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SHORT COMMUNICATION

Effects of Sea Urchin Shell Powder on Volatile Fatty Acids in Poultry Litter: A Field Study

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Abstract

We investigated the effects of sea urchin shell powder on 2 volatile fatty acids, acetic and butyric acid, in poultry litter. A total of 60 1-d-old male broiler chicks (Arbor Acres) were allocated to 2 treatments (basal diet and 1% sea urchin shell powder) with 3 replicates of 10 birds each. During the 4-week experimental period, significant differences in acetic acid and butyric acid concentrations were observed between treatments ($P < 0.05$), except for acetic acid at 1 week. Additions of 1% sea urchin shell powder resulted in lower acetic and butyric acid concentrations compared to the litter of control birds. We conclude that the sea urchin shell powder used in this study might prove beneficial in reducing environmental pollution caused by poultry litter.

Key words : Sea urchin shell powder, Acetic acid, Butyric acid, Poultry litter

1. Introduction

Sea urchins (*Hemicentrotus pulcherrimus*) are spiny-skinned marine invertebrates with a global distribution. Recent reports have shown that the use of sea urchin shells confers certain beneficial advantages, including antioxidant and pharmaceutical effects (Kim et al., 2002; Shankarlal et al., 2011). Sea urchins have therefore received increased attention as a possible source of antibiotic replacements. They may also be used as a diet source for animals, because sea urchins are easy to harvest. Moreover, there is great interest in the recycling of waste materials from sea urchin. The most optimal way to use sea urchin shell is to supplement diets for poultry. To date, however, no study has investigated the use of sea urchin shells with respect to feed additives or to the environmental impacts of the poultry industry. The objective of this study was to evaluate the effects of dietary sea urchin shell powder on volatile fatty acids (VFAs) in poultry litter.

2. Materials and methods

2.1. Birds and diets

All experimental procedures complied with the principles and guidelines for experimental poultry farms in Gunwi (South Korea). A total of 60 1-d-old male broiler chicks (Arbor Acres) were allocated to 2 treatments with 3 replicates of 10 birds each. Control birds received only the basal diet, whereas birds in the treatment group received the basal diet enriched

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with 1% sea urchin shell powder. Birds received starter diets containing 23% crude protein from 1 to 21 d and finisher diets containing 21% crude protein from 22 to 28 d of age. Light, temperature, heating, and ventilation in the poultry facility were regulated by an automatic control system. Each pen (1.1 m × 1.4 m) was equipped with an automatic bell drinker and feeder. Bedding material (rice hulls and wood shavings) was applied to a depth of 8 cm in each pen. All birds were allowed *ad libitum* access to feed and water until they reached 28 d of age. Sea urchins were purchased from local markets. The soft body and spines were removed to obtain the sea urchin shells, which were then dried and ground into a fine powder.

2.2. Sample preparation and analytical procedures

Litter samples were collected weekly from 5 random locations in each pen. The litter samples were thoroughly mixed and weighed approximately 100 g. All samples were sealed individually in plastic bags to avoid any contact with air and maintained in frozen storage before VFA analysis. For determination of VFAs, a 10-g sample of the litter was added to 100 mL of deionized water and shaken for 2 h using a mechanical shaker. Samples for VFA analysis were centrifuged for 15 min at 6000 rpm and filtered. The supernatant from these samples was used for the determination of VFA concentrations (Muck and Dickerson, 1998) using HPLC (L7485; Hitachi®, Tokyo, Japan) equipped with a UV detector (Spectroflow; ABI Analytical Kratos Division, Ramsey, NJ).

2.3. Statistical analysis

The experimental units were the pens. Data were analyzed using the PROC GLM procedure in SAS (SAS Institute, 2000). Differences between means were evaluated using Student's *t*-test, where $P < 0.05$ indicated statistical significance.

