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Research Article

Influence of the Combination of Herbal Extracts and Essential Oils on Meat Quality After Slaughter

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Abstract

The experiment aimed to evaluate the influence of the combination herbal extracts and essential oils on meat quality after slaughter. A total of four hundred fifty crossbred weaned pigs [(Yorkshire - Landrace) x Duroc; 28 days old; 7.21 ± 0.08 kg of BW] were randomly allotted to 3 treatments in a randomized complete design. The 3 treatments included (1) a basal diet, (2) the basal diet + 3 g/kg of feed CHE (a combination of herbal extracts and essential oils) and (3) the basal diet + 5 g/kg of feed CHE. Finishing the study, six pigs (3 barrows and 3 gilts) per treatment were slaughtered at 103.2 ± 1.4 kg of BW). The *Longissimus dorsi* (LD) muscles, were removed from the carcass at the 10^{th} to 15^{th} ribs with a weight of 1.5 - 2.5 kg, vacuum-packed, and stored frozen (4°C) for meat quality parameter. The results showed that using the combination of herbal extracts and essential oils improved the quality pork after slaughter. Specifically, at 24 hours after slaughter, the L* value in the CHE 5 g/kg feed supplement treatment (53.202) was significantly higher ($P < 0.001$) compared with other treatments. At both time points measurement, the b* values were lower when using CHE - supplemented diet. Similarly, the drip loss rate after 24 hours of slaughter in 3 treatments was 0.358; 0.351; 0.315 with $P < 0.05$. In addition, the shear force in the treatment supplemented with CHE 5 g/kg feed (20.25 N) was not significantly higher ($P > 0.05$) than in the treatments supplemented with CHE 3 g/kg feed (18.26 N) and the treatment without CHE (17.48 N). The addition of herbal preparations tended to improve the nutritional profile and fatty acid composition of pork, but this difference was not statistically significant ($P > 0.005$).

Keyword: Color Meat; Essential Oils; Fatty Acid Profile; Herbal Extracts; pH Value

Abbreviations

LD: *Longissimus dorsi;* L*: Linghtness; a*: Redness; b*: Yellowness

Introduction

Genetics, environment and storage are the factors affecting pork quality. After slaughter, the basic properties of the meat have changed since the autolysis happened to affect the shear force, color, and flavor of pork [16]. Maintaining ultimate pH, limiting microbial contamination, and preventing lipid oxidation [16] are considered measures to improve meat quality after slaughter. The lipid oxidation leads to a change in the fatty acid profile and the appearance of unpleasant odors [20]. Using herbs extracts [30]

and essential oils [3] as potential lipid antioxidants are effective and safe for human consumption. Herbal extracts such as phenolic compounds flavonoid [5], tannin [12], phenolic acids [30], hydroxylated derivatives of benzoic acid and cinnamic acid [1] are highly potent antioxidants. Besides herbal extracts improved the flavor of pork during processing [7,11], the effect of meat color [2], reduced drip loss and cholesterol content and enhanced flavor characteristics of pork [17], increased meat storage time when the turmeric-supplemented diet for finishing pigs [21].

Materials and Methods

Location

The study was conducted at Huong Vinh Cuu piggery, Dong Nai province from October 2020 to March 2021.

The measurement of meat quality was conducted at the laboratory of the department of Animal Production, Nong Lam University, Ho Chi Minh City, located in Quarter 5, Linh Trung Ward, Thu Duc District, Ho Chi Minh City.

Animals and experimental design

A total four hundred fifty crossed weaning pigs [(Yorkshire - Landrace) x Duroc; 28 days old; 7.21 ± 0.08 kg of BW] including half borrows and half gilts, were assigned, on the basis of weight and sex, to three dietary treatments: Control diet (C), diet supplemented with a blend of herbal extracts and essential oils (CHE) with level 3 mg/kg feed (CHE 3) and diet supplemented with CHE with level 3 mg/kg feed (CHE 5).

The CHE supplement contained 90% herbal extracts flour (garlic, ginger and turmeric) and 10% of essential oils (cinnamon and anise). The CHE mixed with basal diet. There were 30 pigs/pen and 5 replicate pens/treatment. Pigs were placed in a ventilated house. Each pen measured 6.0 m x 5.0 m in size with a slatted floor and had three nipple drinker.

Slaughter

Six pigs (3 barrows and 3 gilts) per treatment were slaughtered at 103.2 ± 1.4 kg of BW). The pigs were transported to the abattoir, after an on-farm fasting period of 8 hours.

Pigs are stunned by electric shock (Voltage ≥ 200V, Time ≥3 seconds), then hung up for bleeding, scalding and depilation. Then go to the slaughter line for inspection carcasses and removal of slaughter by-products (the front feet, head and contamination biliary).

