Influences of pre-slaughter simulated transportation

Investigations on quality parameters of chicken breast, drumstick and thigh meats

By Ali Samet Babaoğlu, Ramazan Yetişir, Kubra Unal, Mustafa Karakaya and Bedri Bora Ertem

Poultry meat quality is generally affected by pre-slaughter stress factors. One of the important stressor is transportation. The present study aims to determine the effects of simulated transportation on quality of chicken meats. Five levels of transportation distance (0, 80, 160, 240 and 320 km) were applied to the male broilers at slaughtering age on the simulation case. For the 80, 160, 240 and 320 km transportation distance, the simulation case was operated for 5, 10, 15 and 20 minutes, respectively. After the simulation treatments were applied, the broilers were slaughtered and breast, drumstick and thigh meats of each broiler were separated. pH, WHC and textural properties (MORSF and MORSE) of breast (B), drumstick (D) and thigh (T) meats were determined. The simulated transportation increased the pH values and decreased water holding capacity of samples. The tenderness of meats was significantly reduced due to transportation. The long-distance transported samples (240 and 320 km) had the highest MORSE and MORSF values. It was determined that transportation distance of 240 km and over deteriorates the meat quality.

KEYWORDS

›› Breast meat
›› Drumstick meat
›› Simulated transport
›› Tenderness
›› Thigh meat

Poultry meat quality is affected by preslaughter conditions which are heat stress, shackling, struggle, crating, transportation and feed withdrawal (Ali et al., 2008). Transportation is one of major stressor and deteriorates meat quality due to altering metabolism and psychological state of broilers (Owens and Sams, 2000; Pérez et al., 2002). During transportation, the birds interact with environmental stresses such as thermal conditions, humidity, motion, noise, vibration and social disruption (Nicol and Scott, 1990; Tarrant and Grandin, 2000). Each of these factors and/or their various combinations influence negatively transformation of muscle to meat and the resultant meat quality parameters including pH, color, texture, protein functionality (Schwartzkopf-Genswein et al., 2012).

Researchers have reported that transportation is stressful to broiler and also reduces broiler meat quality (Cashman et al., 1989; Duncan, 1989; Whiting et al., 2007; Chauvin et al., 2010). Several studies have been conducted about the effects of transportation time and distance on animal welfare and meat quality of broilers (Warriss et al., 1990; Nijdam et al., 2004; Vecerek et al., 2006; Lengkey et al., 2013). It was reported that 2 h transportation reduced the meat tenderness and water holding capacity of broilers while 4 h transportation improved these quality parameters (Ehinger, 1977). Owens and Sams (2000) found that higher pH values of samples which are transported turkeys compared to be slaughtered without transportation. It was determined that 2 h transportation caused higher pH values of thigh meat of birds. However, quality of breast meats did not affected transportation (Debut et al., 2003). Bonou et al. (2017) studied about effects of transportation and capture chase pre-slaughter stress on meat quality of Benin chicken. They found that drip loss and cooking loss of samples did not affected the pre-slaughter stress but pH values of transported chickens' breast and thigh meats were higher compared to control (without pre-slaughter stress) samples.

The aim of this study was to evaluate the effects of simulated pre-slaughter transportation on the meat quality of six weeks old male broilers. pH values, water holding capacity (WHC) and textural properties of breast, drumstick and thigh meat samples were determined.

Materials and methods

Material

An amount of 50 male Ross 308 broilers were reared together until six weeks old. Completely Randomized Design was used for this study. Randomly selected broilers were slaughtered after pre-slaughter transportation. Breast, drumstick and thigh meats obtained from each broiler carcass were used as experimental material.

Simulation of transportation

"The Vibration Simulation Case" had been designed and constructed during a post university study (Aydin, 1993). It was reconstructed and renewed for this study. The simulation case (585 cycle/min; f = 9.75 H2 frequency, ϑ = 0.2 g acceleration, S = 5 cm amplitude value) is able to simulate the inter-city road conditions. For the 80, 160, 240 and 320 km

Experimental design

Tab. 1: Experimental design of the study
Tab. 1: Experimentelles Design der Studie

Simulation time and equivalence in transportation distance	Sample codes
0 min: 0 km (control)	S0 (control)
5 min: 80 km	S5
10 min: 160 km	S10
15 min: 240 km	S15
20 min: 360 km	S20

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transportation distance, the simulation case was operated for 5, 10, 15 and 20 minutes, respectively.

Experimental design

In this study, five levels of transportation distance (0, 80, 160, 240 and 320 km) were applied to the male broilers at slaughtering age on the simulation case. For each treatment, two transport cages (each having five broilers) were used. After the simulation treatments were applied, the broilers were slaughtered and breast (B), drumstick (D) and thigh (T) meats of each broiler were separated. Experimental analyzes were made on these meats. The experimental design of the study is shown in Table 1.

