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Korrespondenzadresse:
carsten.krischek@tiho-hannover.de

[1]Institute of Food Quality and Safety, Centre of Food Sciences, Foundation University of Veterinary Medicine, Bischofsholer Damm 15, 30173 Hannover, Germany;
[2]Division Animal Breeding and Genetics, Department of Animal Sciences, Georg-August-University Goettingen, Albrecht-Thaer-Weg 3, 37075 Goettingen, Germany
[3]Heidemark Maesterkreis GmbH & Co. KG, Haldensleben, Germany

Nutrient composition of broiler and turkey breast meat in relation to age, gender and genetic line of the animals

Nährstoffzusammensetzung von Hähnchen- und Putenbrustfleisch in Abhängigkeit von Alter, Geschlecht und Genetik der Tiere

Carsten Krischek[1], Sabine Janisch[2], Ronald Günther[3], Michael Wicke[2]

Summary

The correct labelling of nutrient values of poultry breast meat on self service packages is important to reduce problems with the responsible authorities and consumers. As meat nutrient contents are influenced by several endogenous factors, in the present investigation fat, protein, ash and dry mass contents of breast meat collected from broiler and turkeys were investigated. The animals differed in age, gender or genetic line and each species was reared under similar husbandry and feeding conditions. In broiler, age of the animals influenced the fat and ash content of the breast meat, whereas the genetic line had an impact on the fat and dry mass values. An impact of the gender could not be determined. In turkeys, age and gender but not genetic line influenced the fat and protein contents of the breast meat. Correlation analysis indicates an impact of the carcass and breast weights on the fat, protein and ash contents in all broiler and fat and protein content in all turkeys. The results indicate that sorting of breast meat with regard to the described factors – especially the carcass or breast weight in turkeys – is useful to reduce the variation of the nutrient values before packaging and the incorrect labelling of the packages.

Keywords: Broiler, turkey, nutrient values, breast meat

Zusammenfassung

Die korrekte Kennzeichnung der Nährwerte von Geflügelbrustfleisch auf der Selbstbedienungsverpackung ist wichtig, um Probleme mit den zuständigen Behörden und den Verbrauchern zu reduzieren. Da der Nährstoffgehalt des Fleisches durch verschiedene endogene Faktoren beeinflusst wird, wurden in der vorliegenden Untersuchung Fett-, Protein-, Asche- und Trockenmasse-Gehalte von Brustfleisch, die von Masthähnchen und Puten untersucht. Die Tiere unterschieden sich in Alter, Geschlecht oder genetischer Linie und jede Spezies wurde unter gleichen Haltungs- und Fütterungsbedingungen aufgezogen. Während der Fett- und Asche-Gehalt von Masthähnchen-Brustfleisch vom Alter und der Fett- und Trockenmasse-Werte durch die Linie beeinflusst werden, konnte ein Einfluss des Geschlechtes nicht ermittelt werden. Bei Puten konnte ein Einfluss von Alter und Geschlecht aber nicht der Linie auf die Fett- und Protein-Gehalte gefunden werden. Die Korrelationsanalyse zeigt einen Einfluss des Schlachtkörper- und Brust-Gewichtes auf die Fett-, Protein- und Asche-Gehalte in allen Masthähnchen und die Fett- und Protein-Gehalte in allen Puten an. Die Ergebnisse zeigen, dass das Sortieren von Brustfleisch bezüglich der beschriebenen Faktoren und – besonders des Schlachtkörper- oder Brustgewichtes bei Puten – sinnvoll ist, um die Variation der Nährstoff-Werte vor der Verpackung und eine nicht korrekte Kennzeichnung der Packungen zu reduzieren.

Schlüsselwörter: Masthähnchen, Pute, Nährwerte, Brustfleisch

Ausgabe für imr:livelyzachary Die Inhalte sind urheberrechtlich geschützt. Eine Weitergabe an unberechtigte Dritte ist untersagt.

