The Effect of Mustard Meal in Laying Hen Diets

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ABSTRACT : A total of 252, 50 week-old Isa-brown laying hens were randomly allotted to 7 groups of 3 replicates. Mustard meal (MM) which is a by-product from mustard processing plant, was dried under the sun or in a gas heated pan. It contained on DM basis 30-32% CP, 19-22% EE and 12-13% CF. The meal from either drying method was incorporated into the diets at 0, 10, 20 and 30% which was equivalent to the substitution levels for soybean meal at 0, 31, 63 and 94%, respectively. All birds were individually kept in battery cages where feed and water were freely accessed throughout 84 days experimental period. It was found that egg production, feed intake, body weight gain and egg weight significantly decreased with the increased MM level. The inclusion of 20% MM did not show a significant difference in egg production and quality from the control, but produced 6-8% lower egg production. Feed intake was linearly decreased with the MM levels, except the 10% sun dried MM group. Fat deposition of the birds fed MM diets significantly decreased, while kidney weight increased when compared with the control group. However, the weight of thyroid glands and spleen trended to be heavier in the MM groups, but this was not significantly different among dietary treatments. It was concluded, MM from both drying methods could be incorporated in laying hen diets at the level of 10% without any adverse effect. (*Asian-Aust. J. Anim. Sci. 2001. Vol 14, No. 11 : 1605-1609*)

Key Words : Mustard Meal, Plant Protein, Visceral Organ, Thyroid Gland, Laying Hen

INTRODUCTION

Mustard belongs to the same family (*Brassica*) as rape seed. It has many species and tolerates well drought and cold conditions (Downey, 1983). Although this plant is not cultivated in Thailand, a high amount of the seed (3,000 tons/year) has been imported for essence oil and flavor extraction. The extracted products are exported to Japan.

Since only 20% of oil and 1% of essence oil and hot flavor are extracted from the seed, 79% which is equal to about 2,400 tons/year was discarded. This residue (mustard meal, MM) contained on DM basis 30-32% crude protein (CP), 19-22% ether extract (EE), 12-13% crude fiber (CF), 5-6% ash and 28-31% nitrogen free extract (NFE; Cheva-Isarakul et al., 2001). The sun dry residue had 2,888 kcal AME or 3,348 kcal TME/kg DM (Cheva-Isarakul et al., 2001). It should be used as animal feed. However, some toxic substances, e.g. glucosinolate and sinapine, may remain in the meal in a substantial amount (Göhl, 1981; Bell, 1990; Newkirk et al., 1997), this causes an adverse effect on poultry performances if a high level of MM is incorporated in the diet (Bhattacharjee et al., 1995).

Tangtaweewipat et al. (2001) found that MM could be fed to broilers at 10% of the diet without adverse effect on performances and carcass quality. Das and Ali (1993) reported that MM could substitute for sesame meal at 50% without harm on egg production, but at a higher incorporation level, it decreased egg size and feed intake. Marangos and Hill (1976) noted that MM could be used in a layer diet at 12% with safety for egg production, but it caused fishy flavor.

MM has been investigated for ME value and the potential for use in broiler diets, but information for layers was missing. Therefore, the objective of this experiment was to find out the optimum level of MM in layer diets which cause no adverse effect on production performance and egg quality.

MATERIALS AND METHODS

Two hundred fifty two Isa-brown layers of initial age 50 weeks were randomly allotted to 7 groups, each of 3 replicates (12 heads/rep.). They were raised individually in battery cages. Water and feed, in mash form, were provided *ad libitum* while light was given 16 hours/day.

Two types of MM were used, i.e. gas dry and sun dry at 0, 10, 20 and 30% of the diet which were equal to the substitution of soybean meal (SBM) at 0, 31, 63 and 94%, respectively. All diets were isonitrogenous and isocaloric at 16% CP and 2.8 kcal/g air dry. Feed formulation and nutrient composition are shown in table 1.

