SESAME MEAL AS SOYBEAN MEAL SUBSTITUTE IN POULTRY DIETS
II. LAYING HEN

B. Cheva-Isarakul[1] and S. Tangtaweewipat

Department of Animal Science, Faculty of Agriculture
Chiang Mai University, Chiang Mai 50002, Thailand

Summary

The study on the nutritive value and the potential use of two kinds (local vs. import) of sesame meal (SSM) in layer diets as substitute for soybean meal (SBM) at 25, 50, and 75% was carried out. Three hundred and thirty six layers were kept individually on a battery cage and fed isonitrogenous diets, 16% crude protein (CP), for 252 days. The local and the imported SSM contained on air dry basis 35.7 and 36.3% CP, 24.7 and 9.1% ether extract (EE), respectively. Their amino acid contents are all lower than those reported by NRC (1984). The local material contained remarkably lower lysine (0.44 vs. 0.94), methionine + cystine (1.06 vs. 1.75) and threonine (0.52 vs. 1.22) than the imported meal. Imported SSM could be substituted for SBM as high as 50% in layer ration without statistically adverse effect on egg production, feed intake, body weight gain, average egg weight and egg size, while local SSM was inferior to the control in all aspects. However, when production performance of the groups fed either kind of SSM was compared, no significant difference was found at the two lower substitution levels.

(**Key Words**: Sesame Meal, Plant Protein, Layer, Egg Production, Egg Quality)

Introduction

The insufficient production of soybean meal (SBM) in the country has lead to the permission being granted for a quota of imports of the product. However, the price is considerably still high due to the government policy which also on the other hand has to encourage soybean growers in the country. In order to eleviate feed cost due to the high price of soybean, attempts are made to investigate the potential use of other plant protein to substitute SBM in animal feed.

Sesame (*Sesamum indicum*) is one of the interesting plants in tropical and subtropical regions. The production yield in Thailand is about 30,000 tons annually. Imported SSM tends to gain popularity due to its attractive low price.

Sesame seed of mixed varieties, black, brown and white colours, contained 21-23% CP, 50-52 % EE (Khajarern et al., 1988). The mechanical process, usually used for oil extraction of sesame, caused high oil residue in the meal (8-9%). The meal locally produced by the small plant in Chiang Mai contained 3 times higher oil content than the average product (24.7 vs. 9.1%, table 1). Crude protein content of SSM is 75% of SBM (35-36 vs. 44%), while metabolizable energy (ME) content of both feedstuffs reported by NRC (1984) is comparable due to the higher EE but at the same time, the higher crude fiber (CF) content of SSM. However, the ME value of the local oily meal seems to be higher (table 1).

The advantage of SSM as animal feed is its high methionine (Met) content, while lysine (Lys) seems to be the first limiting amino acid (Aboul et al., 1986) due to its lower amount (50% of SBM; NRC, 1984) and only 67% digestibility (Canale et al., 1975). In addition SSM has, among oil seed meals, the lowest true amino acid availability value (35%) compared to 92% of SBM (Yamazaki and Kamata, 1986). The high amounts of calcium (Ca) and phosphorus are also less available due to its high phytic acid content. Thus, Ca is suggested to be supplemented to SSM feed (Caldwell, 1952; cited by Gohl, 1981). Phytic acid could be partially eliminated when the meal was heat treated under 15 psi for 4 hours (Lease and Williams, 1967).

[1]Address reprint requests to Dr. B. Cheva-Isarakul, Department of Animal Science, Faculty of Agriculture, Chiang Mai University, Chiang Mai 50002, Thailand.

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Sesame meal could be used to substitute SBM at 25% in broiler diet (Bell et al., 1990). The higher level caused higher fat depot but lower water and protein content of the carcass (Heo et al., 1990). However, with the sufficient supplement of Lys and Met + cystine (Cys) to the diet, the substitution level may be as high as nearly 50% (Baghel and Netke, 1987). On the other hand, only 5% SSM in layer diet was reported to decrease egg production (Hassan, 1974), with the exception of the groups supplemented with 0.27% Lys and 0.07% Met or 1% sodium glutamate.

