Effects of Dietaries with Two Rice Husk Charcoals on Egg Qualities and Feces Smell in an Ecological Poultry Experiment

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The bad smell pollution from livestock farms becomes the social problem. As the experiment was done for the reduction of bad smell in a poultry production, the effects of dietary added 1% rice husk charcoal to 372-day-old laying hen were found that the ammonia gas densities on their feces as bad smell in the poultry farm was reduced almost by a half and the eggshell strength was slightly improved. This rice husk charcoal (RHC) was expensive at the price of 208 yen per kg as a manufactured product. It is ecologically necessary to investigate the effects of farmer made rice husk charcoal (FRHC), being a low cost. In this experiment, 1% and 3% of RHC and FRHC were added into the formula feed at inner percents. Effects of both 1% and 3% RHC and FRHC dietaries to each 22 laying hens (451-day-old) were investigated in comparison with Non RHC dietary. The egg production rate during the test was indicated that 1% FRHC and 1% RHC dietaries increased but 3% FRHC and 3% RHC dietaries decreased than Non RHC dietary. However, the ammonia gas densities on their feces was significantly reduced 21-44% in 1% and 3% RHC dietaries and also 21-25% in 1% and 3% FRHC dietaries at 5-6 weeks in comparison with Non RHC dietary, and was also significantly reduced in 1% RHC dietary at 2-6 weeks continuously.
Key words: Ammonia gas density, Dietary, Egg quality, Feces smell, Laying hen, Rice husk charcoal

1. INTRODUCTION

Bad smell in livestock farming has been mainly a social environmental problem in Japan. In the investigation on the complaint for the livestock farming by residents surrounding livestock farms, the Ministry of Agriculture, Forestry and Fisheries reported in 1996 that the percentage of complaint kind for bad smell, water pollution, occurrence of harmful insect and noise (including other complaints) was 61%, 34%, 12% and 6%, respectively. Then, the percentage of livestock kind for pig, milking cows, poultry and beef cattle was 34%, 33%, 20% and 11%, respectively. The percentage of complaint for bad smell in poultry was amounted to 50.6% at a high level.

Bad smell in poultry is generally caused by mainly large densities of ammonia gas sprung as advances of breaking up the organic matter in feces. The reason is why the nitrogen quantities of chicken feces were 4.6%, being larger than 1.8% of cattle feces [1]. Some methods were developed like the deodorization technologies using soil [2] and rock-wool [3] to reduce bad smell in pig and poultry farms. Instead of their methods being costly, however, they require cheaper methods.

Charcoals have useful functions of purification of water and air, absorption of polluted air, promotion of fermentation of the organic matter.

As results of the experiment for reduction of bad smell in poultry farm, the effects of dietary added 1% rice husk charcoal to 372-day-old laying hen were reported by Hosokawa and Saito that the ammonia gas densities on their feces was reduced almost by a half in summer and the eggshell strength was slightly improved [4]. This rice husk charcoal (RHC) in this experiment was, however, expensive because of a manufactured product. It is necessary to investigate the effects of feeding RHC more and of feeding the farmer made rice husk charcoal (FRHC) being a low cost.

In this paper, results of examining the effects of feeding 1% and 3% RHC and FRHC added into the formula feed to old laying hens in the autumn period are reported.

2. EXPERIMENTAL METHOD

2.1 Rice husk charcoal

Rice husk, as shown in Fig. 1, is removed rice by a rubbing machine from rough rice. The rice husk charcoal (RHC) in this experiment was manufactured by roasting at about 700°C completely in the angled-dram after rice husks were enough mixed in the bentnite solution to cover with the bentnite. This RHC was bought for 208 yen per kg from Bright Ceramic Co., Ltd., Nagano city. On the other hand, the farmer made rice husk charcoal (FRHC), as also shown in Fig. 1, was smoked rice husk at below 400°C by using some big drum by a farmer. This FRHC was supplied by Tokiwa Poultry in Tokiwa village, Aomori prefecture. However, a few raw rice husks were found in places in Fig. 1.

The chemical components of RHC and FRHC are shown in Table 1. SiO_2 in RHC and FRHC was a large percentage by containing in rice husks themselves, and Al_2O_3 of them in RHC was also richer because bentnite is mainly composed by $Al_2O_3 \cdot 4SiO_2 \cdot nH_2O$, but the percentage of carbon in FRHC was richer than in RHC.

