Effect of Vit E, potassium, and alcohol-fermented feed supplementation before transport on body weight, carcass characteristics, and meat color of Hanwoo Steers

Efecto de la suplementación con Vitamina E, potasio y alimentación fermentada con alcohol antes del transporte en el peso corporal, características de la canal y color de la carne de novillos Hanwoo

Efeito da suplementação com Vitamina E, potássio e ração fermentada a álcool antes do transporte em relação ao peso corporal, às características da carcaça e à cor da carne dos Bovinos Hanwoo

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Abstract

Background: During transport of cattle, not only does weight loss occur due to transport stress, but meat quality also deteriorates due to changes in meat color. Hence, stress generated during transportation causes economic loss for livestock farms. **Objective:** To investigate the effect of vitamin E, potassium, and alcohol-fermented feed supplementation before transport on body weight, carcass characteristics, and meat color of Hanwoo steers. **Methods:** Forty steers were divided into four treatment groups, with 10 cattle per treatment in two pens. (1) Vitamin E was fed at 500 IU/head/day. (2) An alcohol-fermented feed was fed at 1.58 kg/head/day for six months prior to transport. (3) Potassium at 1.45% of daily feed amount was fed orally one day before transport and (4) the control group. Transportation loss, carcass characteristics, and surface meat color were measured and data were analyzed by GLM (Generalized Linear Model) and Duncan's Multiple Range test using SAS (V.8.01; 2000) package. **Results:** Weight loss due to transport stress was lower in the treatment groups than in the control, especially with potassium treatment. Meat color, redness, clarity, and hue angle were significantly improved (add the p-value) in treatments compared to the control but fat color, marbling score, back fat thickness, carcass percentage, and meat production index were not different among treatments. **Conclusion:** Supplementation of alcohol-fermented feed, potassium, and vitamin E before transportation improves productivity by preventing loss in body weight and deterioration of the meat color due to transportation stress.

Keywords: *alcohol-fermented feed; carcass grade; Hanwoo steers; meat characteristics; meat quality; transportation stress; potassium; productivity; weight loss; vitamin E.*

Resumen

Antecedentes: Durante el transporte de ganado, no solo se produce pérdida de peso debido al estrés del transporte, sino que la calidad de la carne también se deteriora debido a cambios en el color de la carne. Por lo tanto, el estrés generado durante el transporte ocasiona pérdidas económicas para las explotaciones ganaderas. **Objetivo:** Investigar el efecto de la suplementación con vitamina E, potasio y alimentación fermentada con alcohol antes del transporte en el peso corporal, las características de la canal y el color de la carne de novillos Hanwoo. **Métodos:** Cuarenta novillos fueron divididos en cuatro grupos de tratamiento, con 10 cabezas de ganado por tratamiento en dos corrales. La vitamina E se administró a razón de 500 UI/cabeza/día. Se suministró una alimentación fermentada con alcohol a razón de 1,58 kg/cabeza/día durante seis meses antes del envío, y el potasio se administró por vía oral al 1,45% de la cantidad diaria de alimento un día antes del envío. Se midieron las pérdidas durante el transporte, las características de la canal y el color superficial de la carne, y los datos se analizaron mediante un Modelo Lineal Generalizado (GLM) y la prueba de Rango Múltiple de Duncan utilizando el paquete estadístico SAS (V.8.01; 2000). **Resultados:** La pérdida de peso debido al estrés del transporte fue menor en los grupos de tratamiento que en el grupo control, sobre todo con el tratamiento de potasio. El color de la carne, la rojez, la claridad y el ángulo de tonalidad fueron significativamente mejores en los tratamientos en comparación con el grupo de control, pero el color de la grasa, la calificación de marmoleo, el grosor de la grasa dorsal, el porcentaje de canal y el índice de producción de carne no mostraron diferencias entre los tratamientos. **Conclusión:** La suplementación con alimento fermentado con alcohol, potasio y vitamina E antes del transporte mejora la productividad al prevenir la pérdida de peso corporal y el deterioro del color de la carne debidos al estrés del transporte.