Introduction

Over the past few years increasing quantities of poultry meat have been sold as cut up parts stored in modified atmosphere packages (MAP) for self-service (Petracci et al. 2009). Although labelling of the nutrient content according to the EU directive 90/496/EEG is optional, most of the meat producers present protein, fat, carbohydrate and energy data on the packages. The consequence is that the producers are responsible for the correct declaration of the foodstuff. Although fast analysis of the meat e.g. by using the ultrasound or NIR technology (Morlein et al. 2005; Prieto et al. 2009) is possible, it could not be excluded that meat with varying nutrient content is sold, especially if the food producers do not change the labelling regularly considering the actual analytical data. It could be argued that the variation is less problematic, because the labels only present average nutrient values, but a reduction of the variation might be useful to prevent problems with the responsible authorities and the consumers and to reduce the number of analyses after cutting of the carcasses. Besides the normal nutrient content variation of meat from birds of the same flock, meat from different poultry flocks can have a higher nutrient variation due to different gender, age or genetics of the broiler and turkey. In different publications the influence of these factors on the nutrient values of broiler and turkey meat were investigated (Fernandez et al. 2001; Fanatico et al. 2005; Castellini et al. 2006; Intarapichet et al. 2008; Jaturasitha et al. 2008; Ristic et al. 2008; Werner et al. 2008; Laudadio et al. 2009), but each of the investigations considered only one of these factors. In the study by Baeza et al. (2010) the factors age, gender and genetics of broiler were considered, but the authors investigated regional lines slaughtered at high age of more than 84 d. In the present study the impact of gender, age and genetics as well as the slaughter weight on the fat, protein, dry mass and ash contents was investigated using commercial broiler or turkey lines. The birds of each species were reared under similar husbandry and feeding conditions. The aim was to investigate the possibility to reduce the nutrient variation and possible complaints by consumers and authorities by sorting the carcasses before cutting and packaging of the breast meat.

Material and Methods

Animals and husbandry

Broiler hens and cockerels (60 birds each) of the genetic line A and 60 cockerels of the genetic line B were reared according to the animal welfare recommendations ("Bundeseinheitliche Eckwerte für eine freiwillige Vereinbarung zur Haltung von Masthähnchen und Mastputen (Uniform and voluntary rules for the husbandry of broiler and turkeys") in an experimental barn that provided good husbandry conditions (e. g., stocking density, litter, ventilation). The birds were raised under similar conditions in the same barn equipped with nine pens (20 birds of the same line per pen). The size of each pen was approximately 2 m^2. The animals had no access to the outdoor environment to minimize any disturbing influences. At the beginning, the room temperature was 24 °C and the poults had access to extra radiant heaters providing a spot temperature of approximately 32 °C. During growth the heaters were removed and the room temperature was gradually reduced to 18 °C. Lighting conditions comprised natural daylight as well as artificial high-frequency light sources. Intensities varied according to weather conditions and day time. Daily lighting was reduced from 24 h hours to 16 h within the first week remaining at this regime until the end of the trial. The litter (wood shavings) condition was controlled daily (e. g., dirt, wetness) and additional material was added continuously. The birds were fed commercial diets.

Turkey hens and toms (60 birds each) of the genetic line C and 60 toms of the genetic line D were reared according to the animal welfare recommendations in an experimental barn that provided good husbandry conditions (e. g., stocking density, litter, ventilation). The animals had no access to the outdoor environment to minimize any disturbing influences. The room temperature in the barn was 24 °C at the beginning of the trial and the poults had access to extra radiant heaters providing a spot temperature of 34–36 °C. During growth the heaters were removed and the room temperature was gradually reduced to 13–15 °C. Lighting conditions comprised natural daylight as well as artificial high-frequency light sources. Intensities varied according to weather conditions and day time. Daily lighting was reduced from 24 h hours to 16 h within the first week remaining at this regime until the end of the trial. The litter (wood shavings) condition was controlled daily (e. g., dirt, wetness) and additional material was added continuously. The turkeys were fed commercial diets ad libitum consisting of 6 phases depending on the age of the birds.

Slaughter and sample collections

At day 28 (broiler) and 112 (turkeys) half of the birds per genetic line and gender (N = 30) were caught at the compartments and transported carefully to a commercial abattoir. The remaining birds (N = 30 per genetic line and gender) were transported and slaughtered at day 41 (broiler) and day 147 (turkeys).