2.2 The experimental hens and the feeding method

In this experiment, each 22 hens (451-day-old laying hens at the starting time) of ASUNARO II-lineage were tested. These hens were classified the last stage of laying hen because of 451-day old. First two days were for the preparatory test, and the test period was exactly 6 weeks from 451-day old.

The feeding method had five ways, i.e. four experiment and one control dietaries. Four experiment dietaries were "1% and 3% RHC", meaning to add the dietaries of 1% and 3% RHC into the formula feed at inner percents, and also "1% and 3% FRHC"; the dietaries of 1% and 3% FRHC samely. The control dietary was indicated "Non RHC", as adding no rice husk charcoal into the formula feed. The crude protein (CP) and the metabolizable energy (ME) of the formula feed was 17.0% and 2,852 kcal per kg, respectively. Laying hens were fed as one hen in one small cage in 3 floor-cages in the same poultry house, while feeding the above dietaries and the drinking water freely.

2.3 Measurement of the environment conditions

The temperature and humidity in the hen's house were recorded by the self-writing temperature and humidity recorder (Sato, NS-IIQ) during the test period. The temperatures in the feces were also measured at about 3cm depth from the feces surface in Non RHC, and 3% RHC, 1% and 3% FRHC dietaries.

The indicator of bad smell is generally based on the ammonia gas density. The ammonia gas densities were measured at about 1cm on the feces of each 4 points in the floors of the control and experiment dietaries in the poultry house without a wind's influence, by the Gas sensor (GASTEC, No.3La, Range of NH_3: 2.5- 200ppm) every week.

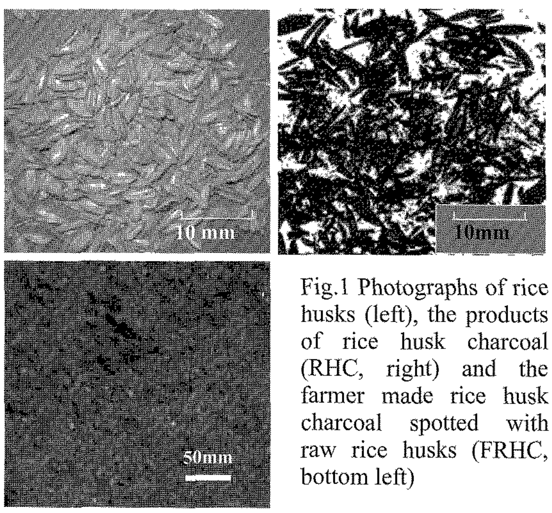

Fig.1 Photographs of rice husks (left), the products of rice husk charcoal (RHC, right) and the farmer made rice husk charcoal spotted with raw rice husks (FRHC, bottom left)

Table 1 Chemical components* of RHC and FRHC

Chemical formula		RHC	FRHC
Ash component except for carbon	SiO_2	63.47	37.91
	Al_2O_3	3.25	0.03
	Fe_2O_3	2.14	0.06
	K_2O	1.25	0.84
	CaO	1.25	0.19
	MgO	0.96	0.08
	Na_2O	0.89	0.22
	Other	0.92	0.38
	Total	74.13	39.71
Carbon		25.87	60.29

* Unit: wt %

2.4 Investigation of the feeding conditions

The feed remained for one week after feeding the feed was measured every week and the feed consumption of hen per day was calculated in each week. The body weight was measured at 0-week (the start of the test), 3-week and 6-week (the last). The feces quantities stacked on each experimental floor were weighed every week. The moisture content of feces at random sampling was measured every week. Above all measuring was conducted in the control and experiment dietaries.

2.5 Investigation of the egg production and qualities

In the egg production, the Hen-day egg production rate, the averaged egg weight (Fig.2) and the egg mass per day were calculated by investigating the egg productive condition every day each hen in the control and experiment dietaries.

In the egg qualities, the height of egg white, the coloring of egg yolk, the eggshell breaking load, the eggshell thickness, the eggshell weight were measured every two weeks by using the 3-point height instrument of egg white, the color meter, the Harding tester (Intesco, H-10), the eggshell thickness instrument and the electronic scale, respectively, as shown in Fig.2. Haugh unit (HU) indicating egg freshness was calculated by using values of the height of egg white and the egg weight.