Palabras clave: *alimento fermentado con alcohol; grado de la canal; novillos Hanwoo; características de la carne; calidad de la carne; estrés de transporte; potasio; productividad; pérdida de peso; vitamina E.*

Resumo

Antecedentes: Durante o transporte de gado, não somente ocorre perda de peso devido ao estresse do transporte, mas a qualidade da carne também se deteriora devido a mudanças na cor da carne. Por isso, o estresse gerado durante o transporte causa perdas econômicas para as fazendas pecuárias. **Objetivo:** Investigar o efeito da suplementação com vitamina E, potássio e ração fermentada a álcool antes do transporte em relação ao peso corporal, às características da carcaça e à cor da carne de bovinos Hanwoo. **Métodos:** Quarenta bovinos foram divididos em quatro grupos de tratamento, com 10 bovinos por tratamento em dois currais. A vitamina E foi fornecida a 500 UI/cabeça/dia. Uma ração fermentada a álcool foi fornecida a 1,58 kg/cabeça/dia durante seis meses antes do embarque, e o potássio a 1,45% da quantidade diária de ração foi fornecido por via oral um dia antes do embarque. A perda durante o transporte, as características da carcaça e a cor da superfície da carne foram medidas, e os dados foram analisados pelo GLM (Modelo Linear Generalizado) e pelo teste de intervalo múltiplo de Duncan usando o pacote SAS (V.8.01; 2000). **Resultados:** A perda de peso devido ao estresse do transporte foi menor nos grupos de tratamento do que no controle, especialmente com o tratamento com potássio. A cor da carne, o rubor, a claridade e o ângulo de matiz melhoraram significativamente nos tratamentos em comparação com o controle, mas a cor da gordura, o índice de marmorização, a espessura da gordura dorsal, a porcentagem de carcaça e o índice de produção de carne não foram diferentes entre os tratamentos. **Conclusão:** A suplementação de ração fermentada a álcool, potássio e vitamina E antes do transporte melhora a produtividade ao prevenir a perda de peso corporal e a deterioração da cor da carne devido ao estresse do transporte.

Palavras-chave: *ração fermentada a álcool; grau da carcaça; bovinos Hanwoo; características da carne; qualidade da carne; estresse no transporte; potássio; produtividade; perda de peso; vitamina E.*

Introduction

During transport of cattle, not only does weight loss occur due to transport stress (Deng *et al*., 2017), but meat quality also deteriorates due to changes in meat color (Lister *et al*.,1989; Sun *et al*., 2017). Hence, stress generated during transportation causes economic loss for livestock farms (He *et al*., 2010).

A recent study on transport loss have shown that the average transport loss is about 3–10% of body weight, and young cattle have a greater transport loss compared to older cattle or those with high body fat accumulation (González *et al*., 2012). Various factors such as breed, season, climatic conditions (González *et al*., 2012; Schaefer *et al*., 1997), age, weight, transport density, transport distance (Jacobsen *et al*., 1993), transport speed (Warriss *et al*., 1990; Phillips *et al*., 1981), and pre-transport feed affect the transport loss (Schaefer *et al*., 1997). In addition, transport stress has been reported to affect meat pH, color, texture, and water content, resulting in dark meat and deteriorating meat quality (Lister *et al*., 1989; Price *et al*., 1981). It has been reported that minimizing stress in pre-slaughter operations, including transport and handling, is a way to minimize transport loss (Haurez *et al*., 1986).

The autonomic nervous system of livestock is activated when faced with stress such as transportation, causing cations such as sodium and potassium to increase and anions such as chloride to decrease. It is known that the resulting excitement of the nervous system and imbalance in the concentration of ions in the body cause stress in the body (Schaefer et al., 1990). To prevent this, a previous study reported that the transport loss of Holstein steers administered alcohol was reduced by approximately 9 kg (Choi *et al*., 2002), and many studies reported the effect of administering cations such as potassium on reducing transport weight loss. (Schaefer *et al*., 1990; Haurez *et al*., 1968; Tarrant *et al*, 1988; Warner *et al*., 1989). Vitamin E (as an antioxidant) is known to prevent changes in meat color. Schaefer *et al*. (1997) found that when vitamin E was fed before the end of fattening, it was possible to prevent economic loss caused by changes in meat color. In a study of Holstein beef cattle, 91% of consumer preferences for meat color and fat distribution were in the vitamin E-fed group (Sanders et al. 1997). Because transport stress is not only a weight loss factor but is also a cause of deterioration in meat color and meat quality, it is necessary to take appropriate steps before transportation to prevent meat quality deterioration. So far, studies have been conducted to reduce transport stress by feeding various substances such as electrolytes (Schaefer *et al*., 1990; Schaefer *et al*., 1997; Haurez *et al*., 1968; Tarrant *et al*, 1988; Warner *et al*., 1989) and vitamin E (Sanders *et al*. 1997) before transport.

