Effect of Supplemental Japanese Pepper Seed on the Palatability of Feed in Chicks

Khushdil Maroof, Takao Oka, Mika Fujihara and Takashi Bungo

1Laboratory of Animal Behavior and Physiology, Graduate School of Biosphere Science, Hiroshima University, Higashi-Hiroshima 739-8528, Japan
2Wakayama Prefectural Kihoku Livestock Hygiene Service Center, Wakayama 640-8483, Japan

The present study aimed to establish whether supplemental Japanese pepper seed (JPS) affects feed intake in broiler chicks under ad libitum conditions. Experiments were designed to estimate the acute effect of JPS on feed and water intake using 5%–20% JPS supplemental feeds. JPS supplemental feed demonstrated a tendency to suppress feed intake and water intake in a dose-dependent manner during the 2 h post-feeding period, and chicks seldom ate 20% JPS supplemental feed at 1 h post-feeding. No significant difference was observed in the rectal temperature between groups during the 2 h post-feeding period. In a 5-h feeding experiment, no JPS level had any effect on feed or water intake in chicks. These data suggest that the adverse effect of JPS may be due to volatile stimulation; however, the effect disappears after 5 h post-feeding.

Key words: broiler, by-products, feed additives, feed intake, water intake

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Introduction

The utilization of agro-industrial by-products as feedstuffs has been of interest to animal producers for developing sustainable agriculture (Devendra and Thomas, 2002). Using agro-industrial by-products requires the estimation of nutrients and determination of whether the components have beneficial or adverse effects on animal production. In fact, by-products occasionally have harmful effects on feeding behavior and performance in poultry (Salgueiro et al., 2010; Tajodini et al., 2015). In particular, feed containing harmful components, even if rich in nutrients, can reduce animal performance. The palatability of feeds, an important consideration in controlling feed consumption in poultry, includes factors such as feed color (Hurnick et al., 1971), odor (Baldwin and Cooper, 1979), taste (Gentle, 1972), and shape and form (Savory, 1974).

Japanese pepper (Zanthoxylum piperitum) belongs to the Rutaceae (citrus and rue) family, and is distributed in Japan and East Asia. The popularity of cultivating of edible leaves and fruits has resulted in an appreciable amount of seeds remaining as unutilized agro-industrial by-products. In Wakayama Prefecture, which produces 70% of the total yield of Japanese pepper in Japan, using Japanese pepper seeds as a feedstuff for layer chickens has been examined; however, there are currently no data on the palatability of these seeds for broilers.

The present study aimed to investigate the palatability of Japanese pepper seed (JPS) for broiler chicks.

Materials and Methods

Animals

Day-old male broiler chicks (Chunky) were purchased from a local hatchery (Fukuda Hatchery, Okayama, Japan). Newly hatched chicks were housed in wooden cages with a wire-mesh floor (18×25×20 cm) at a population density of three chicks per cage. The birds were maintained in a room with 24-h lighting. The ambient temperature was controlled at 30°C±1°C for the first 3 days and gradually lowered to 26°C±1°C until the chicks had reached 11 days of age. The chicks were provided ad libitum access to a commercial starter diet (22% CP, 3,100 kcal/kg of AMEn; Nichiwa Sangyo Co. Ltd., Kobe, Japan) and water during the pre-experimental period. The handling of birds was performed in accordance with the regulations of the Animal Experiment Committee of Hiroshima University.

Experiment 1

At 4 days of age, twenty eight chicks were distributed into four groups based on their body weights, so that the average body weights of the groups were as uniform as possible (control: 95.4±3.0 g, 5% JPS: 95.0±2.5 g, 10% JPS: 93.1 g, 20% JPS: 91.4±2.0 g).
Average body weight of each group was as follows: control, 99.3 ± 2.9 g; 20% JPS: 94.3 ± 2.5 g. The birds were reared individually in experimental cages (13 × 25 × 25 cm) and had ad libitum access to feed and water until the end of the experiment. The control group was fed with ground commercial starter diet (basal diet), whereas the other groups were fed a basal diet with added ground JPS at 5, 10, or 20%. The supplemental level was determined by reference to a previous report, which showed the effects of sunflower seeds in broiler rations (Cheva-Isarakul and Tangtaweewipat, 1990). JPS was obtained from a Japanese pepper farm in Wakayama Prefecture, Japan. The chemical composition of JPS is presented in Table 1. Feed and water intake were measured at 1 and 2 hours after providing the experimental feed. The weight of the feeders and water cups were measured using an electronic digital balance of precision ± 1 mg. The evaporated volume was also recorded and taken into account when measuring water intake. Rectal temperature was also measured at the time of the feeder access to feed and water until the end of the experiment.

Experiment 2

Similar to the experiment described above, food and water intake were also measured at 5 h after providing the experimental feed. There were seven birds in each group. The average body weights of each group were as follows: control, 99.3 ± 2.9 g; 5% JPS, 97.6 ± 2.3 g; 10% JPS, 96.2 ± 2.0 g; 20% JPS, 94.5 ± 2.4 g.

Statistical Analysis

The data from Experiment 1 were statistically analyzed using a repeated measures analysis of variance (RM-ANOVA), using the commercially available package, Stat View (Version 5; SAS Institute, Cary, USA, 1998). This analysis provided P-values for differences between treatment, differences over time, and for the interaction of treatment with time. Treatment effects were partitioned into linear contrasts to determine the dose-response relationships at each time period. Correlation between the rectal temperature and feed intake was analyzed using the Pearson's product-moment correlation method. For comparisons among means of feed and water intake in Experiment 2, one-way ANOVA was used. Differences were declared significant at P < 0.05, and a value of P ≤ 0.10 was considered to reflect a trend towards significance.