3. RESULTS AND DISCUSSIONS

3.1 Changes of the environment conditions

Fig. 3 shows changes of the temperature and humidity in the poultry house. The day-average temperature ranged between about 10 to 20°C was gradually dropped down passing days because of autumn. The day-average humidity was ranged 75-100%. The day-maximum temperature was ranged 30-12°C and the day-minimum temperature was also 17-2°C, and the day-maximum

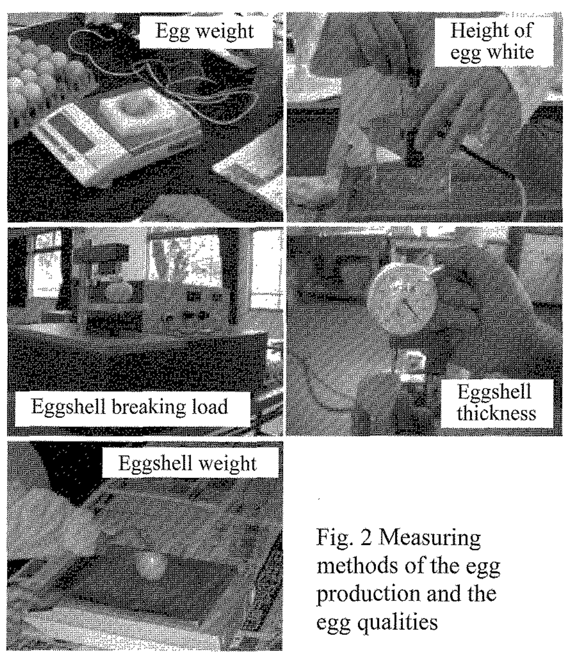

Fig. 2 Measuring methods of the egg production and the egg qualities

humidity was 100% and the day-minimum humidity was also 50-100%. Thus colder environment in the poultry house in autumn may be influenced to the egg production.

The temperature in feces, as shown in Fig. 4, changed to drop down gradually as the temperature in the poultry house dropped down. The temperature in feces in both 3% RHC and FRHC dietaries kept 0.6-0.7°C higher than in the other experiment dietaries. It was estimated that mixing RHC and FRHC in feces was influenced to be keeping the temperature heat slightly.

Fig. 5 shows the change of ammonia gas densities. 3-, 4-, 5- and 6-week during the test was October 21st and 28th, November 4th and 11th, respectively, and the ammonia gas densities dropped down from 3-week until 6-week remarkably as the result of dropping the temperature. Dropping the temperature of house in autumn led the drop of feces temperature and also the reduction of ammonia gas density because of controlling

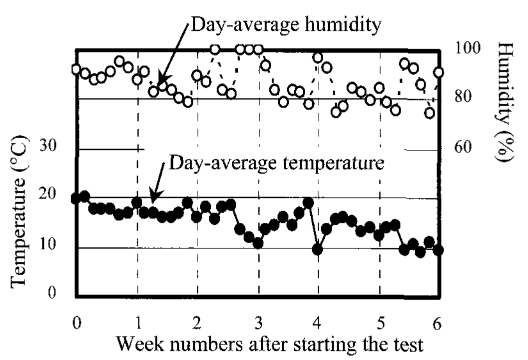

Fig. 3 Changes of the day-average temperature and humidity in the poultry house

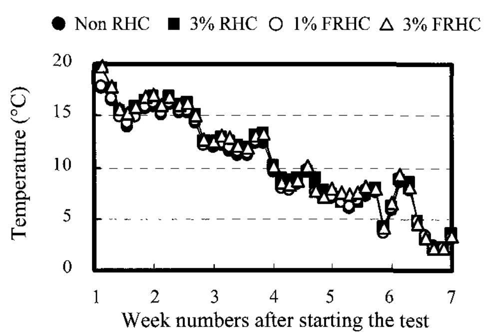

Fig. 4 Changes of the temperature in feces

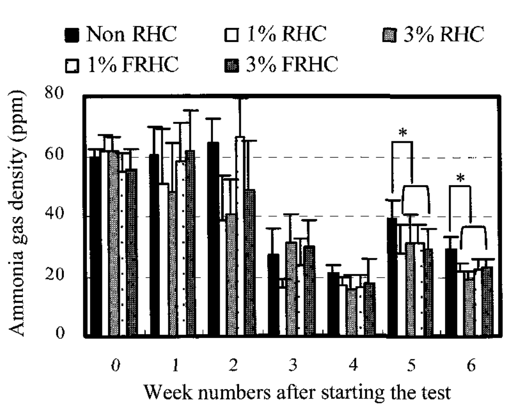

Fig. 5 Changes of the ammonia gas densities

* : a significant difference at 5% level

an activity of bacteria in feces. In 5- and 6-week, the ammonia gas density of both RHC and FRHC dietaries was reduced 21-44% and 21-25% compared with the start conditions, respectively ($P<0.05$), while especially reducing between 2-week and 6-week in 1% RHC dietary continually ($P<0.05$). The averaged ammonia gas density during the test was 38.5ppm in 1% RHC ($P<0.10$), 38.1ppm in 3% RHC ($P<0.10$), 41.8ppm in 1% FRHC and 39.8ppm in 3% FRHC, compared with 43.7ppm in Non RHC dietary.