Therefore, the purpose of this study was to investigate the effect of vitamin E, potassium, and alcohol-fermented feed supplementation before transport on body weight, carcass characteristics, and meat color of Hanwoo steers.

Materials and methods

Ethical considerations

All procedures on animals were carried out in compliance with the South Korea regulations (Animal and Plant Quarantine Agency · Ministry of Food and Drug Safety Joint Animal Testing and/or Laboratory Animal Related Committee (IACUC; 2020) Standard Operating Guidelines).

Location of the experiment

This experiment was conducted in Hanwoo Farm, Hongcheon-gun, Gangwon-do, Korea (37°40'45''N, 127°55'56''E, 159 masl).

Animals, management and treatments

This study was conducted using forty Hanwoo steers (average body weight: 572.2kg) six months before transport were randomly assigned to one of four dietary treatment: no treatment (Control), alcohol-fermented feed treatment (T1), potassium treatment (T2), and vitamin E treatment (T3). The alcohol-fermented feed was fed at 1.58 kg/head/day, vitamin E was fed at 500 IU/head/day for six months prior to transport, and potassium was dissolved orally in 1.45% of the daily feed amount, and administered orally one day before transportation. Alcohol-fermented feed used in this study was prepared by mixing corn grit and brewers grain in a 50:50 ratio and molasses and yeast was added before fermentation for 48 hours at about 30 °C under anaerobic conditions (Table 1).

Table 1. Chemical composition of the experimental diets.

Ingredients	**Commercial feed**	**Fermented diet**	**Rice straw**
Dry matter (%)	96.33±0.09	66.09±0.59	89.56±0.30
Crude protein (% of dry matter)	12.39±0.37	11.69±0.44	5.66±0.16
Ether extract (% of dry matter)	4.05±0.33	6.81±0.11	4.51±0.21
Crude ash (% of dry matter)	6.89±0.01	3.80±0.11	8.44±0.03
NDF (% of dry matter)	30.71±0.24	17.79±0.08	53.36±0.37
ADF (% of dry matter)	10.77±0.74	3.98±0.20	29.78±1.90

NDF: Neutral detergent fiber. ADF: Acid detergent fiber.

Transportation loss

The transport of the experimental animals was by truck with a capacity of 8,000 kg, with an average transport density of 5 cattle per vehicle. Duration of transportation is approximately 2 hours, and transportation loss was calculated from the weight at the time of transport (weight before transportation) and the weight upon arrival at the slaughterhouse after transport (weight after transportation).

Carcass characteristics

Feed was withdrawn from animals at the farm 24 hours before slaughter and cattle continued to receive water. For the evaluation of refrigeration for 24 hours after slaughter, items such as carcass ratio, meat quantity index, back fat thickness, rib-eye area, marbling score, meat color, fat color, and meat quality grade were evaluated based on the national carcass grading standards (MAFRA, 2018).

Surface meat color

Color measurement was performed using a color difference meter (CR-310, Minolta Co., Japan), where CIE L* (lightness), a* (redness), b* (yellowness), and chroma value were measured. Chromaticity values of the standard white plate were Y = 93.7, x = 0.3129, and y = 0.3194. As the spectrophotometer was equipped with a reflectance attachment (UV-2410PC, Shimadzu, Japan), the reflectance of 630 nm and 580 nm was measured to calculate the value of R_{630}-R_{580} (Strange *et al*., 1974).

Statistical analysis

Generalized linear models were used for statistical inferences. After the linear model fitting, Duncan's Multiple Range test was applied to determine the statistical significance of the difference between the variables. SPSS v.8.01 package program (2000) was used for statistical analysis. For weight, carcass characteristics and meat color, the following statistical model was adopted:

$$Y_{ijk} = \mu + T_i + C_{ij} + e_{ijk}$$

in which Y_{ijk} is the dependent variable, μ is the general average, T_i is the effect of diets, C_{ij} is the effect of the covariate, and e_{ijk} is the experimental error.