The work was conducted at Chiang Mai University farm for 84 days (3 periods, each lasted 28 days) during June-September, 2000. Hens were weighed individually at the beginning and the end of the experimental period. All eggs were weighed and graded. Haugh unit, egg shell thickness, and egg yolk color were determined from 2 eggs in each replicate during the last 3 days of each period. At the end of each experiment, 3 hens/group were slaughtered. Heart, liver,

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Table 1. Feed formulation and nutrient composition of laying hen diets during 50-62 weeks of age

Type of MM		Sun dried[1]			Gas dried[1]		
MM in diet (%)	0	10	20	30	10	20	30
MM substit. SBM (%)	0	31	63	94	31	63	94
Ingredients:							
Corn	57.16	53.34	49.52	45.70	52.60	48.02	43.45
SBM (44% CP)	18.42	12.62	6.83	1.03	12.64	6.86	1.08
MM [2]	0.00	10.00	20.00	30.00	10.00	20.00	30.00
Rice bran oil	0.52	0.35	0.17	0.00	1.08	1.64	2.20
DCP	0.88	0.82	0.76	0.70	0.82	0.76	0.70
Oyster shell	7.89	7.80	7.70	7.61	7.79	7.70	7.60
Met	0.11	0.09	0.08	0.06	0.09	0.08	0.07
Lys	0.12	0.08	0.04	0.00	0.08	0.04	0.00
Constant[3]	14.90	14.90	14.90	14.90	14.90	14.90	14.90
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated chemical composition (% air dry basis);							
CP	16.00	16.00	16.00	16.00	16.00	16.00	16.00
ME (kcal/g)	2.80	2.80	2.80	2.80	2.80	2.80	2.80
CF	4.89	5.43	5.96	6.50	5.42	5.96	6.49
EE	4.44	5.78	7.12	8.46	6.78	9.12	11.47
Ca	3.40	3.40	3.40	3.40	3.40	3.40	3.40
P, available	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Lys	0.80	0.80	0.80	0.81	0.80	0.80	0.81
Met	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Met + Cys	0.58	0.57	0.57	0.56	0.57	0.56	0.56

[1] 3 days sun dried or 8 h dried in a pan by gas heating.

[2] CP, EE, CF (%) and ME (kcal/g) of sun dried mustard meal were 28.90, 17.07, 11.34, 2.724, while those of gas dried mustard meal were 29.50, 20.04, 11.56 and 2.328, respectively.

[3] The other ingredients were incorporated in all diets at a constant percentage, i. e. rice bran 12.00, fish meal (57% CP) 2.40, salt 0.25 and vitamin-mineral premix (BASF) 0.25.

pancreas, kidney, spleen, abdominal fat and thyroid glands were weighed and calculated as percentage of body weight. Mortality was recorded immediately. All data were subjected to ANOVA according to completely randomized design. The difference between groups was tested using Duncan's new multiple range test (Steel and Torrie, 1984).

RESULTS

Production performance and egg quality

The use of MM in layer diets, regardless of drying method, caused a reduction in egg production with increasing level of MM although no significant difference was found when the incorporation level was less than 20%. Feed intake significantly decreased with the increasing level of MM except the group fed 10% sun dry. However, there was no significant difference among groups fed 20% MM in feed conversion ratio. Body weight of hens fed 20-30% MM decreased while those fed 10% or the control diet gained weight (table 2).

Hen fed up to 20% MM produced smaller eggs and pale color of yolk than the control. However, specific gravity, Haugh unit and egg shell thickness were not affected by MM (table 2).

Visceral organs and thyroid glands

The use of MM significantly decreased abdominal plus visceral fat while kidney weight increased. The weight of thyroid glands and spleen tended to increase. However, MM had no effect on the weight of heart, liver and pancreas (table 3).

Production cost

Since MM was a nonconventional feed and is still uncommercialized, there was no actual price. However, the price of MM in this experiment was assumed, according to its nutritive value, to be around 55% of SBM (5.00 vs 9.10 Baht/kg, approx. 1 $US = 43 Baht). It was found that feed price as well as feed per kg egg of the groups fed MM was lower than the control. At 10-20% incorporated level, the sun dry meal gave a lower feed cost than the gas dry meal, but at 30% both types of meal gave a similar result (table 4).