3. Results and Discussion

The effects of sea urchin shell powder on acetic acid and butyric acid concentrations as a function of time are summarized in Fig. 1 and 2. During the 28-d experimental period, acetic acid and butyric acid concentrations differed significantly between treatments (P < 0.05), except for acetic acid at 1 week. Overall, the acetic acid concentration in treatments with sea

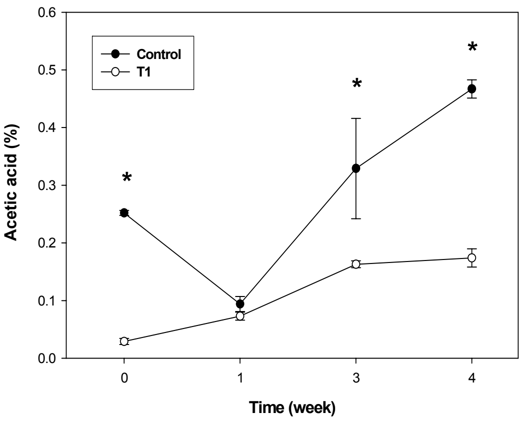

Fig. 1. Effects of sea urchin shell powder on acetic acid as a function of time. An asteroid (*) indicates statistically significant difference at P < 0.05. Treatment means T1 = 1% sea urchin shell powder.

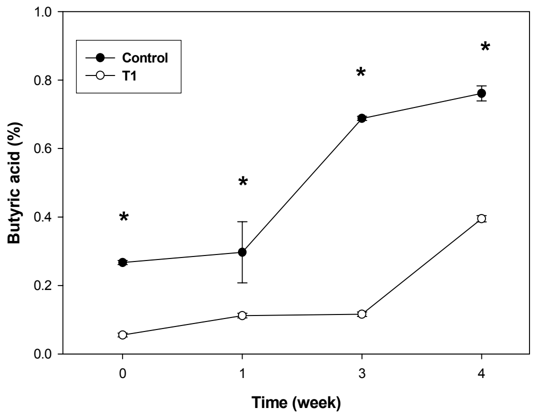

Fig. 2. Effects of sea urchin shell powder on butyric acid as a function of time. An asteroid (*) indicates statistically significant difference at P < 0.05. Treatment means T1 = 1% sea urchin shell powder.

urchin shell powder was 0.029%, 0.073%, 0.163%, and 0.174% at 0, 1, 3, and 4 weeks, respectively, compared to 0.252%, 0.094%, 0.329%, and 0.467%, respectively, in control samples. Butyric acid concentrations in sea urchin shell powder-treated diets were 0.0553%, 0.112%, and 0.116% at 0, 1, and 3 weeks, respectively, and reached 0.395% at 4 weeks. Control samples had butyric acid concentrations of 0.267%, 0.297%, 0.688%, and 0.761% at 0, 1, 3, and 4 weeks, respectively. Thus, broiler chicks fed a diet supplemented with 1% sea urchin shell powder produced waste with lower acetic and butyric acid concentrations than broilers fed only the basal diet (control). This result might be explained by the fact that sea urchin shell powder acts as an acidifier, thereby lowering the pH of the litter, since it was suggested that these activities are very dependent on pH (data not shown). In general, VFA, including acetic acid, propionic acid, butyric acid, and iso-valeric acid, which are important factors that determine odor production, are produced in animal manure and litter from livestock facilities (Jacobson et al., 2001; Zahn et al., 1997, 2001). Acidifiers not only improve poultry production and health but may also mitigate environmental concerns, e.g., by reducing pathogen loads and ammonia levels in litter (Shah et al., 2006). Our data are in agreement with those of Choi and Moore (2008), who reported that liquid $AlCl_3$ as an acid-forming compound reduced VFA levels in poultry litter, possibly as a result of the reduced litter pH inhibiting microbial growth and activity.

4. Conclusion

In conclusion, we found that the addition of sea urchin shell powder to diets reduced the concentrations of acetic and butyric acid in poultry litter. This result suggests that the sea urchin shell powder used in this study can be used to reduce environmental pollution caused by poultry litter. However, more detailed research is needed to evaluate the function of sea urchin shell powder in poultry diets with respect to mitigating negative environmental impacts.

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