A total of 36 LD muscles, were removed from the carcass at the from 10^{th} to 15^{th} ribs with a weight of 1.5 - 2.5 kg, vacuum-packed, and stored frozen (4°C) for meat quality parameter such as chemical composition, fatty acid profiles, pH value, color meat, drip loss, and cooking loss.

Measurement of meat quality

pH value: 36 LD muscle samples with a weight of about 120 g were stored at 2 - 4°C in vacuum-packed. Then measure the pH with the Portable Meat pH Meter - HI9816 at 2 times of 24 hours and 48 hours after slaughter. Each sample is measured at 5 different locations, the pH value is the average of 5 measurements.

Color meat: Samples were performed at 24 hours and 48 hours after the slaughter, using the CR-300 Chroma Meter (Minolta Camera, Co., Osaka, Japan) at 5 different points/samples. Meat color value is the average result of 5 measurements with indicators L* (brightness), a* (redness), b* (yellowness).

Drip and cooking losses: it was determined with 36 samples with a weight of about 120 g were stored at 2 - 4°C in vacuum-packed. After the storage time (24 hours and 48 hours), the sample was blotted dry and determined weight. The drip loss rate was determined based on the difference in sample weight before and after storage. The cooking loss determination, cooking by Water bath machine at 75°C for about 60 minutes so that the internal temperature reaches 70°C. Similar, the cooking loss rate was determined based on the difference in sample weight before and after cooking.

Shear force: LD muscle samples with a weight of about 120 g were stored at 2 - 4°C in vacuum-packed. Using a hollow cylinder with a diameter of 1 cm, take the sample by rotating the cylinder clockwise and parallel to the muscle fibers of the meat sample. The meat samples were then cut perpendicular to the muscle fibers using a CT3 Texture Analyzer cutter. The toughness of the meat sample is determined through the cutting force which is the average value of 5 measurements.

Chemical composition and fatty acid profiles: LD muscle samples with a weight of about 120 g were stored at 2 - 4°C in vacuum-packed. Samples were sent for analysis at the UP Science laboratory located at 1B Quarter, An Phu, Thuan An, Binh Duong.

Statistical analysis

Data were analyzed as a randomized complete design by ANOVA using the GLM procedure (Minitab 16.2). The pen was considered

the experimental unit. The incidence of diarrhea was compared by χ^2 analysis. Treatment effects were considered significant at P < 0.05.

Results

pH value

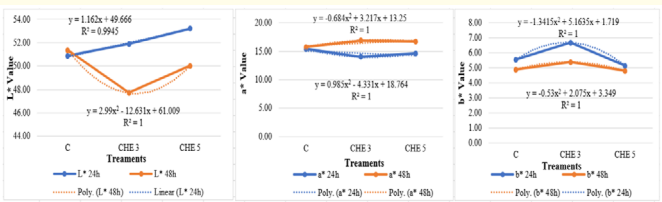
Items	C	CHE 3	CHE 5	SEM	P
pH24	5.519	5.547	5.578	0.024	0.233
pH48	5.553^{ab}	5.474^{b}	5.612^{a}	0.030	0.011

Table 1: pH value of *Longissimus dorsi* muscle after slaughter.

The a, b, c in the same line are significantly different from each other, P < 0.05.

The pH value at 2 times of measurement of 24 hours tended to be higher in the group using herbal in the diet compared with the control group with P > 0.05 (Table 1). After 48 hours of slaughter, the pH value of pigs fed the 5 mg CHE - supplemented diet was higher control treatment in the same sector with 5.612 and 5.553, respectively (P < 0.05). The short, CHE - supplemented diet maintained the pH within the optimal range to ensure meat quality.

Color meat



(A) (B) (C)

Figure 1: (A, B, C). Color meat of *Longissimus dorsi* muscle after slaughter.

24 hours after slaughter, color meat including a* (red) and b* (yellowness) value were improvements in diet supplement CHE with level 5 g/ kg feed than control diet(P < 0.001) (Figure 1 (B) and (C)).

At 48hours after slaughter, the L* (lightness) value in CHE - supplemented diet was lower than that of the control treatment (P < 0.001). According to Warner., *et al.* (1997), the larger the L* value after slaughter (> 50), the lighter the meat, the smaller the L* value (< 42), the pork was tends to be darker, the L* in the range 42 - 50 normal meat. The a* values were 15.783; 16.948; 16.745 respectively (P < 0.05). The b* value had a similar tendency to be higher in the treatment with CPTM supplementation in the feed, but the difference was statistically significant P > 0.05.