DISCUSSION

The decreasing of production performances (egg production, egg weight and body weight gain) according to the increased level of MM was due to the lower intake of

Table 2. Production performance of laying hen fed diets containing various levels of mustard meal (MM) during 50-62 weeks of age

MM level in diet (%)	0	10		20		30		
MM substit. SBM (%)	0	31		63		94		SEM
Type of MM[1]	-	Sun	Gas	Sun	Gas	Sun	Gas	
Performance								
Egg production (%)	86.74^{a}	83.58^{a}	81.42^{ab}	80.00^{ab}	78.13^{abc}	70.71^{c}	73.27^{bc}	1.0
Feed intake (g)	120.2^{a}	112.6^{ab}	110.4^{bc}	110.2^{bc}	107.1^{bcd}	103.9^{cd}	101.3^{d}	1.0
Feed/dozen egg (kg)	1.66	1.62	1.63	1.65	1.65	1.77	1.66	0.01
Feed/kg egg (kg)	2.16^{b}	2.15^{b}	2.16^{b}	2.25^{b}	2.20^{b}	2.42^{a}	2.28^{ab}	0.02
Body weight gain (g)	86.7^{a}	68.2^{a}	25.1^{ab}	-6.2^{bc}	-26.7^{bcd}	-94.6^{d}	-74.4^{cd}	8.60
Egg quality								
Egg weight (g)	64.26^{a}	62.78^{ab}	62.69^{ab}	61.24^{b}	62.23^{ab}	60.75^{b}	60.56^{b}	0.3
Specific gravity	1.088	1.089	1.087	1.088	1.088	1.088	1.088	0.001
Haugh unit	75.6	77.5	76.8	76.4	78.9	76.8	77.2	1.3
Shell thickness (mm)	0.357	0.352	0.342	0.345	0.342	0.337	0.339	0.02
Yolk color (score)[2]	7.1^{a}	6.5^{b}	6.9^{a}	6.5^{b}	6.5^{b}	6.4^{b}	6.2^{b}	0.04
Egg grading (%)								
No. 1 (>70 g.)	18.7	12.2	13.0	9.2	10.1	5.9	9.0	1.3
No. 2 (66-70 g.)	32.9^{a}	29.8^{a}	31.4^{a}	20.8^{bc}	27.9^{ab}	18.6^{c}	21.5^{bc}	0.9
No. 3 (61-65 g.)	35.5	32.5	31.7	34.5	33.5	35.4	28.7	1.8
No. 4 (56-60 g.)	12.6	20.8	18.8	26.9	22.6	28.9	28.5	1.4
No. 5 (< 55 g.)	0.4	4.6	5.0	8.6	6.0	11.2	12.3	1.4

[a-d] Means in the same row with no common superscripts differ significantly ($p<0.05$).

[1] 3 days sun dried or 8 h dried in a pan by gas heating.

[2] Roche yolk color fan.

Table 3. Weight of visceral organs and thyroid glands of laying hen fed with different levels of mustard meal (MM) diets

MM level in diet (%)	0	10		20		30		
MM substit. SBM (%)	0	31		63		94		SEM
Type of MM[1]	-	Sun	Gas	Sun	Gas	Sun	Gas	
Visceral organs (% BW)								
Heart	0.41	0.47	0.42	0.39	0.49	0.46	0.46	0.02
Liver	2.00	2.32	2.54	2.14	2.16	2.38	2.27	0.09
Pancreas	0.218	0.216	0.321	0.217	0.243	0.338	0.307	0.02
Kidney	0.50^{c}	0.70^{ab}	0.67^{abc}	0.68^{abc}	0.64^{bc}	0.85^{a}	0.74^{ab}	0.02
Spleen	0.16	0.22	0.32	0.22	0.24	0.34	0.31	0.02
Fat[2]	6.59^{a}	3.03^{b}	2.85^{b}	4.30^{b}	2.08^{b}	1.90^{b}	2.59^{b}	0.28
Thyroid glands								
(mg/100 g BW)	5.61	7.88	7.87	6.62	7.45	7.03	9.31	0.38

[a-c] Means in the same row with no common superscripts differ significantly ($p<0.05$).

[1] 3 days sun dried or 8-hrs dried in a pan by gas heating.