Results

Transportation loss

The pre-transport body weight of the control, alcohol-fermented feed, potassium, and vitamin E treatments were 652.0, 688.9, 677.5, and 745.7 kg, respectively (Table 2). The pre-transport body weight was higher in the treatment groups than the control group. The weight after arrival at the slaughter house was also higher in the treatments than in the control

(control, alcohol-fermented feed, potassium and vitamin E; 626.0, 670.0, 660.0, and 725.0 kg, respectively).

The transport loss of the control, alcohol-fermented feed, potassium, and vitamin E treatments was 26.0, 18.9, 17.5, and 20.7 kg, respectively, indicating that the transport loss was lower in the treatments than in the control ($p < 0.05$). In addition, the transport loss of the test groups was shown in the following order: control group > vitamin E group > alcohol-fermented feed group > potassium group. Compared to the control and vitamin E, alcohol-fermented feed and potassium were found to be significantly effective in controlling transport loss. Transport loss occurred in both the control and treatment groups in this experiment, but transport loss was significantly reduced in the treatment groups compared to the control group.

Table 2. Effect of the alcohol-fermented diet, potassium and vitamin E shrinkage in Hanwoo steers.

Items	**Control**	**T1[1]**	**T2[2]**	**T3[3]**
SW[4] (kg)	652.0±66.76[b]	688.9±31.89[a]	677.5±18.87[a]	745.7±28.33[a]
LW[5] (kg)	626.0±67.08[b]	670.0±28.28[a]	660.0±18.71[a]	725.0±35.00[a]
Shrinkage (kg)	26.0±4.06[a]	18.9±4.15[b]	17.5±1.12[b]	20.7±8.67[b]

[1]T1: group fed alcohol-fermented feed; [2]T2: fed potassium before transportation; [3]T3: fed vitamin E before transportation; [4]SW: farm shipping weight; [5]LW: slaughterhouse live weight.
[a, b] Means in same row with different superscripts differ ($p < 0.05$).

Carcass characteristics

The meat color of the control, alcohol-fermented feed, potassium, and vitamin E treatments was 5.50, 5.00, 5.25 and 4.25, respectively (Table 3), and the results were lower in the treatments, except the potassium treatment ($p < 0.05$). Among treatments, meat color in the vitamin E treatment was significantly lower ($p < 0.05$) than in the alcohol-fermented feed and potassium treatments.

In the case of fat color, there was no difference ($p > 0.05$) between treatments. In the case of marbling score, compared to the control group, the alcohol-fermented feed, potassium and vitamin E groups showed a higher tendency, but statistical significance was not recognized ($p > 0.05$).

Among the factors determining the quantity of meat, there was no difference ($p > 0.05$) among treatments in the case of back fat thickness, carcass percentage, and meat production index, but in the case of the rib-eye area, there was an increased result in the treatment groups compared to the control ($p < 0.05$). On the other hand, meat color was improved in each treatment group (alcohol-fermented feed, potassium, and vitamin E treatment) compared to the control, and the vitamin E treatment improved meat color compared to the alcohol-fermented feed and potassium treatments.

Therefore, if Hanwoo steers are fed alcohol-fermented feed, potassium, and vitamin E for a certain period of time before transportation or at a specific point in time, it is thought that the stress generated during transportation can be suppressed to improve meat color and marbling score. In particular, if vitamin E is supplied for a certain period of time before shipping, it is thought that the deterioration of meat color due to transportation stress can be effectively controlled.

Table 3. Effects of fermented diet, potassium and vitamin E on carcass characteristics in Hanwoo steers.

