Effects of Feeding Dried Leftover Food on Productivity of Laying Hens

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ABSTRACT : This experiment was conducted to investigate the effects of different levels of dried leftover food (DLF) in the diet on feed utilization and egg-laying performance of hens. One hundred sixty-eight, 18 week old Tetra brown commercial layers, were assigned to 7 treatments in a completely randomized design. Each treatment has four replications per treatment with six animals per replication. All the experimental animals were fed diets for 7 weeks. The treatments included 1) control group without DLF, 2) diet with 10% DLF, 3) diet with 20% DLF, 4) diet with 30% DLF, 5) 10% higher protein level of diet with 10% DLF, 6) 20% higher protein level of diet with 20% DLF and 7) 30% higher protein level of diet with 30% DLF. Average daily feed intake (ADFI) tended to be improved with DLF feeding. ADFI of group fed diets with 20% was significantly higher than that of control ($p<0.05$). Feed conversions of DLF-fed groups were higher than that of control. Egg production tended to be higher in groups fed diets with 10% DLF than control diet without significant differences ($p>0.05$). However, those of groups fed diets containing 20 and 30% DLF were lower than that of control. Supplementing protein source to DLF-containing diets improved egg production ($p<0.05$). Increasing level of DLF in the diet for layer decreased egg weight and egg mass compared to control without significant differences ($p>0.05$). Protein supplementation to DLF-containing diets increased egg mass without significant difference ($p>0.05$). The range of egg cholesterol concentration of DLF-fed groups was 11.94-14.10 mg/g while that of control group was 12.31 mg/g although there was no significant difference among treatments ($p>0.05$). ***(Asian-Aust. J. Anim. Sci. 2004. Vol 17, No. 4 : 518-522)***

Key Words : Laying Hens, Dried Leftover Food, Feed Conversion, Egg Production, Yolk Cholesterol

INTRODUCTION

The amount of leftover foods generated annually was estimated 4.2 million tons in Korea. In recent years, leftover foods were disposed as landfill or burned out. But landfill disposal has been causing a pollution problem associated with underground water quality. However, it is impossible to continue landfill disposal from 2005 in Korea when Korean government will put more strict regulation on the factors causing environment pollution. We would also expect various problems associated with a setup and management of incinerator because of air pollution caused by incineration. Therefore, such an increasing demand for resource preservation has stimulated recycling of leftover foods into livestock feed and crop fertilizer.

Protein, fat, and mineral contents of leftover foods are adequate enough to use as feed resources although its salinity content is relatively high. Kim (1995) reported that dried leftover foods could be used as a supplemental feed or a feed ingredient for swine and poultry. He also reported that approximate composition of leftover foods was 20-28% for crude protein (CP), 10-14% for crude fat (EE), 2-4% for crude fiber (CF) and 6-12% for crude ash when its moisture content was below 5%. Soliman et al. (1978), Hoshii and Yoshida (1981), and Lipstein (1984, 1985) also suggested that leftover food has such nutritive values necessary to use as an ingredient of feed for broiler and laying hens. Sehgal and Simmi (1993) reported that leftover food could save production costs of commercial feed by substituting 25% of it with leftover foods.

Maeng et al. (1997) found that increasing substitution levels of fermented leftover foods in the diet for laying hens resulted in increasing feed intake. They also observed that there were no significant differences in egg production up to 80% substitution level. Egg weight was not different between substitution levels except 20% substitution level. The objective of this experiment was to determine the optimal level of dried leftover foods in the diet for laying hens in terms of feed utilization and egg quality.

MATERIALS AND METHODS

Animals and experimental design

One hundred sixty-eight 18 week-old Tetra brown commercial layers were assigned to 7 treatments in a completely randomized design. Each treatment has four replications with six animals per replication. All the animals were fed experimental diets for 7 weeks.

The treatments were 1) control without dried leftover foods (DLF), 2) diet containing 10% DLF, 3) diet containing 20% DLF, 4) diet containing 30% DLF, 5) 10% higher protein level of diet containing 10% DLF, 6) 20% higher protein level of diet containing 20% DLF and 7) 30% higher protein level of diet containing 30% DLF.

