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Effects of Dietary added 1% Rice-Husk Charcoal to Laying Hen on their Feces-Smell and Egg Qualities —A Study on Ecological Poultry Production—

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To reduce bad smell from feces of laying hen, the effects of 1% charcoal dietary (the dietary of 1% rice-husk charcoal added to the formula feed) to 372-day-old laying hens were investigated in comparison with the non-charcoal dietary for 6 weeks in the summer period. The results show that both ammonia gas densities on the stacked feces and inside the poultry house by the 1% charcoal dietary were significantly reduced by 52% and 39% of them by the non-charcoal dietary. The Hen-day egg production rate, the egg mass and the eggshell breaking load by the 1% charcoal dietary was tend to be improved by 5%, 4% and 8%, respectively, as compared to the non-charcoal dietary. However, there was no respective difference between both dietaries in the feed consumption, the body weight, the average egg-weight, the eggshell weight, and the feces quantity. Therefore, it was clearly suggested that, although feeding the dietary added only 1% rice-husk charcoal to the laying hens, it did not have bad influences on the egg production and qualities, and the bad smell on the stacked feces and inside the poultry house was effectively reduced.

Key words: Ammonia gas density, Dietary, Egg quality, Feces smell, Laying hen, Rice-husk charcoal

1. INTRODUCTION

The complaint for the livestock farming by residents surrounding livestock farms was investigated by the Ministry of Agriculture, Forestry and Fisheries in 1996, and the result was reported in 1997. In the percentage of complaint kind of the result, bad smell, water pollution, occurrence of harmful insect and noise (including other complaints) was 61%, 34%, 12% and 6%, respectively. Then, in the percentage of livestock kind of the result, pig, milking cows, poultry and beef cattle was 34%, 33%, 20% and 11%, respectively. Thus bad smell in the livestock farming has been mainly a social environmental problem in Japan. Especially in the poultry, bad smell was 50.6%, indicating the most highly percentage of the complaint.

The bad smell in poultry production is caused by mainly a large quantity of ammonia gas as advances of breaking up the organic matter in feces. The reason is why the nitrogen quantity of chicken's feces was 4.6% and this percentage was larger than 1.8% of cattle feces [1]. Many methods to reduce bad smell in pig farms and in poultry farms were developed like the deodorization technologies using soil [2] and rock-wool [3]. Their methods are still costly, however, they hope cheaper methods to reduce bad smell.

Charcoal made from wood and other natural materials has many small apertures to adsorb various gases like bad smell, and is used actually as adsorbents in houses and other places, particularly inside refrigerator and in wash room smelling up sometimes. On the other hand, rice husk is an agricultural waste in the rice production area widely and the quantity of rice husk is amount to about 2 million tons per year in Japan, and about 1 hundred million tons per year in the world. In Japan, rice husk is, for example, used for culvert materials improving bad drainage in rice field ground, for moisture absorption materials of cattle bed in cattle barn or for compost materials from domestic animal, as effective utilization of agricultural waste. However, their quantity is not so many. As the method of making charcoal from rice husk is not difficult, it is interesting if the rice-husk charcoal is effective to adsorb bad smell as environmental improvement material in the livestock farming.

This research was conducted to develop the effective feeding technology using rice-husk charcoal, being a natural material, in the form of new application to ecological poultry production with better environment reducing bad smell from chicken's feces. In this paper, results of examining the effects of the dietary of 1% rice-husk charcoal added to the formula feed to laying hens in the summer 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. Rice-husk charcoal was manufactured by roasting completely in angled-dram after rice husk was enough mixed in the bentnite solution to cover with bentnite. The price of rice-husk charcoal product, bought from Bright Ceramic Co., Ltd., Nagano City, was 208 yen per kg.

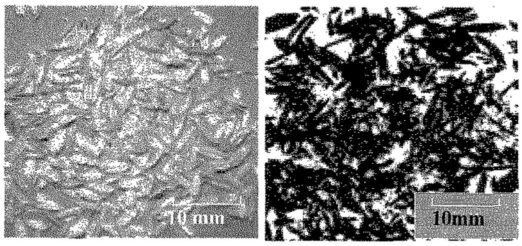

Fig.1 Photographs of rice husk (left) and rice-husk charcoal (right)

Table 1 Chemical components of rice-husk charcoal*

	Chemical formula	Rice-husk charcoal (Product)	Rice-husk charcoal (Farm)
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
	TiO_2	0.26	-
	P_2O_5	0.21	0.21
	SO_3	0.16	0.09
	F	0.15	-
	MnO	0.07	0.10
	BaO	0.04	-
	SrO	0.01	-
	Other	0.02	0.01
	Total	74.13	39.71
Carbon		25.87	60.29

* Unit: wt %

The chemical component of rice-husk charcoal (Product) using in this research is shown in Table 1, in comparison with rice-husk charcoal (Farm), which was in general smoked rice husk by farmer producing rice by using some big drum as an easy method in his garden.