[2] Abdominal plus visceral fat.

the MM fed groups. This caused a lower intake of nutrients such as protein, methionine, lysine and particularly ME (table 5). The result might be owing to the toxic effect of sinapine on feed intake (GÖhl, 1981; Bell, 1990) or glucosinolate and its derivatives, which influenced the metabolism of hens to be slightly inferior to the control. It was noticed that kidney weight increased significantly while the weight of thyroid and spleen tended to increase. The reduction of abdominal plus visceral fat of the groups fed MM might indicate the inefficient use of energy by hens, thus the production performances decreased and at the same time only a small amount of ME was accumulated in the form of fat. The slight decrease in production of the 10% MM group as compared with the control is similar to Tangtaweewipat et al. (2001). They recommended the incorporation level of MM from the same factory at 10% in a broiler diet, which was equal to the substitution level of SBM at 21, 26 and 31% during week 2-3, 4-6 and 7 of

Table 4. Feed cost of laying hen fed mustard meal (MM) diet during 50-62 weeks of age

MM level in diet (%)	0	10		20		30		
MM subst. SBM (%)	0	31		63		94		SEM
Type of MM [1]	-	Sun	Gas	Sun	Gas	Sun	Gas	
Performance								
Egg production (%)	86.7[a]	83.6[a]	81.4[ab]	80.0[ab]	78.1[abc]	70.7[c]	73.3[bc]	1.0
Feed/dozen egg (kg)	1.66	1.62	1.63	1.65	1.65	1.77	1.66	0.01
Feed/kg egg (kg)	2.16[b]	2.15[b]	2.16[b]	2.25[b]	2.20[b]	2.42[a]	2.28[ab]	0.02
Feed cost (Bt) per								
kg feed	6.57	6.22	6.33	5.88	6.10	5.55	5.87	-
kg eggs	14.19	13.39	13.70	13.24	13.44	13.45	13.40	0.11
dozen eggs	10.94[a]	10.08[b]	10.31[ab]	9.73[b]	10.04[b]	9.81[b]	9.74[b]	0.08

[a-c] Means in the same row with no common superscript differ significantly ($p<0.05$).

[1] 3 days sun dried or 8 h dried in a pan by gas heating.

[2] Price of each ingredients (Bt/kg) : Corn 5.60, Rice bran 4.10, SBM 9.10, Fish meal 16.50, Rice bran oil 20.00, DCP 12.00, Oyster shell 2.00, Met 160.00, Lys 75.00, Salt 3.00, Vitamin-mineral premix 65.00 and Mustard meal 5.00 (Approx. 1 $US = 43 Bt).

Table 5. Daily nutrient intake of laying hens fed different levels of mustard meal (MM) in the diets during 50-62 weeks of age

Level of MM (%)		CP	Met	Lys	ME
In diet	Substituted for SBM	(g)	(g)	(g)	(kcal)
0	0	19.2	0.42	0.96	336
Sun dried mustard meal [1]					
10	31	18.0	0.39	0.90	315
20	63	17.6	0.39	0.88	309
30	94	16.6	0.36	0.84	291
Gas dried mustard meal [1]					
10	31	17.7	0.39	0.88	309
20	63	17.1	0.37	0.86	300
30	94	16.2	0.35	0.82	284

[1] 3 days sun dried or 8 h dried in a pan by gas heating.

chickens' age. However, Marangos and Hill (1976) reported that MM could be used in a layer diet at 12% without adverse effect on egg performance, with the exception of fishy flavor in eggs. Das and Ali (1993) found that MM could safely substitute 50% of sesame meal in a layer diet. The higher incorporation level decreased egg size and feed intake, similar to this experiment.

The small egg size of the MM groups is suspected to be caused by erucic acid which remained in the meal at high amount due to the oil remaining in the meal (17-20% oil). March and Soong (1976) found a similar result in rape seed meal which contained high erucic acid. The pale egg yolk color of the groups fed MM was due to the partial replacement of ground yellow corn, which contained natural pigment, by MM.

CONCLUSIONS

Both types of mustard meal (MM), i.e. sun dry and gas heating which had similar content of nutrients (30-32% CP, 19-22% EE and 12-13% CF, on DM basis) could be incorporated in layer diets at 10% without adverse effect on production performance and egg quality. The higher incorporation level decreased feed intake and caused the enlargement of kidney, thyroid glands and spleen. In addition egg yolk color of the group fed MM was paler than the control. However, feed cost per kg egg or per dozen eggs of these groups was lower.

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