Items	Treatment			
	Control	**T1**	**T2**	**T3**
Quality traits				
Meat color	5.50 ± 0.58^{a}	5.00 ± 0.00^{b}	5.25 ± 0.50^{ab}	4.25 ± 0.50^{c}
Fat color	3.00±0.00	3.00±0.00	3.00±0.00	3.00±0.00
Marbling score	3.25±1.26	4.50±1.29	4.50±1.29	3.55±1.89
Quality grade	2.00±0.82	2.00±0.82	1.50±0.58	2.50±1.00
Quantity traits				
Back fat thickness (mm)	10.00±4.08	6.50±1.73	7.75±0.50	8.75±3.50
Rib-eye area (cm^2)	81.25 ± 5.19^{b}	88.75 ± 2.36^{ab}	96.75 ± 7.41^{a}	92.25 ± 4.35^{a}
Carcass percent (%)	59.43±5.49	55.89±0.92	59.71±0.50	58.72±2.03

Meat yield index score	68.12±1.72	70.10±0.59	70.16±0.72	69.11±1.13

[1]T1: group fed alcohol-fermented feed; [2]T2: fed potassium before transportation; [3]T3: fed vitamin E before transportation;

[a, b, c] Means in same row with different superscripts differ ($p < 0.05$).

Meat surface color

Meat color reacts very sensitively to nutrient specifications and transportation stress (Table 4). The lightness (L*) of the meat in the control, alcohol-fermented feed, potassium, and vitamin E treatments was 34.93, 35.13, 38.15 and 37.64, respectively, and was higher in the potassium and vitamin E treatments than in the control ($p < 0.05$). Although statistical significance was not obtained, the alcohol-fermented feed treatment tended to produce brighter meat than the control.

Redness is known to be the most important factor in determining meat color, it was 20.48, 22.97, 23.63, and 25.66, in the control, alcohol-fermented feed, potassium, and vitamin E treatments, respectively, and the redness of the treatments (especially vitamin E) was higher than in the control ($p < 0.05$). In the case of clarity (chroma value), which is an indicator of red strength, the control, alcohol-fermented feed, potassium, and vitamin E treatments were 21.94, 24.69, 25.61, and 27.81, respectively, and the treatments were higher than the control ($p < 0.05$).

For hue angle, which is an indicator of the degree of brownness of meat, the control, alcohol-fermented feed, potassium, and vitamin E treatments were 22.63, 21.41, 22.67, and 20.98, respectively, and the color of the vitamin E treatment was significantly lower than the control ($p < 0.05$). Although statistical significance was not obtained, the color of the alcohol-fermented feed treatment also showed lower results than the control. Alcohol-fermented feed and vitamin E can therefore maintain the stability of meat color by suppressing the phenomenon where meat color becomes brown.

For yellowness, which affects the fat color of meat and is a factor that decreases meat quality, the control, alcohol-fermented feed, potassium, and vitamin E treatments were 10.73, 9.05, 9.89, and 7.86, respectively, and the yellowness of the treatments was lower than that of the control ($p < 0.05$). Within the treatment groups, the yellowness of the fermented and vitamin E treatments was lower than that of the potassium treatment ($p < 0.05$), such that fermented and vitamin E were effective in improving the yellowness of Hanwoo steers meat. Therefore, in this experiment, the brightness, redness, clarity, and yellowness of the treatments were superior to those of the control.

Table 4. Effect of the fermented diet, potassium and vitamin E on meat color in Hanwoo steers.

Items	**Control**	**T1**	**T2**	**T3**
Lightness	34.93±0.98[b]	35.13±1.90[b]	38.15±1.65[a]	37.64±1.43[a]
Redness	20.48±1.98[c]	22.97±0.54[bc]	23.63±2.20[ab]	25.66±1.15[a]
Chroma value	21.94±1.98[c]	24.69±0.66[b]	25.61±2.28[ab]	27.81±1.36[a]
Hue angle	22.63±0.91[a]	21.41±1.47[ab]	22.67±0.96[a]	20.98±0.89[b]
Yellowness	10.73±0.83[a]	9.05±0.74[b]	9.89±0.73[ab]	7.86±0.39[c]

[1]T1: group fed alcohol-fermented feed; [2]T2: fed potassium before transportation; [3]T3: fed vitamin E before transportation;

[a, b, c] Means in same row with different superscripts differ ($p < 0.05$).