2.2 The experimental laying hens and the feeding method

In this research, each 51 laying hens (372-day old hens at starting time, kind: Road Island Red) were used in the control and the experiment. First two weeks were for the preparatory test, and the test period was exactly 6 weeks from June 7 (386-day old) to July 19 (482-day old).

The feeding method has two ways. One is the dietary of 1% rice-husk charcoal added to the formula feed to laying hens in the experiment in the test period. The other is the non-charcoal dietary, treating in the control and the experiment at the preparatory test period and in the control in the test period to compare with the experiment. Experimental laying hens were fed as one hen in one small cage in 3 floor-cages in a poultry house, while freely drinking water and eating the feed.

2.3 Measurement of the environment conditions in the hen's house

The temperature and the humidity in the hen's house were recorded by the self-writing temperature and humidity recorder (Sato, NS-IIQ) during the test period.

The indicator of bad smell is based on the ammonia gas density. The ammonia gas density was measured in two places. One was inside the poultry house, measured at 1.2 meters height on the floor in the control and the experiment areas at the same one point every week, in the condition of leaving feces stacked in the feces pit for one week before taking them out to the compost facility. The other was on the feces in the compost facility, measured at three points of 2 cm upper on feces every week, without a wind condition. Both ammonia gas densities were measured by the gas sensor (Kitagawa, Gas sensor).

The temperature and humidity surrounding the feces and the feces temperature at 20 cm depth in the compost facility were recorded by the thermo data-loggers (Sato, SK-L200TH and SK-L200T), while the feces was enough mixed up and down themselves to ferment once a week in the compost facility.

2.4 Investigation of the feeding conditions

The feed remained for one-week after feeding the formula feed was measured in each week and the feed consumption per laying hen and per day was calculated in each week. The body weight of laying hen was also measured at the start and the end of this test period. The feces-quantity stacked in the feces pit was measured every one week, and then the feces after taking out from the pit was stacked in the compost facility. The moisture content of feces at random sampling was measured every two weeks. Above all measuring was conducted in the control and experiment areas by the same method to compare.

2.5 Investigation of the egg production and the egg quality

In the egg production, the Hen-day egg production rate, the average egg-weight and the egg mass per day were calculated by investigating the egg productive condition every day each hen in the control and in the experiment.

In the egg quality, the eggshell breaking load and the eggshell weight were measured about all eggs every two weeks, by using the Harding tester (Intesco, H-10) and the electronic scale, respectively.

2.6 The chemical components of the eggshell and the structural investigation on the surface of eggshell

The chemical component of the eggshell was analyzed by using the Fluorescence X-rays Analyzer after grinding enough the mixed eggshell from any ten eggshells in the control and the experiment each.

The structural investigation on the back surface of eggshell and the top surface of eggshell, selected at random from the control and the experiment eggshells, was carried out by using the electron microscope, i.e. SEM (Hitachi High-Technology, S4300 type).

3. RESULTS AND DISCUSSIONS

3.1 Changes of the environment conditions in the poultry house and in the compost facility

Fig. 2 shows changes of the environment conditions in the poultry house. The day-average temperature in 4-6 weeks after starting the test was indicated above 25°C and the maximum temperature during the test period was 39°C. The day-average humidity during the test was indicated 60-90%. Therefore, there was comparatively hot and wet condition in the poultry house and it was

