. Simultaneously, slow growing broilers do not suffer from dermal lesions and gait abnormalities to the same degree as fast growing broilers [3;7], indicating a higher ethical quality. However, in addition to these qualities also the meat quality needs to be taken into consideration. Differences in breast meat quality among genotypes with different growth rates have been identified [8], but very little has been published in relation to old dual-purpose breeds. A study on sensory quality found that the texture of the breast meat of two dual-purpose breeds was improved if they were slaughtered at 120 days of age compared to 91 days of age, whereas the opposite development was found in a slow growing broiler hybrid [9]. Thus, the difference in meat quality of slow growing dual-purpose breeds and fast growing broiler breeds and the interaction with production systems is still a scope for more research. Due to the different levels of activity and growth rates among dual-purpose breeds and fast growing broiler hybrids, especially the meat quality of the drumsticks might be influenced by breed. The aim of present study was to test for distinct differences in meat quality attributes of chicken thigh meat from males from a dual-purpose breed and males from a relatively fast growing broiler hybrid, and whether this was influenced by feed type and age at slaughter.

II. Materials and Methods

A. Breeds and feeding

A New Hampshire dual-purpose breed (NH) and a commercial broiler hybrid (JA757) were selected for the experiment. The latter is currently the only breed used for organic broiler production in Denmark. Both breeds were reared in the same flock and fed the same feed (21% crude protein) until 39 days of age, where they were divided into 12 flocks with 47 chickens in each flock. Six flocks with New Hampshire and six with JA757. Within each breed three flocks were fed a commercial produced broiler compound feed and three flocks were fed a compound feed for growers. In the broiler feed the major carbohydrate sources were maize (36%) and wheat (25%) and in the grower feed it was wheat (50%) and barley (15%). Major protein sources were soy (20%) and sunflower (12%) cake in the broiler feed and in the grower feed it was soy (9.3%) and sunflower (12%) cake and fish meal (3%). Crude protein content was analysed to 19.2 and 18.2%, respectively. All flocks had access to a broiler house with perches and an outdoor area at 9.5 m^2 per broiler and each pen contained approximately 110 apple trees.

B. Slaughtering

The broilers were slaughtered at 82 or 110 days of age according to the Label Rouge concept. Live weights for New Hampshire (NH) males at slaughtering were 1784 and 2828 g, respectively, and live weights for JA757 males were 4339 and 5583 g, respectively. Six male broilers were randomly selected from each flock. They were transported to the slaughterhouse during the night (one hour of transport), and slaughtered in the early morning. The carcasses were scalded in at temperatures of 58-61 ^{o}C dependent on breed. Feathers were subsequently removed in a plucking machine, and the carcasses were cooled in water and eviscerated. Finally, they were hung up in a cold storage room at a temperature at 4 ^{o}C declining to 1 ^{o}C. After 24 hours in the cold storage room the carcasses were frozen to -18 ^{o}C.

C. Meat quality measurements

After thawing the meat, the skin of the carcasses was removed.

On the right and left thigh on the largest and lightest parts (*M.iliothibialis)* from all birds, meat colour was measured using a Minolta Spectrophotometer (Minolta Co Ltd.). The instrument produced L* (lightness), a* (redness), and b* (yellowness) values. The average of 3 measurements across the meat surface was used.

For water-holding capacity measurements (WHC), two 5 gram pieces was taken (duplicate). The samples were pressed between two filter papers and two acrylic glass plates. WHC was measured as the difference in weight of the papers before and after the pressing, and was expressed in percentage.

Instrumental tenderness was measured using the Warner Bratzler shear force method (WBSF), and maximum shear force (*N*) was recorded. The samples were vacuum-packed and heated in a water bath for 35 to 60 min in +85 °C, then cooled in tap water until the next day. Pieces with the dimension of 1 cm x 1 cm x 5 cm was taken out. The fibre direction was parallel to the longitudinal direction of the sample. From each of the two muscles, 2 strips were sheared perpendicular to the fibre axis using a Instron Texture Analyser equipped with a Warner-Bratzler shear force blade with a rectangular blade. Nine registrations per animal were performed.

Cooking loss was registered as the weight loss of the samples before and after cooking and cooling, and was expressed in percentage.

D Statistical analyses

The statistical analyses were performed using the R package [10, 11]. Systematic effects tested were: Genotype (JA VS. NH), Age (82days VS 110days), Feed Protein content (16,2 % VS. 19,2 %). Firstly, GLM models with all fixed effects - breed, feed type, age of slaughter and their interactions were computed. We continued with stepwise selection (add-drop) by AIC to find out the best model with significant effects on dependent variable: Warner-Bratzler, water holding capacity, cooking loss, L*, a*, b*. In case of the Warner-Bratzler evaluation we used generalized LM with Gamma error distribution because the assumption for GLM – homogeneity of residual variance - was violated. Beside the AIC, the significance of the effects in the final models was considered by analysis of deviance - F test. The models were fitted in R software. The package 'effects' in R was used to figure out the model-predicted means, s.e.m. and 95% CI.