Results

Effect of JPS on Feed Intake, Water Intake, and Rectal Temperature During the 2-h Post-feeding Period

Figure 1 shows the effect of supplemental JPS on feed intake in broiler chicks. Although the main effect of JPS level showed a trend towards significance (P = 0.052), the interaction between JPS and time was not significant (P = 0.694). At 1 h post-feeding, the following regression equation was obtained between feed intake and the levels of JPS: feed intake (g) = 0.745(SE 0.128) − 0.037(SE 0.011) × (R² = 0.247; P = 0.0027). At 2 h post-feeding, the following regression equation was obtained between feed intake and the levels of JPS: feed intake (g) = 1.251(SE 0.198) − 0.043(SE 0.017) × (R² = 0.191; P = 0.0201).

Figure 2 shows the effect of supplemental JPS on water intake in broiler chicks. The main effect of JPS level showed a trend towards significance (P = 0.079); however, the JPS × time interaction was not significant (P = 0.693). At 1 h post-feeding, the following regression equation was obtained between water intake and the levels of JPS: feed intake (g) = 0.632(SE 0.124) − 0.033(SE 0.011) × (R² = 0.258; P = 0.0058). At 2 h post-feeding, the following regression equation was obtained between water intake and the levels of JPS: feed intake (g) = 1.092(SE 0.187) − 0.037(SE 0.016) × (R² = 0.166; P = 0.0236).

Figure 3 shows the effect of supplemental JPS on rectal temperature in broiler chicks. The main effect of JPS level was not significant (P = 0.752); however, an interaction between JPS and time showed a trend towards significance.

Table 1. Chemical composition of Japanese pepper seed

| Item                  | Value   |
|-----------------------|---------|
| Energy (kcal/100 g)   | 469     |
| Crude protein (g/100 g) | 13.3    |
| Crude fat (g/100 g)   | 24.6    |
| Carbohydrate (g/100 g) | 48.7    |
| Moisture (g/100 g)    | 7.02    |
| Crude ash (g/100 g)   | 6.36    |
| α-tocopherol (mg/100 g) | 0.30   |
| γ-tocopherol (mg/100 g) | 4.06   |
| δ-tocopherol (mg/100 g) | 0.22   |
| Polyphenol (mg/100 g) | 670     |

Fig. 1. Cumulative feed intake of chicks during the 2 h after providing the experimental feed. PSE, pooled SE; open circles, control; solid circles, 5% JPS; solid triangles, 10% JPS; solid squares, 20% JPS. The number of chicks in each group was seven. The correlations were as follows: feed intake at 1 h (R² = 0.247; P < 0.01) and feed intake at 2 h (R² = 0.191; P < 0.05).
However, the correlation was not significant at any of the points. The relationship between rectal temperature and feed intake at 2 h is shown in Figure 4. Statistical analysis demonstrated no correlation between them ($R^2 = 0.030; P = 0.7105$).

**Discussion**

Voluntary control of feed intake in chickens depends on integration of the feedback from a great variety of humoral and neural signals (Bungo et al., 2011; Honda et al., 2016). The result of the 2 h feeding examination showed that chicks avoided 10 and 20% JPS supplemental feeds (Fig. 1). Because chicks seldom ate the 20% JPS supplemental feed at 1
h post-feeding, it appeared that the anorexic effect was not due to the taste of JPS. Although Bryant and Mezine (1999) reported that sansho, an ingredient of JPS, has a strong pungent characteristic when applied to the human tongue, it is known that chickens are able to eat dietary spices that most mammals cannot (Brenes and Roura, 2010). Thus, the main reason for the anorexic effect of JPS supplemental feed may be the volatile ingredients. It has been demonstrated that an intense dietary smell as a novel stimuli can cause fear in animals (Simitzis et al., 2008). Epple et al. (2001, 2004) reported the anorexic effect of Japanese pepper extracts in mammals, and concluded that the volatile constituents induced these avoidances. Although JPS supplemental feeds were not chemically analyzed for volatile stimulation, the odor of the 20% JPS supplemental feed resulted in a stinging sensation our nostrils with a strong volatile stimulation.

In general, water intake correlates strongly with feed intake in animals (Patrick and Ferrise, 1962). The result of drinking showed a similar change to the result of feeding (Fig. 2), suggesting that water intake correlated strongly to feed intake. Symeon et al. (2010) found that dietary essential oil induced food neophobia, and then decreased the visiting rate of the drinkers by reducing the rate of feeder in broiler chickens. Because higher JPS supplemental feeds resulted in chicks avoiding feeders as mentioned above, water intake might have been decreased.

Although there was no significant difference between groups on rectal temperature, interaction between JPS and time tended to be significant (Fig. 3). It is because fasting was the cause of lowered temperature in higher JPS groups. On the other hand, we found no relationship between the rectal temperature and feed intake in 5% JPS group at 2 h (Fig. 4). Therefore, the possibility that JPS had a direct influence on the thermoregulation system was low.

Numerous feeding experiments have been performed using herbs or spices as feed additives, and some reports have indicated their harmful effects on feeding behavior and performance (Salgueiro et al., 2010; Tajodini et al., 2015). Higher JPS suplementations inhibited feeding behavior during the 2-h period after providing the experimental feed; however, JPS supplementation did not affect feed and water intake in the 5 h feeding experiments (Fig. 5). Two possible reasons can explain this finding: 1) a decrease in volatile ingredients, or; 2) feed habituation. Because the JPS feed was prepared on the day before the experiment, it is unlikely that the volatile compounds suddenly dissipated within the 3–5 h of the experiment. Epple et al. (2001) revealed that Zanthoxylum stimuli was avoided for 10 d in rats.

Thus, our findings suggest that JPS as a feed supplementation may be included in broiler starter diets without taste aversion in broiler chicks.

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