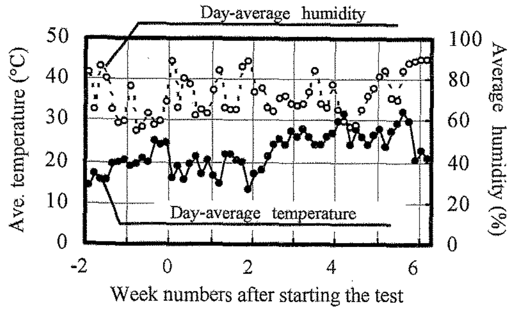

Fig. 2 Changes of the day-average temperature and humidity in the poultry house

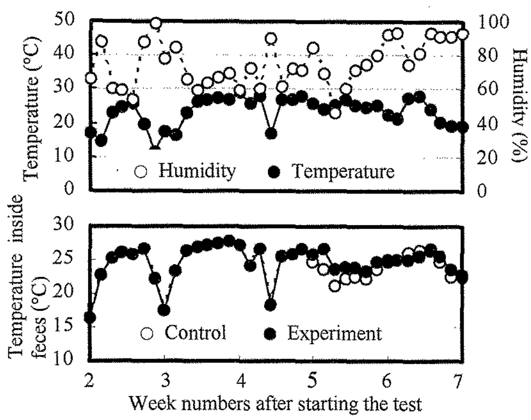

Fig. 3 Changes of the temperature, humidity, and temperature inside feces in the compost facility

estimated that the environmental element to be influenced to the ammonia gas density from raw feces on the floor inside the poultry house and in the compost facility was almost same.

On the other hand, the compost facility was also under hot and wet condition as shown in Fig. 3. The changes of the temperatures inside feces in the control and experiment areas were indicated almost same, and it was suggested that the environmental element to be influenced to the ammonia gas density from feces stacked in the compost facility was almost same.

The change of ammonia gas densities inside the poultry house was shown in Fig. 4. The ammonia gas densities of the control and experiment area was indicated almost same until starting the test but the ammonia gas density in the experiment area was indicated 39% (average) of them in the control during the test period, as being a significant difference at 1% level.

The change of ammonia gas densities on the stacked feces in the compost facility was shown in Fig. 5. The ammonia gas density in the experiment area was also indicated 52% (average) of them in the control during the test period, as being a significant difference at 1% level.

Fig. 6 shows the comparison of water content of feces on the floor in the poultry house. At 2-6 weeks, the water contents of feces in the experiment were slightly lower than the control, while the water contents in the experiment were slightly large. It is estimated that the rice-husk charcoal taken with feeds reduced the ammonia

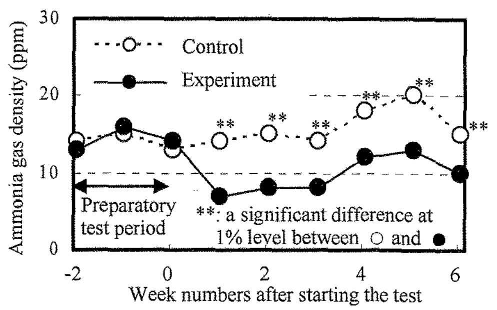

Fig. 4 Changes of ammonia gas densities inside the poultry house

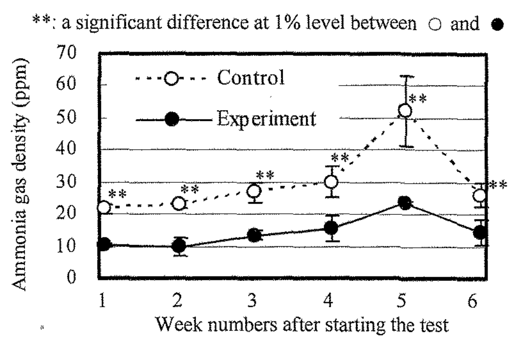

Fig. 5 Changes of ammonia gas densities on the stacked feces in the compost facility

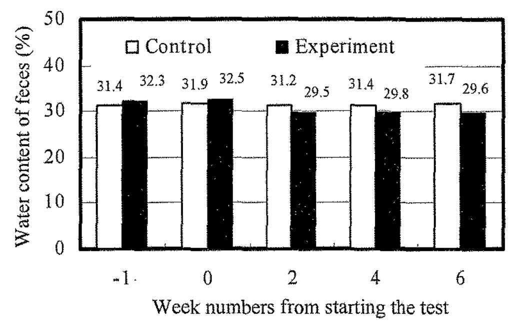

Fig. 6 Comparison of water content of feces

gas densities in hen's body.

From these results, both ammonia gas densities on the stacked feces and inside the poultry house by the 1% charcoal dietary were significantly reduced by 52% and 39% of them by the non-charcoal dietary. Mishina at al [4] reported about the ammonia gas reduction as the effects of feeding wood charcoal flour and wood vinegars, but this research suggested the reduction effects of ammonia gas density by the 1% rice husk charcoal dietary.