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Table 1. Formula and chemical composition of experimental diets (%)

Ingredients	Control	DLF 10%	DLF 20%	DLF 30%	AP10+ DLF 10%	AP20+ DLF 20%	AP30+ DLF 30%
Dried leftover food	0.00	10.00	20.00	30.00	10.00	20.00	30.00
Corn grain	65.59	59.90	55.38	49.74	58.10	51.30	42.84
Wheat bran	6.50	7.05	4.50	5.10	4.10	0.00	0.00
Soybean meal-45	16.00	12.05	12.60	8.50	17.07	20.50	18.20
Corn gluten meal-60	2.60	2.55	0.00	0.00	2.35	0.80	2.40
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Vit.-Min. premix[1]	0.30	0.30	0.30	0.30	0.30	0.30	0.30
L-Lysine	0.04	0.14	0.15	0.24	0.08	0.07	0.19
Methionine	0.07	0.10	0.17	0.19	0.12	0.19	0.23
Limestone	7.73	6.78	5.87	4.98	6.78	5.87	4.96
Tricalcium phosohate	0.87	0.83	0.73	0.60	0.80	0.67	0.58
Chemical composition[2]							
ME (kcal/kg)	2,750	2,750	2,750	2,750	2,750	2,750	2,750
Crude protein (%)	15.01	15.02	15.03	15.01	16.51	18.00	19.50
Lysine (%)	0.69	0.69	0.70	0.69	0.76	0.83	0.90
Methionine (%)	0.30	0.30	0.30	0.30	0.33	0.36	0.39
Ca (%)	3.25	3.25	3.25	3.25	3.25	3.25	3.25
Avail. P (%)	0.25	0.25	0.25	0.25	0.25	0.25	0.25

[1] Vit-min. mix provided following nutrients per kg of diet: Vit. A, 9,000,000 IU; Vit. D_3, 2,100,000 IU; Vit. E, 15,000 IU; Vit. K, 2,000 mg; Vit. B_1, 1,500 mg; Vit. B_2, 4,000 mg; Vit. B_6, 3,000 mg; Vit. B_{12}, 15 mg; Pan-Acid-Ca, 8,500 mg; Niacin, 20,000 mg; Biotin, 110 mg; Folic-acid, 600 mg; Fe, 40,000 mg; Co, 300 mg; Cu, 3,500 mg; Mn, 55,000 mg; Zn, 40,000 mg; I, 600 mg; Se, 130 mg.

[2] Calculated values. DLF: Dried leftover food, AP: Additional protein based on control.

Table 2. Effects of feeding DLF on feed intake of laying hens (g/hen/day)

Weeks \ Treatments	Control	DLF 10%	DLF 20%	DLF 30%	AP10+ DLF 10%	AP20+ DLF 20%	AP30+ DLF 30%
1	115.5	127.5	96.5	121.5	133.5	120.0	128.5
2	113.0[b]	120.0[ab]	133.5[a]	120.0[ab]	120.0[ab]	120.0[ab]	125.0[a]
3	113.0[b]	119.0[b]	138.0[a]	115.5[b]	125.0[ab]	115.5[b]	116.5[b]
4	107.0[b]	116.5[ab]	134.0[a]	121.5[ab]	130.0[ab]	127.5[a]	120.0[ab]
5	113.0[b]	122.5[ab]	147.5[a]	116.5[b]	128.5[ab]	131.0[ab]	124.0[ab]
6	114.5[b]	121.5[ab]	130.0[ab]	120.0[ab]	124.0[ab]	132.0[a]	121.5[ab]
7	107.0	106.0	119.0	112.0	115.5	113.0	113.0
Overall	111.9[b]	119.0[ab]	128.4[a]	118.0[ab]	125.2[ab]	122.7[ab]	121.2[ab]

[a, b] Means with different superscripts within row are significantly different ($p<0.05$). DLF: Dried leftover food, AP: Additional protein based on control.

Experimental diets and feeding

Dried leftover food as a feed resource was processed by the fluidized bed dry method at a local processing company (Samneung construction Inc. Gwangju, Korea). Chemical compositions of dried leftover foods were analyzed according to AOAC. method (1990). The chemical compositions of DLF were as follows: 93.70% dry matter (DM), 20.62% CP, 9.99% EE, 8.87% CF, 13.67% crude ash, 0.41% lysine and 0.18% methionine. The ingredients and chemical compositions of experimental diets are shown in Table 1. Laying hens were individually housed in three-layer cage and offered water and experimental diets with free access. Other managements followed the routine practices adopted by the farm.

Measurements

Feed intake and feed conversion : Feed intake was determined by measuring feed residues on weekly basis since the beginning of the experiment. Feed conversion was calculated by dividing feed intake by egg mass.