Drip loss and cooking loss

Items	C	CHE 3	CHE 5	SEM	P
24 hours after slaughter					
Drip loss	0.038	0.039	0.027	0,005	0,282
Cooking loss	0.58^{a}	0.351^{a}	0.315^{b}	0,004	0,012
48 hours after slaughter					
Drip loss	0,062	0,043	0,045	0,005	0,154
Cooking loss	0,424	0,354	0,365	0,016	0,107

Table 2: Drip loss and cooking loss of Longissimus dorsi muscle after slaughter.

The a, b, c in the same line are significantly different from each other, P < 0.05.

At 24 hours after slaughter, the values of drip loss were 0.038 0.039; 0.027 respectively with P > 0.05 (Table 2), this difference is not significant. The cooking loss rate at 5g CHE - supplemented diet was the lowest (0.315) and the highest in the treatment without CHE (0.358) with P > 0.05. At 48 hours after slaughter, there was no statistically significant difference in the drip loss rate in the 3 treatments with P > 0.05. The values of cooking loss when adding CHE to the diet had tendency decrease.

Shear force (N)

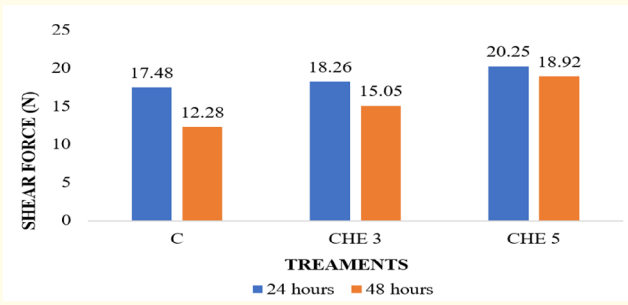


Figure 2: Shear force of *Longissimus dorsi* muscle after slaughter.

In general both 24 hours and 48 hours after slaughter, the shear forces (N) were higher in the treatment supplemented with CHE (Figure 2). Specifically, at 48 hours after slaughter, the shear force in CHE - supplemented diet with level 5 g/kg feed was the highest (18.92 N) while the data in the diet without CHE was the lowest (12.28 N) with $P < 0.05$.

Chemical composition

Items	C	CHE 3	CHE 5	SEM	P
Dry mater, %	71.60	71.90	72.12	0.96	0.931
Crude Protein, %	23.23	22.80	23.28	0.68	0.868
Ash, %	1.37	1.23	1.19	0.09	0.452
Lipid, %	4.40	4.54	5.26	1.37	0.897

Table 3: Chemical composition of *Longissimus dorsi* muscle after slaughter.

Indicators of the moisture, crude protein, and total fat in the treatment supplemented with CHE 5 g/kg feed had the same trend higher than the other 2 treatments but were not statistically significant with $P > 0.05$. In contrast, the ash value was lowest in the CHE - supplemented diet 5 g/kg feed (1.19) and the highest in the control diet (1.37) with $P > 0.05$. In summary, adding CPTM 3 g/kg TA and CPTM 5 g/kg TA did not affect the chemical composition of meat after slaughter.

Fatty acid profiles

Items	C	CHE 3	CHE 5	SEM	P
Caprylic acid (C 10:1)	0.10	0.15	0.15	0.041	0.650
Undecanoic acid (C 12:0)	0.25	0.25	0.2	0.041	0.650
Myristic acid (C 14:0)	1.90	1.60	1.50	0.058	0.033
Palmitic acid (C 16:0)	24.00	23.90	22.30	0.200	0.007
Palmitoleic acid (C16:1)	2.40	2.50	2.35	0.065	0.372
Stearic acid (C18:0)	12.95	13.10	11.55	0.212	0.025
Cis - Oleic acid (C18:1 n9)	0.4	0.45	0.45	0.122	0.947
Linoleic acid (C18: 2)	0.3	0.15	0.1	0.119	0.539
Linolenic acid (C18:3)	0.55	0.50	0.60	0.029	0.192
Eicosenoic acid (C 20: 1)	0.75	0.60	0.70	0.065	0.372
Eicosadiennoic acid (C20:2)	0.85	0.80	0.90	0.104	0.807
Arachidonic acid (C20:4)	0.45	1.40	0.85	0.358	0.310
Sum of Omega 3	0.65	0.80	0.75	0.077	0.422
Sum of Omega 6	12.6	13.4	14.2	0.860	0.505
Sum of Omega 9	38.00	38.40	40.55	0.724	0.160
Saturated fatty acids (SFA)	41.00	39.50	36.45	0.429	0.011
Monounsaturated fatty acids (MUFA)	44.70	45.35	47.40	0.724	0.151
Polyunsaturated fatty acids (PUFA)	14.35	15.15	16.15	0.877	0.449
UFA/SFA	1.44	1.53	1.74	0.030	0.012

Table 4: Fatty acid profiles of *Longissimus dorsi* muscle after slaughter (% total fatty acids).