Immediately after stunning (150 mA, 4 s (Turkeys); 120 mA, 5 s (Broiler)) the bleeding was initialized by mechanical cutting of the *A. carotis communis.* After scalding (58–60 °C, 45 s (turkeys); 51–53 °C, 4.5 min (broiler)) the carcasses were defeathered and automatically eviscerated followed by the veterinary meat inspection. Before entering the chilling room 25 carcasses per species, genetic line, age and gender were randomly removed from the slaughter chain and weighed. In broiler, both *M. pectoralis superficialis (MPS)* and both legs and in turkey the left *MPS* and legs were carefully excised from the carcass by an experienced person and weighed after removal of the skin. Only the *MPS* were used for further sample collection and analysis as presented in the chapter "Analysis of the breast meat nutrient contents". Between the investigations, the muscle samples were individually packed in plastic bags and stored on ice.

Analysis of the breast meat nutrient contents

The concentration of fat, protein and ash, and the dry matter was determined in homogenates of the breast meat according to the AOAC (1990).

The protein content was calculated by analysis of the nitrogen concentration after catalytical combustion by an elementary analysis apparatus VarioMax CN (Elementar Analytical Systems GmbH, Hanau, Germany) and multiplying the result by 6.25.

Journal of Food Safety and Food Quality 62, Heft 3 (2011), Seiten 73–104

The ash concentration was analyzed from the weight difference before and after combustion (600 °C, 24 h) of 1 to 2 g material in a muffle furnace (Modell Thermicon T, Kendro Laboratory Products GmbH, Hanau, Germany).

The dry mass concentration was calculated from the weight before and after drying the muscle sample in a drying oven (Kendro Laboratory Products GmbH, Hanau, Germany) at 105 °C for 24 h.

Fat content was determined after acid hydrolysis and extraction in a Soxtherm®-apparatus (Gerhardt Laboratory Systems GmbH, Koenigswinter, Germany) by calculating the weight before and after the procedure.

All experiments were performed in duplicates and were repeated in triplicates, if the results of the first analysis differed more than 10 %.

Statistical Analysis

The (statistical) analysis of the data was performed with the software package Statistica 7.1. Results for the individual birds were subjected to the GLM considering the factors age, gender and genetic.

Statistical significance was calculated with the TUKEY post-hoc test considering a probability error P of 0.05.

Results

Carcass characteristics

After slaughter, carcass, breast and leg weights as well as breast yields of 147 d old turkey toms and 41 d old broiler cockerels and hens were significantly (P<0.05) higher in comparison to the younger birds. In contrast to this, leg yields decreased significantly (P<0.05) with increasing age of turkey toms as well as broiler cockerels and hens.

Male broiler of the lines A and B – slaughtered at 28 d – had comparable carcass characteristics, but with ageing to 41 d slaughter, breast and leg weights increased more in animals of genetic line A differing significantly (P<0.05) from the results of genetic line B. With regard to the gender of the broiler a clear impact on the carcass characteristics was only determined in the 41 d old birds with significantly (P<0.05) higher slaughter, breast and leg weights of male broiler (Tab. 1).

Considering the impact of the turkey genetic line on the carcass characteristics, no significant differences of carcass, breast and leg weights as well as the breast yields were determined between the animals of genetic line C and D either in the 112 d, or the 147 d old toms. However, turkey hens of genetic line C had significantly (P<0.05) lower weight and leg yield results but higher breast yields in comparison to the toms (Tab. 2).

Nutrient content of the breast meat

In Table 3 and 4 the fat, protein, ash and dry mass contents of turkey and broiler breast muscles are presented.