Egg production, egg weight and egg mass : Egg production was calculated by collecting eggs daily and dividing them by number of layers. Egg weight was measured with electronic scales by treatment. Egg mass was calculated by multiplying average egg weight by egg production.

Eggshell thickness : Egg yolk, white and eggshell membranes were removed from bursted egg and eggshell thickness was represented as average thickness of large band, sharp end, and middle of eggshell using Dial pipe gauge (FHK, Japan).

Yolk cholesterol : Eight eggs were collected from each treatment for cholesterol analysis. The cholesterol contents were analyzed according to the method of Brunnekreeft et al. (1983) using Gas Chromatography (GC): 0.5 g of homogenized egg yolk samples with 4 mg of cholestane in 0.5 N KOH solution were saponificated for 30 min. at 55°C. After saponification, samples were extracted with hexane

Table 3. Effects of feeding DLF on feed conversion of laying hens

Weeks \ Treatments	Control	DLF 10%	DLF 20%	DLF 30%	AP10+ DLF 10%	AP20+ DLF 20%	AP30+ DLF 30%
1	2.36^{b}	2.47^{a}	2.41^{ab}	2.45^{ab}	2.46^{ab}	2.39^{ab}	2.46^{ab}
2	1.97^{b}	2.24^{ab}	2.90^{a}	2.46^{ab}	2.39^{ab}	1.70^{ab}	2.11^{ab}
3	2.02^{ab}	1.98^{b}	2.84^{a}	2.21^{ab}	2.15^{ab}	1.98^{ab}	1.96^{b}
4	1.90^{b}	2.01^{b}	2.65^{a}	2.50^{a}	2.17^{b}	2.23^{ab}	2.10^{b}
5	2.04^{b}	2.17^{b}	2.91^{a}	2.22^{b}	2.20^{b}	2.22^{b}	2.07^{b}
6	1.92^{c}	2.07^{c}	2.42^{ab}	2.37^{ab}	1.91^{c}	2.46^{a}	1.98^{c}
7	1.78^{b}	1.84^{b}	2.23^{a}	2.22^{ab}	1.85^{b}	1.95^{b}	1.89^{b}
Overall	2.00^{b}	2.11^{ab}	2.62^{a}	2.34^{a}	2.16^{ab}	2.17^{b}	2.08^{b}

$^{a, b, c}$ Means with different superscripts within row are significantly different (p<0.05).

Table 4. Effects of feeding DLF on egg production of laying hens (%)

Weeks \ Treatments	Control	DLF 10%	DLF 20%	DLF 30%	AP10+ DLF 10%	AP20+ DLF 20%	AP30+ DLF 30%
1	84.3^{ab}	88.4^{ab}	79.4^{d}	79.3^{d}	95.2^{ab}	86.0^{c}	89.3^{a}
2	93.1^{ab}	96.3^{ab}	84.4^{d}	85.1^{d}	95.2^{ab}	95.1^{c}	101.0^{a}
3	93.3^{abc}	97.0^{ab}	83.3^{d}	85.2^{d}	95.1^{ab}	89.0^{c}	99.1^{a}
4	91.5^{ab}	96.2^{ab}	86.0^{d}	85.0^{d}	98.4^{ab}	93.2^{c}	98.0^{a}
5	91.2^{ab}	90.5^{ab}	86.3^{d}	85.2^{d}	98.0^{ab}	95.0^{c}	101.0^{a}
6	94.2^{ab}	93.2^{ab}	86.2^{d}	83.0^{d}	97.1^{ab}	86.2^{c}	99.1^{a}
7	98.1^{a}	93.0^{ab}	88.5^{d}	85.1^{d}	99.0^{ab}	92.3^{c}	97.2^{a}
Overall	92.2^{ab}	93.5^{ab}	84.8^{d}	83.9^{d}	96.8^{ab}	90.9^{c}	97.8^{a}

$^{a, b, c, d}$ Means with different superscripts within row are significantly different (p<0.05).