Fatty acid profiles mainly found in LD muscle include C16:0, C18:0. Specifically, the percentages of C16:0 and C18:0 were highest in the control treatment (24.0% and 12.95%), whereas the data in the 5 g/kg feed CHE - supplemented treatments was the lowest (22.30% and 11.55%) ($P < 0.05$) (Table 4). However, the amount of saturated fatty acids (SFA) in the control treatment (41.00%) was significantly higher than the figures in the CHE - supplemented treatments with levels 3g and 5g/kg of feed was 39.50%, and 36.45%, respectively ($P < 0.05$). Similarly, the UFA/SFA ratio was higher in the diet supplemented with CHE ($P < 0.05$). In addition, the percentage of total Omega 3, 6, and 9 tended to increase in the herbal supplement treatment ($P > 0.05$).

Discussion

Pork is classified as a food source of high nutrition based on its high protein content [6], variety of essential amino acids present in pork protein, vitamins and minerals [31]. After slaughter, the metabolism in the cell stops, the reversible biochemical process

by enzymes turns into an irreversible process [8], these affect the chemical composition and sensory pork that regard to ultimate pH [6], color, shear fore [28] and fatty acid profiles [22] to classify and strictly control pork quality. The pH value is correlated with drip loss, color, or tenderness of the meat, high ultimate pH causes DFD meat (pH > 6), low pH causes meat PSE (pH < 5.2) [8], pH value will yield the best meat quality and long storage (5.2 < pH < 6) [9]. The addition of cinnamon (80 mg/kg of feed) stabilizes and maintains the optimal pH after 24 hours of storage [23], the cinnamon powders-supplemented diet (80 mg/kg of feed) stabilizes and maintains the optimal pH after 24 hours of storage [23], and the addition of herbal extracts what has much phenol stabilizes the pH value after 18 days of storage (pH = 5.69) [13], using of garlic increased to pH value [4] 3 days after slaughter than the control treatment [26]. Enhancing meat color stability when lipid oxidation was prevented [26], this conclusion has demonstrated by the study of garlic supplementation in the diet of pigs. Garlic contains several sulfur compounds [19] which important components of the intracellular antioxidant defense system in muscle fibers [29], when turmeric was added to the diet for similar results [14,21].

Water accounts for approximately 75% of muscle [8]. Water has three forms: bound water (accounting for about 0.5%), entrapped water (accounting for at least 80% [10] and free water (accounting for about 10%). Drip loss and cooking loss not only reduce the moisture of the meat but also loses protein and water-soluble vitamins [8], pork was lost about 50% of water classified as poor quality meat [18]. Besides, drip loss has been shown to affect pork color by structural changes in light scattering resulting in lighter meat color [28]. Drip loss capacity correlates with final pH value [10]. Low pH reduces water-binding capacity, reducing water content leading to reduced meat quality [8]. Using herbal extracts from the diet was evaluated to reduce drip and cooking loss during storage and processing [25].

The fatty acid profiles in pork include saturated fatty acids and unsaturated fatty acids. Saturated fatty acids (SFA) are an energy source of the body, humans only absorb mainly 3 saturated fatty acids including stearic acid, palmitic acid and lauric acid, these account for a large proportion of pork [6], unsaturated fatty acids (UFA) participate in cell structure and the body's activation process. Improving the fatty acid profiles by reducing the SFA content and increasing the PUFA content, especially omega-3 and omega-6 going up the tenderness and flavor of pork [27]. However, higher levels of PUFA can affect oxidation reactions, meat was faster rancid. Some studies have shown that the essential oil (cinnamon essential oil) after being absorbed, distributed and retained in cells with small concentrations but has antioxidant activity [3]. Like essential oils, herbal extracts added to the diet can use as natural antioxidants to help to increase the time of storage [3]. A high concentration of phenolic acids and flavonoids from herbs can protect cells and tissues against the harmful effects of ROS [15]. According to Samolinska., *et al*. [24], garlic supplementation with 5 g/kg feed increased PUFA content in muscle LD, namely n - 6 PUFAs, the same trend of results with this study, CHE*-supplemented diet with level 5 g/kg feed increased MUFA and PUFA content, improve the UFA/SFA ratio.

Conclusions

The addition of the combination of herbal extracts and essential oil to the diets of pigs with level 5 g/kg feed in the growing-finishing stage improved color meat, drip loss, cooking loss, and fatty acid profiles and stabilized optimal pH value of *Longissimus dorsi* muscles after slaughter, without marked effects on the chemical composition of pork.

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