Determination of pH

The pH values of the samples were measured with a pH meter (WTW 315 i set model, Weilheim, Germany) according to AOAC (2000).

Determination of water holding capacity

Water holding capacities (WHC) of samples were determined the method reported by Wardlaw et al. (1973). Each 8 g sample was weighed in a tube and 12 ml 0.6 M NaCl solution were put into a tube and shaked. The tubes were placed into a water bath at 50 °C for 15 min, and were centrifuged at 10,000 rpm and 4 °C for 15 min. The supernatant was obtained to determine the WHC (%) of the samples.

Texture measurements

For textural analyzes, the samples were cooked in a convection oven at 150 °C for 30 min until an internal temperature of 76 °C was reached (Saha et al., 2009). The temperature was measured using a thermometer (Digitale Bratengabel-TCM). The samples were cooled down to room temperature before textural analysis. The texture analysis was conducted using a TA-HD Plus texture analyser (UK) equipped with a Meullenet–Owens razor shear and a 50 kg load cell. Meullenet–Owens Razor blade shear force (MORSF) and Meullenet–Owens Razor blade shear energy (MORSE) were measured. A certain number of readings were made from specific regions of the pieces (B, D and T) using the software program of the texture measuring device (Cavitt et al., 2004). The texture analysis was performed on samples with a height of at least 16 mm according to the MORS blade locations. The MORS blade locations were different for breast, drumstick and thigh meats and it was determined according to Kadioğlu et al. (2019).

Statistical analysis

A completely randomized design was employed (two replicates). All data were analyzed by Minitab for Windows Release 16. When differences were determined to be significant ($p<0.05$) among treatments (transportation distance, meat types and their interaction), a Tukey Test was applied for comparisons.

Effects on physico-chemical data

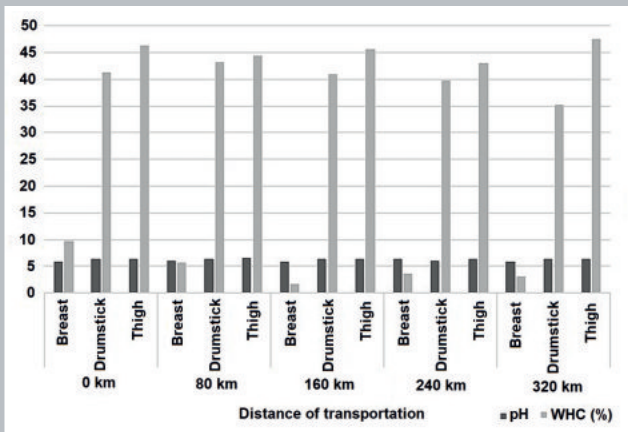
Tab. 2: Effects of simulated transportation on mean pH and water holding capacity (WHC) values of meat types
Tab.2: Auswirkungen des simulierten Transports auf den mittleren pH-Wert und die Wasserspeicherkapazität (WHC-Werte) von Fleischsorten

Treatments	pH	WHC (%)
Simulated Transportation (A)		
S0 (control)	6.20± 0.05^{b}	32.35± 3.17^{a}
S5	6.29± 0.05^{a}	31.13± 3.43^{ab}
S10	6.24± 0.05^{ab}	29.43± 3.69^{ab}
S15	6.22± 0.04^{ab}	28.77± 3.44^{b}
S20	6.22± 0.06^{ab}	28.58± 3.61^{b}
Significance	*	**
Meat type (B)		
B	5.91± 0.02^{c}	4.79± 0.51^{c}
D	6.36± 0.02^{b}	40.02± 0.88^{b}
T	6.43± 0.02^{a}	45.35± 0.80^{a}
Significance	**	**
Interaction sigificance AxB		**

Means within a column with different letters are significantly different.
**($p<0.01$), *($p<0.05$)
S0: 0 dk (0 km, control), S5: 5 dk (80 km), S10: 10 dk (160 km), S15: 15 dk (240 km), S20: 20 dk (320 km)
B: breast, D: drumstick, T: thigh

Source: Babaoglu FLEISCHWIRTSCHAFT 11_2020

pH and WHC



Source: Babaoğlu et al. FLEISCHWIRTSCHAFT 11_2020

Fig. 1: The effects of interaction of simulated transportation and meat types on pH and WHC
Abb. 1: Die Auswirkungen der Wechselwirkung von simulierten Transport- und Fleischarten auf pH und WRG