Table 5. Effects of feeding DLF on egg weight of laying hens (g)

Weeks \ Treatments	Control	DLF 10%	DLF 20%	DLF 30%	AP10+ DLF 10%	AP20+ DLF 20%	AP30+ DLF 30%
1	58.24^{ab}	58.64^{ab}	50.67^{a}	62.81^{ab}	57.23^{ab}	58.44^{a}	58.79^{ab}
2	61.65^{ab}	55.94^{ab}	54.77^{a}	57.57^{ab}	52.84^{ab}	63.32^{a}	58.78^{ab}
3	60.21^{ab}	62.16^{ab}	58.60^{a}	61.54^{ab}	61.37^{ab}	65.59^{a}	60.12^{ab}
4	61.81^{ab}	60.49^{ab}	60.19^{a}	57.99^{ab}	61.09^{ab}	61.51^{a}	58.43^{ab}
5	61.03^{ab}	62.89^{ab}	58.93^{a}	61.83^{ab}	59.62^{ab}	62.28^{a}	59.25^{ab}
6	63.44^{ab}	63.27^{ab}	62.49^{a}	61.03^{ab}	67.08^{ab}	62.41^{a}	62.03^{ab}
7	61.59^{ab}	62.20^{ab}	59.53^{a}	59.45^{ab}	63.22^{ab}	63.01^{a}	61.84^{ab}
Overall	61.13^{ab}	60.79^{ab}	57.88^{a}	60.31^{ab}	60.35^{ab}	62.36^{a}	59.89^{ab}

$^{a, b}$ Means with different superscripts within row are significantly different (p<0.05).

and loaded into GC (HP 5890 series II). Column condition was 25 m×0.32 mm×0.17 μm size of cross-linked methyl silicone HP-1 capillary column with 290°C of running temperature.

Statistical analysis

Differences among treatment means were analyzed using Duncan's Multiple Range Test (Duncan, 1955) with SAS program (SAS, 1995).

RESULTS AND DISCUSSION

Feed intake and feed conversion

The effects of feeding DLF on feed intake of laying hens are shown in Table 2. Average feed intakes of group fed diets containing DLF were higher than that of control during the whole experiment period. Feed intake of group fed diet containing 20% DLF (128.4 g) was significantly higher than that of control (111.9 g) (p<0.05). This agreed well with other results that feed intake was higher when fermented leftover food replaced up to 50% of the feed for laying hens (Maeng et al., 1997).

Increasing level of DLF in the diet resulted in decreasing feed intake without significant difference (p>0.05). However, this result conflicted with other reports that increasing level of swine manure and leftover food mixture in broiler diet increased feed intake (Kim et al., 2001).

The effects of feeding DLF on feed conversion of laying hens are shown in Table 3. Feed conversion of group fed diet containing 20% DLF (2.62) was significantly higher than control group (2.00). However, no differences in feed conversion were found among group fed diets containing 10% DLF and groups fed higher protein levels of diets containing DLF.

Egg production, egg weight and egg mass

The effects of feeding DLF on egg production of laying

Table 6. Effects of feeding DLF on egg mass of laying hens (g)

Weeks \ Treatments	Control	DLF 10%	DLF 20%	DLF 30%	AP10+ DLF 10%	AP20+ DLF 20%	AP30+ DLF 30%
1	48.92[ab]	51.60[a]	40.03[b]	49.62[ab]	54.37[a]	50.26[a]	52.32[a]
2	57.33[b]	53.70[a]	46.04[a]	48.93[a]	50.20[a]	60.15[a]	59.37[a]
3	56.00[ab]	60.30[a]	48.64[b]	52.31[ab]	58.30[ab]	58.38[ab]	59.52[a]
4	56.25[ab]	58.07[ab]	50.56[bc]	48.71[c]	59.87[a]	57.20[abc]	57.26[abc]
5	55.54[b]	56.60[a]	50.68[a]	52.56[a]	58.43[a]	59.17[a]	59.84[a]
6	59.63[ab]	58.84[abc]	53.74[bc]	50.65[c]	65.07[a]	53.67[bc]	61.41[ab]
7	60.36[ab]	57.85[ab]	52.39[bc]	50.53[c]	62.59[a]	57.97[ab]	59.98[ab]
Overall	56.25[ab]	56.70[ab]	48.86[c]	50.67[ab]	58.54[a]	56.68[ab]	58.52[a]

[a, b, c] Means with different superscripts within row are significantly different ($p<0.05$).