The moisture contents in feces at 6 weeks, as shown in Table 2, indicated almost same. In both 3% RHC and FRHC dietaries, the moisture contents were less slightly than in the other experiment dietaries. This phenomenon may be influenced to make the feces temperature a little higher.

From these results, it is estimated that the rice husk charcoal taken with the formula feeds reduced the ammonia gas densities in hen's body. Mishina at al [5] reported about the ammonia gas reduction as the effects of feeding wood charcoal flour and wood vinegars, therefore this research led the reduction effects of ammonia gas density from feces by feeding 1% and 3% RHC dietaries.

3.2 Changes of the feeding condition, the body weight and the feces quantity

As shown in Table 2, the average of formula feed per hen during the test was 111.6 g/day in 3% RHC dietary, which was smaller 5.9% than other dietaries with a significant difference ($P<0.05$). As shown in Fig. 6, the body weight in all dietaries was almost same but that in 3% RHC dietary at the start of the test was slightly light, and its tendency was continued until 6-week at last of the test, in spite of old laying hens.

Fig.7 shows the feces quantities per hen per week. The averaged feces quantity per hen was 133.3 g/day in

Table 2 The moisture content of feces, the formula feed per hen and the Hen-day egg production rate

Treatment	Moisture content of feces (%)	Formula feed per hen (g/day)*	Hen-day egg production rate (%)
1% RHC	76.6	117.6 a	73.3
3% RHC	74.9	111.6 b	62.1
1% FRHC	75.3	120.6 a	67.6
3% FRHC	74.0	116.7 a	67.1
Non RHC	76.5	118.6 a	69.2

*Different letters represent sigunificant differences ($P<0.05$)

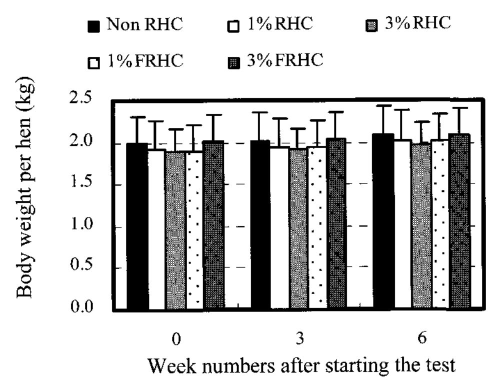

Fig. 6 Changes of the body weight per hen

1% RHC, 135.7 g/day in 3% RHC, 137.5 g/day in 1% FRHC, 133.5 g/day in 3% FRHC, respectively, against 133.8 g/day in Non RHC dietary. The variance of them was, however, found in the control and experiment dietaries each week. Therefore, there was no significant difference among these averaged feces quantities.

Although the growing condition of body weight in all dietaries was almost same, it was estimated that an adjustment of hen's body weight at the start of the test was not enough slightly, and that influenced to not only the difference of the formula feed but also the growing body weight, and the charcoal dietary to hens was not influenced them.

3.4 Changes of the egg production and the egg qualities

In the egg production, the Hen-day egg production rate was indicated that 1% FRHC and 1% RHC dietaries increased but 3% FRHC and 3% RHC dietaries decreased than Non RHC one. The averaged Hen-day egg production rate during the test in 1% RHC dietary was 73.3% and was also improved 4.1% than Non RHC dietary. Then in 3% RHC dietary, that was 62.1% indicating 7.1% lower than Non RHC one. However,

