

## 学 位 論 文 の 要 旨

論文題目     **Studies on Utilization of Japanese Pepper Seeds as Feed Additives  
in Broiler Chicks**  
(ブロイラーヒナ用飼料添加剤としての山椒種子の利用に関する研究)

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Most agricultural waste materials, so-called “by-product” is valuable as resources because they included in useful nutrients for livestock. Additionally, the use of the by-product is indispensable for various industrial establishment and has been a notable economic achievement. It is no exception in the animal production, and should be considered to aim at the development of sustainable agriculture. Agricultural by-products are utilized as feedstuffs for livestock of most countries where agricultural products are restricted. Many efforts have been paid to investigate the utilization of the agro-industrial by-products such as crop residues, and these include soybean cake, cereal straws and bran, cottonseeds, root crop tops and vines, and bagasse. It is not only used for reduction of feed cost, but also these by-products can expect the advantage effects which they content.

Japanese pepper (*Zanthoxylum piperitum*) belongs to the Rutaceae (citrus and rue) family, and is distributed in Japan and the surroundings East Asia. In Japan, the young leaves and fruits of Japanese pepper has been widely used as spice. After fruits in particular becoming ripe and having dried, the pericarps are separated from the seeds and ground. This ground pericarp is commonly used as the spice “sansho powder”, which is considered to enhance not only the flavor but also the digestion. Also, the Japanese pepper is one of the ingredients of Kampo (herbal) medicine, Daikencuto, which has been used as an antifatulent. Regardless of the popularization of edible leaves and fruits, appreciable amount of the seeds become the unutilized agro-industrial by-product as waste. In Wakayama Prefecture that produces 70% of total yield of Japanese pepper in Japan, it has been searched to use the seed of Japanese pepper. The present study was therefore designed to investigate the effect of supplemental Japanese pepper seeds (JPS) on performance, physiological parameters, and heat stress in broilers. This dissertation describes four studies that were designed to evaluate Japanese pepper seeds as feed additives in broiler chicks.

First experiment was designed to estimate acute effect of JPS on feed and water intake, and physiological parameters using 5-20% JPS supplemental feeds. Feed intake in 5% group chicks did not differ from that in control chicks, but higher levels (10 and 20%) of JPS suppressed feed intake in chicks at 2 h post-feeding. Although the main effect of JPS level was slightly significant, an interaction between JPS and time was not significant. Similar to feed intake, higher levels (10 and 20%) of JPS inhibited water intake in chicks. However, a repeated measures analysis of variance for JPS and time revealed both the effect for JPS and a JPS × time interaction were not significant. Rectal temperature in 10 and 20% JPS chicks decreased as time went by, while 5% JPS tended to increase rectal temperature at 2 h post-feeding when compared with 0 and 1 h post-feeding. These data suggest that high levels of supplemental JPS adversely affects starting of feeding behavior by its fragrance ingredient, but the effect disappears five hours later. Additionally, JPS as

feed additives can be included in broiler diets without adversely affecting the blood parameters.

Second experiment was designed to investigate the effect of supplemental JPS (2.5 and 5%) on growth and physiological parameters in broilers. After 7-day feedings, body weight gain and feed intake were not significantly different between the control and the JPS supplement groups. However, feed conversion ratio (FCR) in chicks fed with 5% JPS feed significantly increased compared to control chicks. In the blood parameters, although no significant differences were detected in most parameters among the groups, the level of plasma triglyceride in 5% JPS chicks tended to be lower than that in control ones. As for weight or glycogen concentration of liver, each value was not significantly different between the control and the JPS supplement groups. These data suggest that supplemental JPS have no adverse effect on the growth performance, but that it may affect the lipoprotein metabolism in broilers.

Third experiment was designed to estimate the effect of JPS on weights of muscle, lengths of gastrointestinal tracts, or fat contents in broiler chicks. Although no significant differences were detected in weight and percent per body weight of pectoralis major and sartorius among the groups, the percent per body weight of pectoralis deep in 5% JPS chicks tended to be higher than that in control ones. However, all intestinal tract lengths were not significantly different between the control and the JPS supplement groups. Moreover, each "total body electrical conductivity" value, which indicates fat content levels in animals was not significantly different between the control and the JPS supplement groups. These data suggest that supplemental JPS affect the development of slow motor muscles, but that it does not may affect the development of gastrointestinal tracts of lipoprotein metabolism in broilers.

Last experiment was designed to investigate the effect of supplemental JPS (1 and 2%) on thermoregulation and plasma monoamines in broilers. After 6-day feedings, body weight gain and feed intake were not significantly different between the control and the JPS supplement groups. However, FCR in chicks fed with 1% JP feed significantly decreased compared to control and 2% JPS chicks. Thereafter, all groups were exposed to high temperature at 38°C for 3 h with water but not feed. The latency of panting or wing-droop during heat challenge test were not significantly different between the control and the JPS supplement groups. The temperatures of all groups were elevated by acute heat stress. The effects of JPS and time were significant in heat exposed chicks. An interaction between JPS and time was considered to reflect a trend towards significance. There were tendencies for rectal temperatures of control and 2% JPS chicks to decrease after the 2 hours while that of 1% JPS kept advancing. In the levels of plasma monoamines, there were no significant differences in NA, Ad and 5-HT among the groups while the level of plasma DA in 2% JPS chicks was lower than that in control ones. These data suggest that JPS affect thermoregulation via the catecholaminergic system in chicks but it may become the adverse effect under the long term heat stress in broilers.

In conclusion, these data suggest that JPS (1%) as feed additives can be included in broiler starter diets without adversely affecting the growth performance, but that it may be useful for improvement of feed conversion ratio in broilers. However, it is necessary to consider for use under high ambient temperature in summer.