Table 7. Effects of feeding DLF on eggshell thickness of laying hens (μm)

Weeks \ Treatments	Control	DLF 10%	DLF 20%	DLF 30%	AP10+ DLF10%	AP20+ DLF20%	AP30+ DLF30%
1	380	400	360	410	400	360	380
2	350	380	360	380	370	370	350
3	390	360	360	370	400	320	380
4	350	400	390	370	360	390	370
5	370	410	380	380	400	380	370
6	400	410	420	420	390	410	410
7	390	400	400	410	430	400	380
Average	375.7	394.3	381.4	391.4	392.9	375.7	377.1

Table 8. Effects of feeding DLF on egg yolk cholesterol levels

Item	Cholesterol (mg/g)
Control	12.31±2.57[ab]
DLF 10%	13.53±1.78[ab]
DLF 20%	14.19±0.56[a]
DLF 30%	12.80±0.95[ab]
AP10+DLF 10%	13.06±0.70[ab]
AP20+DLF 20%	11.94±0.43[b]
AP30+DLF 30%	12.69±0.71[ab]

[a,b] Means with different superscripts within column are significantly different ($p<0.05$).

hens are shown in Table 4. Egg production of group fed diet containing 10% DLF tended to be higher than that of control group without significant difference ($p>0.05$). However, egg productions of groups fed diet containing 20% DLF (84.8%) and 30% DLF (83.9%) were significantly lower than that of control (92.2%) ($p<0.05$). Additional protein supplementation improved egg production. Similar results were reported from other research groups that appropriate level of egg production could be achieved with additional supplementation of limited amino acids to low energy feed (Johnson and Fisher, 1959; Quisenberry, 1965; Petersen et al., 1971).

The effects of feeding DLF on egg weight of laying hens are shown in Table 5. Egg weights of DLF-fed groups were lower than that of control without significant differences. This result was in good agreement with other report that increasing supplementary protein level failed to increase egg weight (Lee et al., 1987).

The effects of feeding DLF on egg mass of laying hens are shown in Table 6. Increased level of DLF in the diet for laying hens decreased egg mass. Additional protein supplementation improved egg mass without significant difference ($p>0.05$). Egg mass of group fed diet containing 20% DLF was significantly lower than the other groups ($p<0.05$), due to low egg mass during the first 3 weeks of the experiment.

Eggshell thickness

The effects of feeding DLF on eggshell thickness of laying hens are shown in Table 7. Eggshell thicknesses of DLF-fed groups were thicker than that of control. But, increasing level of DLF decreased eggshell thickness. Ahn et al. (1981) reported that eggshell thickness was thinnest from June to September while it gradually increased from September to March showing the thickest in March. After that, eggshell thickness decreased gradually. Average eggshell thickness was 360 μm for the eggs being traded in commercial market.

In this study, overall eggshell thickness was thicker than annual average because this experiment was conducted during the period of December 2000 to February 2001. More than 360 μm of eggshell thickness are required to prevent egg loss during distribution.

Yolk cholesterol

The effects of feeding DLF on egg yolk cholesterol levels are shown in Table 8. The range of egg yolk cholesterol concentrations of groups fed diets containing DLF were 11.94-14.19 mg/g. There were no significant differences in egg yolk cholesterol concentrations between DLF-fed groups and control (12.31 mg/g) ($p>0.05$). These

Table 9. Effects of feeding DLF on the economic efficacy of laying hens

Item	Control	DLF 10%	DLF 20%	DLF 30%	AP10+ DLF 10%	AP20+ DLF 20%	AP30+ DLF 30%
Feed cost (US $ /kg)	1.32	1.24	1.13	1.04	1.28	1.22	1.21
Feed intake (kg)	5.48	5.83	6.29	5.79	6.13	6.01	5.94
Total feed cost (US $)	7.23	7.22	7.09	6.04	7.83	7.33	7.16
Total egg mass (kg)	2.76	2.97	2.41	2.48	2.86	2.78	2.87
Feed cost per kg egg mass (US $)	2.62	2.43	2.94	2.44	2.74	2.64	2.50
Index	100.00	92.90	112.39	93.03	104.64	100.75	95.36

values were similar to that of Miller and Denton (1962) who reported that concentration of cholesterol in yolk was 12.6-20.2 mg/g when adding dried yolk to feed for laying hens. Li and Ryu (2001) also reported similar results when wood vinegar was supplemented to the diets for laying hens.

Economic analysis

The effects of feeding DLF on the economic efficacy of laying hens are shown in Table 9. Feed cost per unit kg of egg mass was decreased with increased level of DLF in the diet. Feed cost per 1 kg egg mass was about 7% lower in layers fed diets containing 10 and 30% DLF compared to control. Therefore, it appears that the most cost-effective level of DLF in the diet for laying hens should be 10%. It was recommended that additional protein supplementation should be required for those groups fed diets containing more than 20% of DLF in order to achieve the same performance as those fed diet containing less than 10% DLF.

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