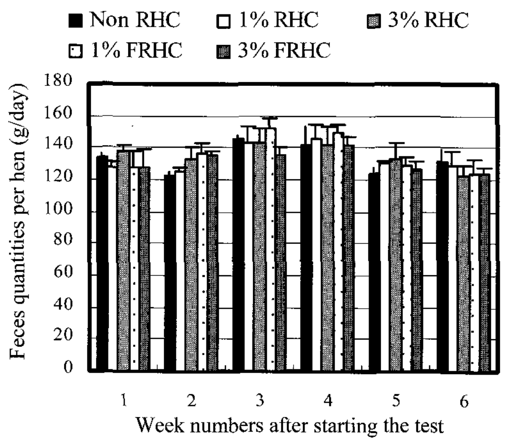

Fig. 7 Changes of the feces quantities per hen

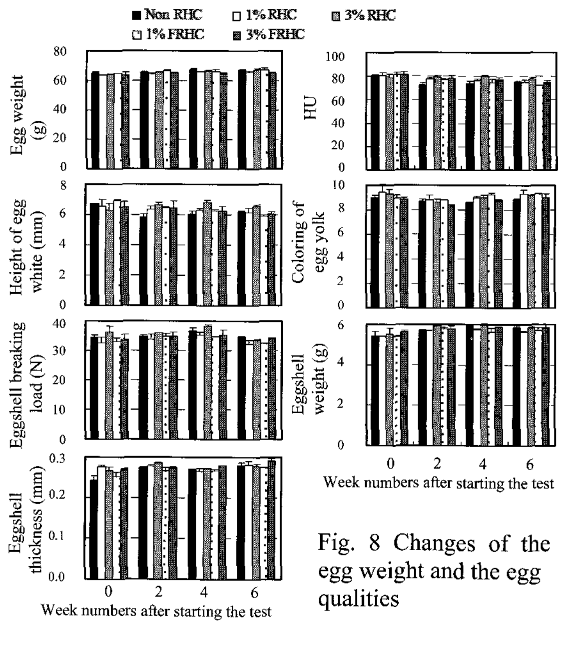

Fig. 8 Changes of the egg weight and the egg qualities

both 1% and 3% FRHC dietaries were almost same as Non RHC dietary. Furthermore, one in Fig. 8 shows the change of egg weight. The difference of the egg weight among 2-, 4- and 6-week against 0-week was clearly not found, and there were no effects by the RHC and FRHC additions.

In the egg qualities, the height of egg white, the eggshell breaking load, eggshell thickness, HU, the color of egg yolk and the eggshell weight are shown in Fig. 8. Except for the color of egg yolk, there were no significant differences. In the color of egg yolk, the experiment dietaries had larger values than the control one. It was estimated the influence of adding the charcoal, indicating a black color, into the formula feed.

4. CONCLUSION

The effects of 1% and 3% RHC and 1% and 3% FRHC added into the formula feed at inner percents were investigated for 6 weeks by using 451-day old lying hens in autumn, in comparison with Non RHC dietary. The results were summarized below;

1) The egg production rate tended to drop in 3% RHC dietary. These influenced that the taste of laying hen became low slightly because of mixing charcoal and that indicating a lower eating the formula feed, rather than 1% RHC and Non RHC dietaries. However, these had no influences to the body weight, the egg weight and the egg qualities.

2) 1% and 3% FRHC dietaries had no difference in the effects of egg qualities compared with Non RHC.

3) The ammonia gas density on their feces at 5-6 weeks was significantly reduced 21-44% in 1% and 3% RHC dietaries and also 21-25% in 1% and 3% FRHC dietaries in comparison with Non RHC dietary, while its reduction effect of FRHC was obviously lower than RHC. Its reduction effect was significantly found in 1% RHC dietary continuously at 2-6 weeks.

5. ACKNOWLEDGMENT

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6. REFERENCES

[1] K. Haga : "Conservation in Animal Husbandry Environment", Ed. by T. Oshida, N. Kakiichi and K. Haga, Yokendo, Tokyo, pp.27-31 and pp.57-60 (1998)

[2] I. Fukumori: Protection of bad smell in animal husbandry by the soil deodorizing method (1), *Research in Animal Husbandry*, 38, 1229-1234 (1984)

[3] I. Fukumori: Practice of Rock-wool deodorizing equipment instead of soil deodorizing method, *Dairy Man*, 42(10), 50-51 (1992)

[4] Y. Hosokawa and K. Saito: Effects of dietary added 1% of rice-husk charcoal to laying hen on their feces-smell and egg qualities –A study on ecological poultry production–, *Transactions of the Material Research Society of Japan*, 32(4), 1143-1146 (2007)

[5] K. Mishina, Y. Suzuki and T. Ohta: An oral administration experiment of the medicine of wood vinegar compounds mainly to reduce ammonia gas from hens feces, *Poultry Disease Research*, 13, 75-78 (1977)

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