The fat concentrations of broiler breast meat ranged between 0.6 and 1.3 %. With ageing of cockerels the fat content increased in both genetic lines – especially in line B that had the significantly (P<0.05) highest fat values in breast meat of 41 d old birds. The 28 d and 41 d old hens had comparable fat concentrations not differing from the results of cockerels of the same genetic line. The protein concentrations varied between 23.7 and 24.4 %. The effects of the age on the protein content were quite variable with comparable values in male broiler of genetic line A, lower contents in 41 d old cockerels of line B and higher protein concentrations in 41 d old hens. No effect of gender and genetic line on the protein content was found in broiler except for the significantly (P<0.05) lower protein concentration in 41 d old cockerels of genetic line B in comparison to line A. Ash contents were significantly (P<0.05) higher in 28 d old birds. No impacts of genetic line and gender on these values were found. The dry mass values increased during ageing of broiler hens, while 28 d and 41 d old cockerels of both genetic lines had comparable results. No effect of the gender was found, but male broiler from

TABLE 1: *Least square means (LSM) (upper values) and standard errors (lower values) of the carcass characteristics depending on genetic line, gender and age of the investigated broiler.*

	Genetic line A (Cockerels)		Genetic line A (Hens)		Genetic line B (Cockerels)	
	28 d old (n = 25)	41 d old (n = 25)	28 d old (n = 25)	41 d old (n = 25)	28 d old (n = 25)	41 d old (n = 25)
Carcass weights [g]	1034.2[c] 17.7	2158.8[a] 40.4	987.2[c] 19.0	1864.4[b] 36.1	984.2[c] 20.7	1972.0[b] 43.7
Breast weights [g]	205.5[c] 5.1	492.3[a] 11.7	194.1[c] 3.5	421.5[b] 9.3	188.8[c] 4.9	453.7[b] 11.8
Leg weights [g]	291.3[c] 6.2	567.8[a] 10.1	276.8[c] 6.7	484.4[b] 11.6	270.2[c] 5.2	516.5[b] 11.6
Breast yields[1] [%]	19.8[b] 0.31	22.7[a] 0.26	19.7[b] 0.31	22.6[a] 0.37	19.1[b] 0.33	22.9[a] 0.25
Leg yields[1] [%]	28.1[a] 0.37	26.3[b] 0.22	28.0[a] 0.27	25.9[b] 0.22	27.4[a] 0.30	26.2[b] 0.25

[1]Breast and leg yields are related to the carcass weights; [abc]LSM with different letters in a line differ significantly (P<0.05).

TABLE 2: *Least square means (LSM) (upper values) and standard errors (lower values) of the carcass characteristics depending on genetic line, gender and age of the investigated turkeys.*

	Genetic line C (Toms)		Genetic line C (Hens)	Genetic line D (Toms)	
	112 d old (n = 25)	147 d old (n = 25)	112 d old (n = 25)	112 d old (n = 25)	147 d old (n = 25)
Carcass weights [g]	11263.3[b] 110.4	16555.6[a] 202.5	8403.6[c] 178.7	10951.6[b] 190.1	15868.4[a] 191.6
Breast weights [g]	2926.2[b] 50.5	4740.0[a] 102.4	2340.7[c] 81.1	2913.1[b] 64.13	4645.6[a] 93.2
Leg weights [g]	3293.3[b] 38.6	4536.8[a] 64.3	2261.8[c] 43.3	3160.8[b] 49.8	4410.4[a] 55.4
Breast yields[1] [%]	25.8[c] 0.32	28.5[a] 0.41	27.7[ab] 0.47	26.5[bc] 0.34	29.2[a] 0.4
Leg yields[1] [%]	29.2[a] 0.26	27.4[bc] 0.32	26.9[c] 0.29	28.9[ab] 0.30	27.8[b] 0.30

[1]Breast and leg yields are related to the carcass weights; [abc]LSM with different letters in a line differ significantly (P<0.05).

genetic line B had significantly (P<0.05) higher dry mass values in comparison to genetic line A.

The breast meat of the turkeys had similar ash and dry mass contents. In contrast to this, age and gender of the birds affected the fat and protein concentrations. With ageing of the toms of both genetic lines meat fat content increased significantly (P<0.05), whereas the protein concentrations decreased (P<0.05). Hens of genetic line C had significantly higher fat values than the 112 d old toms.