Results and discussion

pH values

Mean pH and WHC values of samples are given in Table 2. The simulated transportation significantly ($p<0.01$) affected the pH values of chicken meats. The pH values of samples were higher than non-transported chicken meats. The group of S0 (control) had the lowest pH values (mean pH 6.20). While 80 km (S5) simulated transportation had the highest ($p<0.05$) mean pH values (6.29), the groups of S10, S15 and S20 had lower pH values than S5. It is reported that pre-slaughter stress factors (chasing, struggle, transportation etc.) cause the depletion of glycogen content of muscle which affects ultimate pH of meat (Lawrie, 1998). In the present study, simulated transportation (especially 80 km transportation) led to a decrease in the glycogen amount in the muscle at slaughter time and it was resulted in higher pH values of chicken meats. Similarly, Lengkey et al. (2013) and Bonou et al. (2017) reported that the pH of transported chicken meats were higher than non-transported samples. The meat types also significantly ($p<0.01$) affected the pH values of samples. Breast meat samples had lower pH values than drumstick (D) and thigh (T) meats. Thigh meats had the highest pH values. Present results are in agreement with those of Kadioğlu et al. (2019) who reported the chicken breast meat had lower pH value than drumstick and thigh meats. It was reported that pH values of chicken breast meat were lower than thigh meats (Karakaya et al., 2010; Ünal and Karakaya, 2015). Mean pH ($p>0.05$) and WHC ($p<0.01$) values of interaction of simulated transportation distance and meat types are given in Figure 1.

Effects on force and energy

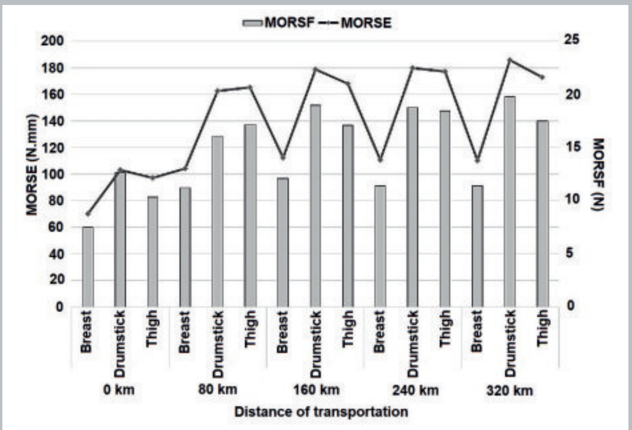
Tab. 3: Effects of simulated transportation on mean Razor Blade Shear Force (MORSF) and Razor Blade Shear Energy (MORSE) values of meat types
Tab.3: Auswirkungen des simulierten Transports auf die Werte der mittleren Rasierklingen-Scherkraft (MORSF) und der Rasierklingen-Scherenergie (MORSE) von Fleischsorten

Treatments	MORSF (N)	MORSE (N.mm)
Simulated transportation (A)		
S0 (control)	10.14± 0.64[c]	90.27± 4.85[b]
S5	14.81± 0.53[b]	144.09± 6.09[a]
S10	16.05± 0.61[ab]	152.97± 6.03[a]
S15	16.22± 0.67[a]	156.12± 6.77[a]
S20	16.24± 0.76[a]	156.24± 7.10[a]
Significance	**	**
Meat type (B)		
Breast	10.72± 0.35[c]	101.52± 3.20[b]
Drumstick	17.26± 0.47[a]	162.11± 5.29[a]
Thigh	16.10± 0.48[b]	156.17± 4.88[a]
Significance	**	**
Interaction sigificance AxB	**	**

Means within a column with different letters are significantly different.
**(p<0.01), *(p<0.05)
S0: 0 dk (0 km, control), S5: 5 dk (80 km), S10: 10 dk (160 km), S15: 15 dk (240 km), S20: 20 dk (320 km)
B: breast, D: drumstick, T: thigh

Source: Babaoglu FLEISCHWIRTSCHAFT 11_2020

MORSF and MORSE



Source: Babaoğlu et al. FLEISCHWIRTSCHAFT 11_2020

Fig. 2: The effects of interaction of simulated transportation and meat types on MORSF and MORSE values
Abb. 2: Die Auswirkungen der Interaktion von simulierten Transport- und Fleischarten auf die MORSF- und MORSE-Werte

