DRY VS RAW MEALWORM LARVAE PROBIOTICS ON MEAT QUALITY AND SHELF LIFE IN GROWER-FINISHER PIGS

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Abstract - The study was conducted to observe the effect of dried mealworm larvae probiotics (DMLP) and raw mealworm larvae probiotics (RMLP) on carcass characteristics, quality and oxidative stability of meat in grower-finisher pig. A total of 96 crossbred (Landrace × Large white × Duroc) growing pigs were randomly allotted into three dietary treatments groups, i) control (basal diet), ii) 0.5% DMLP (basal diet + 0.5% DMLP, DM basis), and iii) 0.5% RMLP (basal diet + 0.5% RMLP, DM basis) in a completely randomized design. Meat quality grade and back fat thickness increased in DMLP and RMLP supplementation, while carcass weight increased in DMLP supplementation (P<0.02). Although meat proximate composition remain unaffected, ∑PUFA and ∑n-6 PUFA content increased in DMLP supplementation (P<0.05). Meat thiobarbituric acid reactive substances (TBARS) value reduced in DMLP supplementation at 2nd and 3rd week of preservation (P<0.05). In conclusion, dietary DMLP and RMLP showed a positive effect on meat quality grade, carcass weight, whereas DMLP supplementation improved fatty acid content and oxidative stability of meat. Therefore, DMLP and RMLP can be supplemented as an alternative feed additive in grower-finisher pig diet.

Key Words: Mealworm Larvae Probiotics, Meat Quality, Pig.

I. INTRODUCTION

Concerning animal protein production, the International Feed Industry Federation (IFIF) believes that the production of meat (poultry, swine, and beef) will even double than the present. This poses severe challenges to the global capacity to provide enough animal feed. Insects, the six legged mini livestock may be a potential source of protein for animal diet with minimum environmental impact due to its production with less energy, small land area and low environmental impact [1]. Broilers fed the 10% ground yellow mealworm diets had significantly greater carcass yield than the chicks that received the commercial corn-soy based diet [2]. Black soldier larvae meal was found to be a suitable ingredient in growing pig diets, being especially valuable for its amino acid, lipid and Ca contents [3]. Therefore, our present study was conducted to evaluate the dried vs raw mealworm larvae fermented with probiotics on quality and oxidative stability of meat in grower-finisher pig diet.

II. MATERIALS AND METHODS

A total of 96 crossbred (Landrace × Large white × Duroc) growing pigs (Barrows, average 32.37 ± 2.16 kg) were randomly allotted in to three dietary treatments groups having eight replications with four pigs per replication in a completely randomized design. The dietary treatments were: i) control (basal diet), ii) 0.5% dry mealworm larvae probiotics (DMLP) (basal diet + 0.5% DMLP, DM basis) and iii) 0.5% raw mealworm larvae probiotics (RMLP) (basal diet + 0.5%

RMLP, DM basis). Commercially available grower and finisher diets were used as the basal diet consisting of all nutrients at the levels recommended by NRC [4]. Dry and raw mealworm larvae (*T. molitor*) were purchased from a commercial insect producer. The beneficial probiotics strains used in this experiment were collected from the Korean Research Institute of Bioascience and Biotechnology, Daejeon, Korea. In fermentation process, we added 1% of *Lactobacillus plantarum* KCTC 3099 and *Saccharomyces cerevisiae* KCTC 7904 and fermented for 2 days at 37^{o}C maintaining 40% moisture in a commercial fermenter and then dried in a force air oven at 32^{o}C for 1 day to reduce the moisture levels. The prepared probiotics were then stored in polyethylene bags separately in air tight condition until mixed with basal diet. DMLP and RMLP were mixed with basal diet by replacing equal amount of commercial diet in grower and finisher stages. The crude protein and metabolisable energy content of the experimental basal diets were 180 g/kg DM and 160 g/kg DM and 3270 Kcal/kg and 3320 Kcal/kg in grower and finisher diets respectively. The experimental pigs were reared in an environmentally controlled, slatted pig house in 24 adjacent pens and provided with *ad libitum* access to feed and water.

At the end of trial, pigs with an average weight of 108.9 ± 4.41 kg were transferred to a commercial slaughter house (Naju, South Korea) and slaughtered (feed was withheld 24 h before slaughtering). Carcass weight was recorded after evisceration and back fat thickness was measured at tenth ribs. The carcass quality grade determined according to Korea Institute for Animal Products Quality Evaluation [5]. Proximate compositions of pork were analyzed according to the methods described by AOAC [6]. Meat fatty acids were determined by the method of fatty acid methyl ester (FAME) using a slight modification of the method described by O'Fallon *et al.* [7] using a gas chromatograph (Agilent, 7890A series, USA). To determine the oxidative stability, meat samples were preserved in the refrigerator at 4°C and TBARS of meat were assayed for fresh meat and on day 7, 14 and 21 according to Sarker and Yang [8]. TBARS values were expressed as micromoles of malondialdehyde (MDA) per 100 g of meat sample.

The mean value and standard errors of the means (SEM) were calculated and all data were subjected to analysis of variance (ANOVA) using SAS 2003 (Version 9.1, SAS Institute, Cary, NC, USA). A group of three pigs served as the experimental unit for carcass characteristics, meat composition, fatty acid profile and oxidative stability. Differences among means were determined by the Tukey's test. The probability level at $P<0.05$ indicated significant difference.