Discussion

Transportation loss

In this experiment, some manifestations of stress on meat quality appeared to be ameliorated by the alcohol, potassium, and vitamin E treatments and balancing the electrolytes in the body. Alcohol-fermented feed and potassium supplementation for Hanwoo steers were found to suppress weight loss caused by transport stress, and vitamin E treatment was less than alcohol-fermented feed and potassium, but nonetheless effective in controlling weight loss in transport compared to the control group. In this study, body weight before transport was not consistent for each treatment group, However, in the study by Jacobsen *et al*. (1993), it was reported that the transport loss increased in proportion to the weight before transport, but in this study, the transport loss decreased in the treatment groups with higher weights compared to the control group with the lowest weight before transport. Potassium supplementation was the most effective in the reduction of the effects of transportation on beef cattle, and the alcohol-fermented feed also demonstrated a positive result. It is thought that potassium supplementation improves the buffering ability of livestock, maintains electrolyte balance, and prevents acidification of body tissues. Schaefer *et al*. (1997) reported that weight loss in beef cattle during long haul transportation was reduced approximately 7% by electrolyte supplementation, supporting the results of the current study. According to a study by Lee *et al*. (2013), long-term administration of alcohol has a sedative effect for stress reduction, and the effect lasts for several hours. In particular, the sedative effect increases depending on the level of alcohol administration, and in an experiment using Holstein steers, the weight loss during transport was reduced by approximately 9 kg in the alcohol administration group (Choi *et al*., 2002).

Therefore, potassium supplementation and alcohol-fermented feed for Hanwoo steers can reduce losses associated with transport, thereby reducing the economic loss for farmers due to the weight loss during the transportation process.

Carcass characteristics

Meat color does not reflect the nutrient, flavor or functional characteristics of meat, but it is an important quality factor that actually determines the consumer's preferences (Lee *et al*., 2001). Meat color was significantly lower in treatment groups compared to the control and that of the vitamin E supplemented group was highly improved. Liu *et al*. (1996) reported improved meat color due to vitamin E supplementation and a reduction in deterioration of meat quality. In a vitamin E feeding experiment with Hanwoo steers, various meat quality improvements, such as the preservation of meat surface color and suppression of lipid oxidation, were observed (Chu *et al*., 2004). Alcohol has also been reported to have an effect on preventing meat color deterioration. Han *et al*. (2014) reported that the supplementation of alcohol was effective in preventing deterioration of meat color (redness) during storage.

Baker (1988) reported that feeding electrolytes to beef cattle before transportation can improve the buffering capacity of electrolytes in the body, thereby reducing side effects caused by transport stress. Although not statistically different, the results of this experiment indicated a tendency to improve the color of the meat in the potassium-treated group compared to the control, and potassium was also considered to improve the color of meat indirectly by suppressing the transport stress of beef cattle.

As discussed above, alcohol-fermented feed, potassium, and vitamin E have been shown to numerically improve meat color of Hanwoo steers.

Surface meat color

Liu *et al*. (1996) reported improved brightness in meat due to the supplementation with vitamin E, and Schaefer *et al*. (1997) changed the color of meat due to stress by administration of electrolytes to beef cattle. In the current study, it was presumed that the brightness of meat from cattle in the treatment groups was improved compared to the control group by stress suppression (anti-oxidants and electrolytes) due to supplementation with alcohol-fermented feed, potassium, and vitamin E.

It has been reported that as the marbling score and fat content increase, the brightness of meat increases (Mitsumoto *et al*., 1993; Demos *et al*., 1996). It is thought that there is a cause for the intramuscular fat of the treatments being higher than the control.

The current study shows that the chroma value of the treatment groups was significantly higher than the control group. Sherbeck *et al*. (1995) reported that as a result of feeding vitamin E to beef cattle, the preference of consumers was increased because the clarity was maintained longer than that of the non-supplemented group. Matter *et al*. (1986) reported that meat coloration was stabilized due to a decrease in stress when feeding electrolytes to beef cattle.

However, it has been reported that supplementation with vitamin E, antioxidants, or electrolytes, including potassium, improves meat coloration and inhibits fatty acid oxidation (Monahan *et al*., 1989; Sherbeck *et al*., 1995; Marusich *et al*., 1975). When vitamin E is added to feed for beef cattle, the stability of redness and meat coloration is not only maintained, but yellowness is also lowered (Liu *et al*., 1996). Gatellier *et al*. (2001) also reported the effects of dietary vitamin E supplementation on color stability and lipid oxidation of beef, supporting the results of this study.