Correlation between carcass and breast weights and the nutrient values

In all broiler cockerels a significant (P<0.05) positive correlation between fat content and carcass and breast weight was calculated, whereas the protein and ash concentrations of breast meat decreased significantly (P<0.05) with increasing breast and carcass weights. Considering only the 28 d old cockerels, increasing weight properties were accompanied with significantly (P<0.05) lower protein and dry mass content of the breast muscle. However, in 41 d old male broiler no significant correlation was found (Tab. 5).

With regard to all turkey toms, significant (P<0.05) positive correlation was found between carcass and breast weights and the fat concentration of the breast meat. In contrast to this, the protein content decreased with increasing weights (P<0.05). In 112 d old turkey toms only the fat values increased significantly (P<0.05) with higher carcass and breast weights, whereas in the group of 147 d old birds fat content increased and protein as well as the dry mass concentrations of the breast meat decreased significantly (P<0.05) with increasing carcass and breast weights (Tab. 6).

TABLE 3: *Least square means (LSM) (upper values) and standard errors (lower values) of the breast meat nutrient values depending on genetic line, gender and age of the investigated broiler.*

	Genetic line A (Cockerels)		Genetic line A (Hens)		Genetic line B (Cockerels)	
	28 d old (n = 25)	41 d old (n = 25)	28 d old (n = 25)	41 d old (n = 25)	28 d old (n = 25)	41 d old (n = 25)
Fat [%]	0.6[c]	0.9[b]	0.7[bc]	0.8[bc]	0.8[bc]	1.3[a]
	0.1	0.1	0.1	0.1	0.1	0.1
Protein [%]	23.9[b]	24.0[ab]	23.9[b]	24.4[a]	24.3[ab]	23.7[c]
	0.1	0.1	0.1	0.1	0.1	0.1
Ash [%]	1.4[a]	1.3[b]	1.4[a]	1.3[b]	1.4[a]	1.3[b]
	0.1	0.1	0.1	0.1	0.1	0.1
Dry mass [%]	25.1[b]	25.2[b]	24.9[b]	25.5[a]	25.5[a]	25.4[a]
	0.1	0.1	0.1	0.1	0.1	0.1

[abc]LSM with different letters in a line differ significantly (P<0.05).

TABLE 4: *Least square means (LSM) (upper values) and standard errors (lower values) of the breast meat nutrient values depending on genetic line, gender and age of the investigated turkeys.*

	Genetic line C (Toms)		Genetic line C (Hens)	Genetic line D (Toms)	
	112 d old (n = 25)	147 d old (n = 25)	112 d old (n = 25)	112 d old (n = 25)	147 d old (n = 25)
Fat [%]	0.6[c]	1.7[a]	1.1[b]	0.6[c]	1.7[a]
	0.1	0.1	0.1	0.1	0.1
Protein [%]	25.4[a]	24.4[b]	25.2[a]	25.4[a]	24.7[b]
	0.1	0.1	0.1	0.1	0.1
Ash [%]	1.2	1.3	1.2	1.2	1.3
	0.1	0.1	0.1	0.1	0.1
Dry mass [%]	26.3	26.4	26.5	26.4	26.6
	0.1	0.1	0.1	0.1	0.1

[abc]LSM with different letters in a line differ significantly (P<0.05).

TABLE 5: *Correlation between the carcass and breast weights and the breast meat nutrient values either in all broiler cockerels, or depending on the age of the investigated birds.*

	All broiler cockerels		28 d old broiler cockerels		41 d old broiler cockerels	
	Carcass weights	Breast weights	Carcass weights	Breast weights	Carcass weights	Breast weights
Fat [%]	0.47*	0.51*	0.00	0.28	–0.05	0.05
Protein [%]	–0.28*	–0.32*	–0.39*	–0.59*	–0.10	–0.22
Ash [%]	–0.60*	–0.62*	–0.19	–0.30*	0.07	–0.02
Dry mass [%]	–0.07	–0.07	–0.34*	–0.44*	–0.16	–0.12

*Correlation coefficients are significant (P<0.05).