Local SSM could be used at 5% in growing pullet diet (6-20 weeks of age) or 10% in Japanese quail diet (Tangtaweewipat and Cheva-Isarakul, 1992) without adverse effect on production performance. At 15-20% of the diet, no increased mortality rate was observed. Thus, indicating the potential use of SSM in spite of its disadvantages, e.g. the bitter taste (Lennerts, 1989), the high selenium content (Brito and Nunez, 1982), the high phytic acid which causes a higher requirement for zinc (Lease, 1972). In addition, the high oxalate also decreased Ca availability (Abrams, 1966).

The imported SSM seems to become more popular as animal feed due to its attractive low price. However, the optimum level for its use is not yet well described. Therefore, the efficient use of both kinds of SSM in poultry diet, substitute for SBM, should be determined.

TABLE 1. CHEMICAL COMPOSITION (% W / W AIR DRY BASIS) OF LOCAL AND IMPORTED SESAME MEAL COMPARED TO THE REFERENCE AND TO SOYBEAN MEAL

	Sesame meal			Soybean meal
	Local[1]	Import[2]	NRC (1984)	(NRC, 1984)
Dry matter	93.8	92.0	93.0	89.0
Crude protein	35.7	36.3	43.8	44.0
Ether extract	24.7	9.1	8.6	0.8
Crude fiber	12.1	8.8	9.7	7.3
Ash	9.4	12.7	NA	7.8
Metabolizable energy (kcal/g)	2.86	NA	2.21	2.23
Essential amino acids				
Lysine	0.44[3]	0.94[3]	1.30	2.93
Methionine	0.94	0.99	1.20	0.65
Cystine	0.12	0.76	0.59	0.69
Threonine	0.52	1.22	1.65	1.81
Tryptophan	NA	NA	0.80	0.62
Isoleucine	0.95	1.10	2.12	2.39
Leucine	2.09	2.29	3.33	3.52
Histidine	NA	NA	1.09	1.15
Phenylalanine	1.30	1.19	2.22	2.27
Tyrosine	NA	NA	2.00	1.28
Valine	1.33	1.49	2.41	2.34

NA = Data not available.
[1] Produced by a small plant in Chiang Mai.
[2] Imported from Myanmar.
[3] Analyzed by Ajinomoto Co. (Thailand) Ltd Laboratory.

Materials and Methods

Two kinds of SSM, i.e. locally produced by the small mechanical plant in Chiang Mai and the imported material were used. Their amino acid content was determined through autoanalyser, Hitachi model 835-30 by Ajinomoto, Co., (Thailand) Ltd laboratory, following the method of Spindler et al. (1984).

Three hundred and thirty six heads of Golden

Hubbard aged 36 weeks (80% of the flock was at the onset of laying) were randomly allocated to 7 groups with 4 replicates according the completely rendomized design. They were individually kept on battery cage and exposed to 17 hours light/day. Either kind of SSM was substituted for SBM at 25, 50, 75% which is equal to the incorporation level of 4, 8, and 13% of the diet, while SBM diet was used as the control (table 2). All diets were isonitrogenous at 16% CP and isocaloric (2,800 ME kcal/kg). The ME value (2,210 kcal/kg) and essential amino acid content of SSM used for ration formulation was after NRC (1984). The experiment which lasted 252 days during July 1991 to April 1992 was divided into 9 periods of 28 days each. Egg production and feed intake were averaged from each period, while egg weight and egg grade classifying were recorded at the last 3 consecutive days of each period. The birds were weighed individually every 3 periods to determine weight change, while mortality was recorded immediately. The data were subjected to one way ANOVA and, where necessary, to Duncan's new multiple range test, respectively (Steel and Torrie, 1960).