In conclusion, alcohol-fermented feed, potassium, and vitamin E supplementation are thought to have positive effects on transport loss and meat color. However, further studies with a larger number of experimental animals are needed to demonstrate the effects of various substances on stress in livestock.

Declarations

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Conflicts of interest

The authors declare they have no conflicts of interest regarding the work presented in this report.

Author contributions

This study was designed and directed by Jongsuh Shin and Byungki Park. Overall paper was written and edited by Gihwal Son. All co-authors were closely involved in the collection, analysis and interpretation of data as well as in the writing and decision to submit the work for publication.

Use of artificial intelligence (AI)

No AI or AI-assisted technologies were used during the preparation of this work.

References

Baker SK. Dark Cutting in Cattle and Sheep. Proceedings of an Australian Workshop; 1988 Perth, Australia.

Chu GM, Cho HW, Ahn BH. Effects of dietary vitamin C and E on lipid oxidation and stability of color in Hanwoo steer beef. J Anim Sci Technol 2004; 46(4): 635-344. https://doi.org/10.5187/jast.2004.46.4.635

Choi BY, Park BK, Shin JS. Effects of stress on productivity in beef cattle. Ann Anim Resour Sci 2002; 13(1):220-231.

Demos BP, Mandigo RW. Color of fresh, frozen and cooked ground beef patties manufactured with mechanically recovered neck bone lean. Meat Sci 1996; 42(4): 415-429. https://doi.org/10.1016/0309-1740(95)00046-1

Deng L, He C, Zhou Y, Xu L, Xiong H. Ground transport stress affects bacteria in the rumen of beef cattle: A real-time PCR analysis. Anim Sci J 2017; 88(5): 790-797. https://doi.org/10.1111/asj.12615

Gatellier P, Hamelin C, Durand Y, Renerre M. Effect of a dietary vitamin E supplementation on colour stability and lipid oxidation of air-and modified atmosphere-packaged beef. Meat Sci 2001; 59(2): 133-140. https://doi.org/10.1016/s0309-1740(01)00063-8

González LA, Schwartzkopf-Genswein KS, Bryan M, Silasi R, Brown F. Factors affecting body weight loss during commercial long haul transport of cattle in North America. J Anim Sci 2012; 90(10): 3630-3639. https://doi.org/10.2527/jas.2011-4786

Han C, Wang J, Li Y, Lu F, Cui Y. Antimicrobial-coated polypropylene films with polyvinyl alcohol in packaging of fresh beef. Meat Sci 2014; 96(2): 901-907. https://doi.org/10.1016/j.meatsci.2013.09.003

Haurez P, JM Chupin. Prevention of high pH meat: Some recommendations. Viandes et produits carnes 1986; 7:231-233.

He C, Zhang K, Deng L. 2010. The research report of TSSBC in henan province. Journal of Henan Agricultural Sciences 2010; 12: 131–132. https://doi.org/10.3969/j.issn.1004-3268.2010.12.036

Jacobsen T, Schaefer AL, Tong AKW, Stanley R, Jones SDM, Robertson WM, Dyck R. The effects of transportation on carcass yield, meat quality and hematology values in electrolyte treated cattle. Congress of Meat Science and Technology 1993. Aug, 1-6; Alberta, Canada.

Lee JS, Kim SG, Jung WY, Yang YH. Sleep and alcohol. Sleep Med Psychophysiol 2013; 20(2): 59-62. https://doi.org/10.14401/kasmed.2013.20.2.59

Lee SK, Kim YS, Kim JY, Liang CY, Yang BK. Effects of reducing ability on meat color stability and lipid oxidation of Hanwoo (Korean native cattle) beef. J Anim Sci Technol 2001; 43(3): 401-408.

Lister, D. Muscle metabolism and animal physiology in the dark cutting condition. In: Fabiansson SU, Shorthose WR, Warner RD, editors. Dark-cutting in Cattle and Sheep Proceedings of an Austalian Workshop. Sydney: Australian Meat and Livestock Research and Development Corporation press; 1989. p. 19-25.