TABLE 6: *Correlation between the carcass and breast weights and the breast meat nutrient values either in all turkey toms, or depending on the age of the investigated birds.*

	All turkey toms		112 d old turkey toms		147 d old turkey toms	
	Carcass weights	Breast weights	Carcass weights	Breast weights	Carcass weights	Breast weights
Fat [%]	0.83*	0.83*	0.34*	0.49*	0.35*	0.38*
Protein [%]	–0.70*	–0.74*	–0.03	–0.19	–0.54*	–0.60*
Ash [%]	0.20*	0.19	–0.03	–0.16	–0.22	–0.10
Dry mass [%]	0.09	0.08	0.04	0.09	–0.28*	–0.28*

*Correlation coefficients are significant (P<0.05).

Discussion

In the present study the influence of genetic line, gender and age of broiler and turkeys on the carcass characteristics as well as the concentrations of fat, protein and ash and the dry mass of the breast meat were investigated. Comparing the presented carcass characteristic data and the nutrient values with already published results is difficult, because factors like genetic line, age, diet, husbandry, slaughter age or preparation of the breasts and legs before weighing differ.

Carcass characteristics presented by Aviagen (2008) and Cobb-Vantress (2008) are within the range of the carcass, breast and leg weights presented in this study. Commercial fast-growing broiler and turkey lines are specially bred for higher amounts of breast and thigh meat (Le Bihan-Duval et al. 2003; Sandercock et al. 2009). Very interesting is the increasing breast yield and the simultaneous decrease of the leg yield with the ageing of the broiler and turkeys, as the breast muscle is the most valuable part of the carcass.

The presented nutrient values are within the range of other studies, that investigated broiler (Qiao et al. 2002; Wattanachant et al. 2004; Fanatico et al. 2005; Castellini et al. 2006; Intarapichet et al. 2008; Jaturasitha et al. 2008, Baeza et al. 2010) or turkeys (Fernandez et al. 2001; Werner et al. 2008; Laudadio et al. 2009). In some of these publications (Fanatico et al. 2005; Zhao et al. 2009) the nutrient values were related to the dry mass of the breast meat and had to be recalculated. Wattanachant et al. (2004) described an effect of the genetic line on the fat, ash and protein content. Castellini et al. (2006) and Jaturasitha et al. (2008) found that the broiler line affects the fat but not the protein content, whereas Intarapichet et al (2008) and Baeza et al. (2010) presented an effect of the genetic line on the ash, protein and fat content. In the publication by Fanatico et al. (2005) no effects of the genetic lines on the nutrient values were found. In turkeys, Fernandez et al. (2001) showed no effects of the genetic line on the fat and ash, but a slight influence on the protein content of the breast meat. In the study by Werner et al. (2008) the genetic line – considering only the fast growing turkey toms – influenced the fat values. The higher fat values in the turkey hens are not related to the weight differences between the hens and toms, since the correlation analysis showed a positive correlation between the weights and fat content. The gender specific differences in turkeys are indirectly supported by Sarica et al. (2009) who found higher abdominal fat percentages in female turkeys. With regard to the broiler the presented results are supported by Baeza et al. (2010). The authors also found no differences of the nutrient values between broiler hens and cockerels. In a study by Ristic et al. (2008) the authors found higher breast meat fat contents in older turkey hens, whereas Rivera-Torres et al. (2011) presented increasing fat and decreasing protein contents of defeathered turkey bodies with increasing age of the birds. These results support the presented results either with regard to the age dependent differences of the turkeys and broiler and the correlation analysis between the carcass and breast weights and the fat content – especially in the turkeys.

In conclusion, the present study shows that the nutrient values of breast meat are influenced by the genetic line, gender and age as well as the slaughter weight of the birds, with species dependent differences. The results indicate that sorting of the poultry meat with regard to the age, genetic line (in broiler), gender and slaughter weight (in turkeys) is useful to minimize variation of the fat and protein contents of the meat pieces before packaging. This might reduce incorrect declaration of the nutrient values on the packages and complaints by the consumers and the responsible authorities.

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Correspondence Address:
Dr. Carsten Krischek
Institute of Food Quality and Safety,
Centre of Food Sciences, Foundation University of Veterinary Medicine,
Bischofsholer Damm 15,
30173 Hannover, Germany
carsten.krischek@tiho-hannover.de