III. RESULTS AND DISCUSSION

A. Tenderness

Compared with Genotype JA, NH had less tender meat after cooking (higher shear force value (WB) on cooked meat). Compared with an Age of 82 days at slaughter, animals with an Age of 110 days had: less tender meat after cooking (higher shear force value (WB) on cooked meat). Compared with a Protein content of the feed of 18%, animals given a Protein content of 19%: tendency to more tender meat after cooking (lower shear force value (WB) of cooked meat)

Significant terms in the model for tenderness was genotype and interaction of age with feed type. Effect of age was more accentuated in chickens fed on protein 19,2%. The lower values of WBSF were found in chickens fed on protein 19.2% with age at slaughter 82 days than in those fed on protein 16.2% with the same slaughter age. Predicted means of WBSF for JA was generally lower than for NH.

B. Cooking loss

Compared with Genotype JA, NH had lower cooking loss (less weight loss after cooking). Compared with an Age of 82 days at slaughter, animals with an Age of 110 days had higher cooking loss (higher weigh loss after cooking).

Generally, significantly lower cooking loss had meat in NH genotype than JA. Chickens in subgroups JA:19,2% and NH:16,2% had lower cooking loss at 82 days of slaghter age than at 110 days of slaughter. This effect of age was not observed in subgroups JA:16,2% and NH:19,2%. Interaction of age, feed type and genotype was significant according to AIC.

C. Meat colour

Compared with Genotype JA, NH had higher L*value (lighter colour on fresh meat), lower a*value (fresh meat ha lower redness), and higher b*value (fresh meat had more yellow colour). Compared with an Age of 82 days at slaughter, animals with an Age of 110 days had no difference in the lightness of the meat (L*value), higher a*value (fresh meat had more red colour), and lower b*value (fresh meat had less yellow colour). Compared with a Protein content of the feed of 18%, animals given a Protein content of 19% tendency to a higher b*value (fresh meat had a more yellow colour).

D. Water-holding capacity

Compared with Genotype JA, NH had a tendency to lower water-holding capacity of fresh meat (more liquid could be pressed out from the meat). Compared with an Age of 82 days at slaughter, animals with an Age of 110 days had no difference in water-holding capacity of fresh meat.

Table 1: Overall means (Mean), median (Med), standard deviation (SD), minimum (Min), maximum (Max) values of the meat quality attributes.

Variable	Mean	Med	SD	Min	Max
L*	57,49	57,31	2,49	50,73	6381
a*	6,88	6,15	2,06	3,59	13,2
b*	7,16	6,13	3,89	-0,85	18,12
WBSF (N)	26,03	24,66	6,06	15,31	46,61
Press-WHC (%)	52,72	52,23	3,44	41,63	60,55
Cooking loss (%)	20,11	19,77	2,9	12,86	27,8

Table 2: *Effect of genotype (Jaor NH) on meat quality attributes (Meat colour: lightness-L*, redness-a* and yellowness-b*), Instrumental tenderness: Warner-Bratzler Shear froce-WBSF,Water-holding capacity (WHC) and Cooking loss. Least-squares means and p-values are presented.*

Effect	Genotype		
Genotype:	**JA**	**NH**	**p-value**
L*	56,99	57,99	0,0174 (*)
a*	7.90	5,89	0,0001 (***)
b*	4,42	9.90	0,0001 (***)
WBSF (N)	23,82	23,02	0,0001 (***)
WHC (%)	52,17	53,25	0,0615 (‡)
Cooking loss (%)	22,24	18.00	0,0001 (***)

Table 3: *Effect of age at slaughter (82 or 110 days) on meat quality attributes (Meat colour: lightness-L*, redness-a* and yellowness-b*), Instrumental tenderness: Warner-Bratzler Shear froce-WBSF,Water-holding capacity (WHC) and Cooking loss. Least-squares means and p-values are presented.*

Effect	Age	At slaughter	
Age:	**82 days**	**110 days**	**p-value**
L*	57,73	57,53	0,794 (ns)
a*	5,68	8,16	0,0001 (***)
b*	8,24	6,12	0.0001 (***)
WBSF (N)	24,68	27,43	0,0032 (**)
WHC (%)	52,83	52,59	0,7032 (ns)
Cooking loss (%)	19,4	20,43	0,0001 (***)

Table 4: *Effect of feed protein concentration (16,2 or 19,2 %) on meat quality attributes (Meat colour: lightness-L*, redness-a* and yellowness-b*), Instrumental tenderness: Warner-Bratzler Shear froce-WBSF,Water-holding capacity (WHC) and Cooking loss. Least-squares means and p-values are presented.*

Effect	Protein	Concentration	(%)
Genotype:	**16,20%**	**19,20%**	**p-value**
L*	57,56	57,41	0,7
a*	6,86	6,95	0,57
b*	6,82	7,57	0,062 (‡)
WBSF (N)	26,95	25,15	0,05 33 (‡)
WHC (%)	53,03	52,41	0,2830 (ns)
Cooking loss (%)	20,16	20,05	0,7352 (ns)

IV. CONCLUSION

Significant effects of Genotype and Age on several of the technological meat quality attributes measured were found. In general, the meat from fast growing birds (JA) was darker, more tender, had a higher water-binding but a higher cooking loss. Birds with a higher age at slaughter was more red, less tender and had a higher cooking loss. Regarding the protein concentration of the feed, no significant effects could be found on meat quality attributes, but a high protein concentration in the feed showed a tendency towards more tender meat.

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