III. RESULTS AND DISCUSSION

Carcass characteristics

Carcass weight increased in DMLP supplementation while meat quality grade and back fat thickness increased in DMLP and RMLP supplementation ($P<0.05$) (Table 1). The increased carcass weight of pigs in this study might be due to the increased slaughter weight [9]. The chitin present in mealworm supplemented diet might improve the meat color which may improve the meat quality grade [10]. The increased fat content of DMLP and RMLP could also improve the marbling and back fat thickness of pork in this study.

Meat composition and fatty acid profile

Dietary supplementation of DMLP and RMLP did not make any significant change on proximate composition of pork (data unpublished). Although, ∑SFA, ∑MUFA and ∑n-3 PUFA remained unaffected, concentration of ∑PUFA, ∑n-6 PUFA and PUFA/SFA ratio were increased in DMLP supplementation compared to control and RMLP dietary group ($P<0.05$) (Table 2). The

increased sum of PUFA and n-6 PUFA in DMLP group of our present study can be explained as the increased concentration of individual PUFAs and n-6 PUFAs in muscle *Longisimus thoracis* in supplementation of dietary DMLP of this study.

Table 1 Carcass characteristics in finisher pigs

Parameters	Treatment			SEM	P value
	Control	DMLP[1] 0.5%	RMLP[1] 0.5%		
Carcass weight (kg)	85.52[b]	87.08[a]	85.63[b]	0.26	0.01
Carcass quality grade[2]	1.80[b]	2.44[a]	2.38[a]	0.09	0.02
Back fat thickness (mm)	20.22[b]	23.06[a]	22.97[a]	0.53	0.02

[a,b]Means with different superscripts in the same row differ significantly (P<0.05).
Each value represents the means of eight replications with three pigs /replication.
[1]DMLP = Dry mealworm larvae probiotics, RMLP = Raw mealworm larvae probiotics.
[2]Carcass quality grade: 1+ = 3, 1 = 2, 2 = 1, nondescript = 0. [5].

Table 2 Fatty acid profile of *Longissimus thoracis* muscle

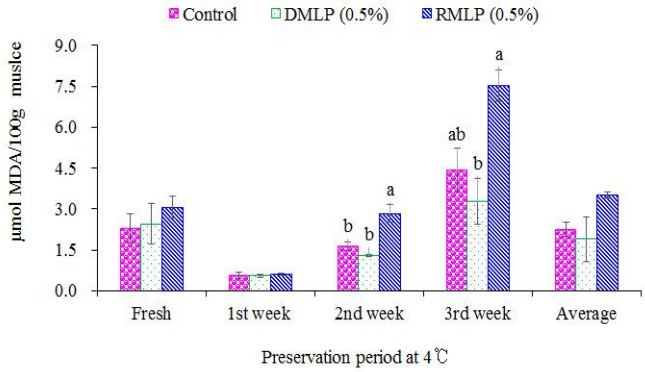
Parameters (g/100g of total fatty acid)	Treatment			SEM	P value
	Control	DMLP[1] 0.5%	RMLP[1] 0.5%		
∑SFA[2]	40.12	39.99	40.43	0.37	0.73
∑MUFA[2]	54.76	57.63	57.09	0.86	0.18
∑PUFA[2]	11.49[ab]	11.89[a]	10.05[b]	0.38	0.03
∑n-6 PUFA	8.84[ab]	9.12[a]	7.66[b]	0.29	0.03
∑n-3 PUFA	2.65	2.77	2.38	0.12	0.18
PUFA/SFA	0.29	0.30	0.25	0.01	0.05
MUFA/SFA	1.36	1.44	1.41	0.02	0.23
n-6/n-3	3.34	3.30	3.24	0.13	0.89

[a,b]Means with different superscripts in the same row differ significantly (P<0.05).
Each vale represent the means of five replications with three pigs /replication.
[1]DMLP = Dry mealworm larvae probiotics,RMLP = Raw mealworm larvae probiotics.
[2]∑SFA = Total saturated fatty acids, ∑MUFA = Total monounsaturated fatty acids
∑PUFA= Total polyunsaturated fatty acids.

Oxidative stability of meat

Although the oxidative stability at fresh and first week of preservation remain unchanged, it decreased in DMLP supplementation but increased in RMLP supplementation at second and third week of preservation (P<0.05) (Figure 1). The combined effect of probiotics supplementation and chitin content of insect larvae might reduce the oxidative stability of meat in our present study.

Figure 1. Meat TBARS value during preservation at 4℃. Bars without a common letter in a week differ significantly (P<0.05).



IV. CONCLUSION

The results showed that carcass weight increased in DMLP supplementation while meat quality grade and back fat thickness increased in DMLP and RMLP supplementation. Increased ∑PUFA, ∑n-6 PUFAs and PUFA/SFA ratio in supplementation of DMLP. A reduced meat TBARS value was found in DMLP dietary group. Therefore, DMLP and RMLP can be supplemented as an alternative feed additives in grower-finisher pig diet to improve meat quality and meat shelf life in grower-finisher pig.

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