Water holding capacity
Table 2 indicates that simulated transportation and meat types significantly (p<0.01) affected the water holding capacity (WHC) of samples. The WHC of chicken meats decreased with increasing transportation distance. Non-transported samples had the highest WHC, whereas the groups of S15 and S20 had the lowest WHC. Similarly, Ehinger (1977) found that the WHC of broiler meat decreased after 2 h transportation but the WHC of 4 h transported samples increased. On the contrary, it was reported that 100 miles transported turkeys had higher WHC (Ngoka et al., 1982). Mean WHC of breast, drumstick and thigh were determined as 4.79%, 40.02% and 45.35%, respectively. This differences in WHC of meat types were statistically significant (p<0.01). Breast meat had the lowest WHC due to its relatively low pH value. Similarly, Kadioğlu et al. (2019) reported that chicken breast meat had lower WHC than chicken drumstick and thigh meats. Figure 1 shows that the groups of S10xB (160 km transported breast meat), S20xD (320 km transported drumstick meat) and S15xT (240 km transported drumstick meat) had the lowest WHC.

Textural properties of samples
Meat tenderness is very important for consumers and it is affected several factors. One of the factors is transportation which deteriorates the texture of meat (Hong and Lee, 2012). Average Meullenet–Owens Razor blade shear force (MORSF) and Meullenet–Owens Razor blade shear energy (MORSE) values of cooked chicken breast, drumstick and thigh meats are given in Table 3. It was observed that mean MORSF values of samples increased when the simulated transportation distance (or transportation duration) was longer. Non-transported (S0) samples (10.14 N) were tenderer than transported chicken meats. The groups of S15 and S20 had the highest MORSF values and the difference between MORSF values of S15 (16.22 N) and S20 (16.24 N) groups of were not statistically significant. Lengkey et al. (2013) investigated the effects of transportation duration (0, 1, 2, 3 and 4 hours) on pH and tenderness of broiler meat. Researchers found that broiler meat tenderness was decreased when the transportation duration was increased. Other researchers reported that transportation at pre-slaughter decreased the meat tenderness (Leheska et al., 2002; Kannan et al., 2003; Shen et al., 2006; Nikbin et al., 2016). It is obvious that the results of this study show similarities with that of mentioned studies above. Differences between MORSF and MORSE values of meat types were significant (p<0.01). It was determined that breast meats were the tenderest samples whereas drumstick meats were the toughest ones. Present results are in agreement with those of (Kadioğlu et al., 2019). Figure 2 indicates MORSF and MORSE values of interaction of simulated transportation distance and meat types. While the group of S0xB had the lowest MORSF (7.49 N) and MORSE (70.39 N.mm) values (tenderest sample), the group of S20xD had the highest MORSF value (19.81 N).

Conclusion

The present study reveals that some meat quality parameters are negatively affected the pre-slaughter transportation. Simulated transportation increased the pH values and decreased water holding capacity of meats. Tenderness of meats was significantly reduced due to transportation, especially 240 and 320 km transportation led to toughest chicken meats. The quality characteristics of the meat types used in the study were different. Chicken breasts had the lowest pH and WHC values than other meat types. Drumstick meats were tougher than other ones.

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Zusammenfassung

Einflüsse von vor der Schlachtung simulierten Transporten – Untersuchungen zu Qualitätsparametern von Hähnchenbrust-, Hühnerkeulen- und Schenkelfleisch

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Brustfleisch | Hühnerkeule | Simulierter Transport | Zartheit | Schenkelfleisch

Die Qualität von Geflügelfleisch wird im Allgemeinen durch Stressfaktoren vor der Schlachtung beeinflusst. Einer der wichtigsten Stressfaktoren ist der Transport. Die vorliegende Studie zielt darauf ab, die Auswirkungen eines simulierten Transports auf die Qualität von Hühnerfleisch zu bestimmen. Im Simulationsfall wurden fünf Stufen der Transportentfernung (0, 80, 160, 240 und 320 km) auf die männlichen Masthähnchen im Schlachtalter angewandt. Für die Transportdistanz von 80, 160, 240 und 320 km wurde der Simulationsfall 5, 10, 15 bzw. 20 Minuten lang betrieben. Nach Anwendung der Simulationsbehandlungen wurden die Masthähnchen geschlachtet und das Fleisch von Brust, Keule und Oberschenkel von jedem Masthähnchen getrennt. pH, WHC und texturale Eigenschaften (MORSF und MORSE) von Brust- (B), Keule (D) und Oberschenkelfleisch (T) wurden bestimmt. Der simulierte Transport erhöhte die pH-Werte und verringerte das Wasserhaltevermögen der Proben. Die Zartheit des Fleisches wurde durch den Transport signifikant reduziert. Die über weite Entfernungen transportierten Proben (240 und 320 km) wiesen die höchsten MORSE- und MORSF-Werte auf. Es wurde festgestellt, dass Transportentfernungen von 240 km und mehr die Fleischqualität verschlechtern.

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