3.2 Changes of the feeding condition, the hen's body weight and the feces weight

The formula feed per laying hen and per day was 120-125 g in the control and experiment areas at 0-3 weeks and then 122-110 g at 4-6 weeks in both areas, but it was under a little bit higher in the experiment area. The feed consumption per laying hen and per day was 2.1-2.2 in both areas until 4 weeks and then 2.5-3.5 at 5-6 weeks in both areas, but it was under a slightly higher in the control area.

Hen's body weight at 0 and 6 weeks was 2.197 kg and 2.147 kg in the experiment area and 2.270 kg and 2.154 kg in the control one. The growing condition of body weight in both areas was almost same. The feces weight per laying hen and per day was 100-120 g at 0-3 weeks and then 115-150 g at 4-6 weeks, indicating same condition in the control and experiment areas.

The hot and wet environment element at the latter half of testing periods might be influenced to changes of the formula feed and the feed consumption per laying hen and per day, and also to the decreasing of body weight.

3.4 Changes of the egg production and quality

In the egg production, the Hen-day egg production rate, the average egg-weight and the egg mass per day in the control and experiment areas was 0.776 and 0.816, 63.5 g and 64.0 g, 49.8 g and 51.6 g, respectively. There was no significant between in both areas, however, the Hen-day egg production rate and the egg mass in the experiment area was tend to be improved by 5% and 4%, respectively, rather than the control area.

The eggshell breaking load and the eggshell weight in the control and experiment areas was 24.9 N and 27.0 N, and 4.98 g and 4.91 g, respectively. The eggshell breaking load in the experiment area tended to improve by 8%, as compared to the control area.

3.5 Chemical analysis and SEM-investigation of eggshell

The chemical component of eggshell in the control and experiment areas shows in Table 2. There was no respective difference between both areas except for "Sr",

Table 2 Chemical component of eggshells (%)

Chemical symbol	Control	Experiment	Ratio*
Ca	98.0	98.0	1.00
Mg	0.67	0.60	0.90
S	0.28	0.31	1.11
P	0.26	0.24	0.92
Na	0.19	0.17	0.89
K	0.16	0.14	0.88
Sr	0.09	0.13	1.44
Cl	0.09	0.08	0.89
Fe	0.02	0.03	1.50

* Ratio = Experiment / Control

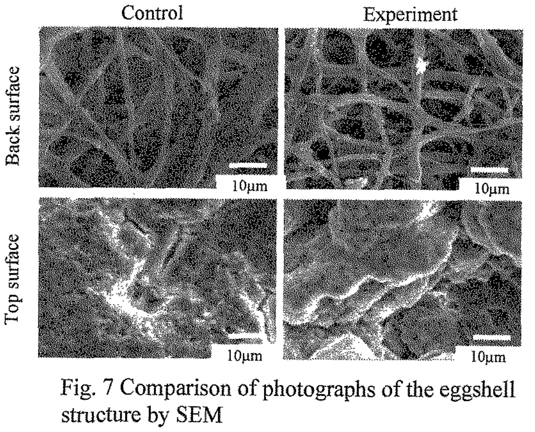

Fig. 7 Comparison of photographs of the eggshell structure by SEM

and the property of "Sr" indicated just like "Ca" to make bone and teeth strong. So, the eggshell breaking load in the experiment area must be stronger. From Fig. 7, the eggshell in the experiment area indicated close structures rather than in the control one.

4. CONCLUSION

In order to reduce the bad smell from feces, the 1% charcoal dietary (the dietary of 1% rice-husk charcoal added to the formula feed) to 372-day-old laying hens were investigated for 8 weeks including two-week preparatory test period in the summer, as compared with the non-charcoal dietary.

The results show that both ammonia gas densities on the stacked feces and in the poultry house by the 1% charcoal dietary were significantly reduced by 52% and 39% of them by the non-charcoal dietary. The Hen-day egg production rate, the egg mass and the eggshell breaking load by the 1% charcoal dietary was tend to be improved by 5%, 4% and 8%, respectively. However, there was no respective difference between the 1% charcoal dietary and the non-charcoal dietary in the feed consumption, the body weight, the average egg-weight, and the feces quantity. Therefore, feeding the dietary added 1% rice-husk charcoal effectively reduced both bad smell on the stacked feces and in the poultry house, without bad influences on the egg production and qualities.

5. ACKNOWLEDGMENT

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