TABLE 2. COMPOSITION AND NUTRIENT CONTENTS OF THE EXPERIMENTAL RATIONS

Ingredients		Level of sesame meal (%)			
	In ration	0	4	8	13
	Substitute SBM	0	25	50	75
Sesame meal		—	4.10	8.19	12.75
Soybean meal, SBM (44.0% CP)		12.68	9.51	6.34	3.17
Yellow corn (8.9% CP)		61.97	61.01	60.06	59.13
Rice bran (12.0% CP)		10.00	10.00	10.00	10.00
Fish meal (55.0% CP)		7.00	7.00	7.00	7.00
Dicalcium phosphate		0.20	0.20	0.20	0.20
Oyster shell		7.50	7.50	7.50	7.50
DL-methionine		0.06	0.06	0.06	0.06
L-lysine		0.09	0.12	0.15	0.17
Salt		0.25	0.25	0.25	0.25
Vitamin-mineral premix[1]		0.25	0.25	0.25	0.25
Total		100.00	100.00	100.00	100.00
Calculated chemical composition, (% air dry basis):					
Crude protein		16.14	16.14	16.13	16.13
ME (kcal/kg)		2,850	2,840	2,830	2,820
Crude fiber		4.46	4.45	4.43	4.41
Ether extract		4.09	4.32	4.55	4.78
Calcium		3.48	3.55	3.63	3.70
Phosphorus (avai)		0.39	0.40	0.41	0.42
Methionine[2]		0.35	0.38	0.41	0.44
Lysine[2]		0.80	0.80	0.80	0.80

[1] Vitamin and mineral premix provided in milligrams per kilogram of diet (except as noted): Vit. A 12,000 IU; Vit. D_3 3,000 IU; Vit. E_{50} 12; Vit K_3 2; Vit B_1 1.5; Vit B_2 5.5; Vit B_6 1.5; Vit B_{12} 1.25 μg; Nicotinic acid 30; Pantothenic acid 11; Folic acid 0.6; Choline chloride 400; Iron 45; Copper 7.5; Manganese 75; Zinc 65; Cobalt 0.2; Iodine 1.1; Selenium 0.1 and Antioxidant 50.

[2] Essential amino acid content of SSM calcultated from NRC (1984).

Results

Essential amino acid content

Essential amino acid (EAA) content of both kinds of SSM was lower than that reported by NRC (1984). This might be due to the lower protein content of the samples. Lys, threonine (Thr) and Met + Cys content of the local SSM were only 50% of the imported material (0.44 vs. 0.94, 0.52 vs. 1.22 and 1.06 vs. 1.75%), respectively (table 1).

Egg production performance and feed cost

Egg production of the birds fed with either kinds of SSM, substituted for SBM at 25, 50 and 75% was shown in table 3. The groups fed with the imported SSM was comparable to the control, while the groups fed with the local material were inferior ($p < 0.05$). However, when both kinds of SSM were compared, no significant difference was found with the exception of the highest substitution level of the local material which caused the lowest egg production. The birds in this group consumed and gained the least weight, while showing the worst feed efficiency, i.e. they required more feed/dozen eggs.

TABLE 3. PRODUCTION PERFORMANCE AND COST OF EGG PRODUCTION OF LAYING HENS FED EITHER KIND OF SESAME MEAL (SSM) DIETS OVER 252 DAYS[1]

Level of SSM (%)		Egg production (%)	Feed per doz. eggs (kg)	Feed intake (g/bird/day)	LW. gain (g)	Feed cost (Bt)[4]	
[2]	[3]					kg. feed	doz. eggs
0	0	75.65^{a}	1.80^{c}	113.5^{ab}	250^{a}	4.83	8.70
4L	25L	71.38^{b}	1.87^{bc}	111.0^{ab}	216^{ab}	4.77	8.92
4I	25I	73.23^{ab}	1.87^{bc}	114.0^{ab}	251^{a}	4.77	8.92
8L	50L	70.63^{b}	1.93^{b}	113.5^{ab}	226^{ab}	4.71	9.09
8I	50I	73.08^{ab}	1.87^{bc}	113.7^{ab}	278^{a}	4.71	8.81
13L	75L	62.21^{c}	2.12^{a}	109.4^{b}	167^{b}	4.64	9.84
13I	75I	72.60^{ab}	1.92^{b}	115.9^{a}	288^{a}	4.64	8.91