Liu Q, Scheller KK, Arp SC, Schaefer DM, Williams SN. Titration of fresh meat color stability and malondialdehyde development with Holstein steers fed vitamin E-supplemented diets. J Anim Sci 1996; 74(1): 117-126. https://doi.org/10.2527/1996.741117x

Marusich WL, De Ritter E. Ogrinz EF, Keating J, Mitrovic M, Bunnell RH. Effect of supplemental vitamin E in control of rancidity in poultry meat. Poult Sci 1975; 54(3): 831-844. https://doi.org/10.3382/ps.0540831

Matter SK, Greene LW, Lunt DK, Schelling GT, Byers FM. Serum mineral concentrations in three breeds of cattle supplemented with different levels of magnesium oxide. In: Beef Cattle Research in Texas. 1986. p. 25-56.

Ministry of Agriculture, Food and Rural Affairs (MAFRA). 2018. Grade rule for cattle carcass in Korea. Korea Ministry of Government Legislation.

Mitsumoto M, Mitsuhashi T, Ozawa S, Yamashita Y, Cassens RG. Studies on measurement and improvement of beef quality. Bulletin of the Chugoku National Agricultural Experiment Station, 1993; Japan.

Monahan FJ, Buckley DJ, Morrissey PA, Lynch PB, Gray JI. Effect of Dietary α-Tocopherol Supplementation on α-Tocopherol Levels TN Porcine Tissues and on Susceptibility to Lipid Peroxtdatton. Food Sci Nutr 1989; 42(4): 203-212. https://doi.org/10.1080/09543465.1989.11904145

Phillips WA, Wettemann RP, Horn FP. Influence of preshipment management on the adrenal response of beef calves to ACTH before and after transit. J Anim Aci 1982; 54(4): 697-703. https://doi.org/10.2527/jas1982.544697x

Price MA, Tennessen T. Preslaughter management and dark-cutting in the carcasses of young bulls. Can J Anim Sci 1981; 61(1): 205-208. https://doi.org/10.4141/cjas81-027

Sanders SK, Morgan JB, Wulf DM, Tatum JD, Williams SN, Smith GC. Vitamin E supplementation of cattle and shelf-life of beef for the Japanese market. J Anim Sci 1997; 75(10): 2634-2640. https://doi.org/10.2527/1997.75102634x

Schaefer AL, Jones SDM, Stanley RW. The use of electrolyte solutions for reducing transport stress. J Anim Sci 1997; 75(1): 258-265. https://doi.org/10.2527/1997.751258x

Schaefer AL, Jones SDM, Tong AKW, Young BA. Effects of transport and electrolyte supplementation on ion concentrations, carcass yield and quality in bulls. Can J Anim Sci 1990; 70(1): 107-119. https://doi.org/10.4141/cjas90-012

Sherbeck JA, Wulf DM, Morgan JB, Tatum JD, Smith GC, Williams SN. Dietary supplementation of vitamin E to feedlot cattle affects beef retail display properties. J Food Sci 1995; 60(2): 250-252. https://doi.org/10.1111/j.1365-2621.1995.tb05648.x

Strange ED, Benedict RC, Gugger RE, Metzger VG, Swift CE. Simplified methodology for measuring meat color. J Food Sci 1974; 39(5): 988-992. https://doi.org/10.1111/j.1365-2621.1974.tb07293.x

Sun SS, Lee SM. Blood Glucose, Creatinine, Lactate, and Cortisol Concentration and Histological Analysis of Muscle Fiber in Blood Splash Hanwoo Muscle. Ann Anim Resour Sci 2017; 28(3): 134-142. https://doi.org/10.12718/aars.2017.28.3.134

Tarrant PV, Kenny FJ, Harrington D, Murphy M. Long distance transportation of steers to slaughter: effect of stocking density on physiology, behaviour and carcass quality. Livest Prod Sci 1992; 30(3): 223-238. https://doi.org/10.1016/S0301-6226(06)80012-6

Warner R. The problem of dark cutting meat. Summary of workshop findings. In: Fabiansson SU, Shorthose WR, Warner RD, editors. Dark-cutting in Cattle and Sheep Proceedings of an Austalian Workshop. Sydney: Australian Meat and Livestock Research and Development Corporation press; 1989. p. 100-103.

Warriss PD, Bevan EA, Brown SN. Time spent by broiler chickens in transit to processing plants. Vet Rec 1990; 127:617-619. https://doi.org/10.1136/vr.139.3.72