[a,b,c] Values within a column with no common superscripts are significantly different ($p < 0.05$).
L = Local SSM, produced by a small plant in Chiang Mai.
I = Imported SSM, from Myanmar.
[1] Mortality rate 4-8%.
[2] In diets.
[3] Substitute soybean meal.
[4] Ingredient price (Bt/kg): yellow corn 3.10, rice bran 3.50, soybean meal 9.00, fish meal 14.00, dicalcium phosphate 12.00, Oyster shell 1.50, DL-Methionine 100, L-Lysine 100, salt 2.00, premix 60, and SSM 5.50.

The group fed with 8% imported SSM produced the highest number of grade A eggs, while that fed with 13% local SSM produced the lowest. However, no significant difference was found among groups on the number of egg in the lower grades and the average egg weight (table 4).

When feed cost was taken into consideration, it revealed that those rations containing SSM were cheaper than the control. Although the groups fed with the imported SSM had similar feed cost per dozen eggs compared to the control, the groups fed with the local SSM showed the higher feed cost due to their inferior feed conversion ratio (table 3).

Discussion

The significant decrease in egg production of the groups fed with local SSM, compared to SBM (table 3), might be due to the insufficient supply of EAA, especially Lys which was lower in the sample than the value used after NRC (1984) for feed formulation (0.44 vs. 1.30%, table 1). The estimated Lys intake of the whole experimental period of the groups fed with SSM were only 190-213 g compared to 229 g of the control (table 5). In addition, the low digestibility of Lys in SSM (Canale et al., 1975) also emphasized the over-estimation of Lys availability in the SSM rations. The lower content of other EAA, especially Met + Cys and Thr of the local material also caused the insufficient supply of these EAA.

On the other hand, EAA of the imported

SSM was only slightly lower than the value reported by NRC (1984). Therefore Lys intake of the groups fed with this material was comparable to the control. This was reflexed by the insignificant difference on egg production.

The lower feed intake, which in consequence effect the lower liveweight gain, of the group fed with the highest level of local SSM (13% of the feed or 75% of the substitution level) might be due to the unpalatability of the material which contained high amount of oil (24.7% EE, table 1). Besides, its bitter taste also limited its use to monogastric animals (Lennerts, 1989). However, at the incorporation level lower than 8% of the local material or the use of the imported SSM at any extent caused no significant difference on feed intake as well as on liveweight gain. The lowest number of eggs in A grade produced by the group fed with 13% local SSM might be the effect of the insufficient use of nutrients in the material, especially Met which directly affects egg size (Doran et al., 1982). This result was less identified in the first 3 months but more stressed at the longer experimental period. However the average egg weight (64.3-65.7 g) of all groups were comparable. No significant difference was found on second egg quality, assuming that oxalic and phytic acid level were not so high to cause deleterious effect. No remarkably feather loss of the groups fed with SSM was observed. This

TABLE 4. EGG WEIGHT AND PERCENTAGE OF EGGS IN EACH GRADE OF HENS FED DIETS WITH LOCAL OR IMPORTED SESAME MEAL (SSM) DURING 252 DAYS

Level of SSM (%)		Source	Mean egg	No. of eggs in each grade (%)[1]			
In diets	Substitute soybean meal	of SSM	weight (g)	A	B	C	D
				.... (%)			
0	0	–	64.3[a]	15.0[ab]	34.7[a]	35.2[a]	15.1[a]
4	25	Local	65.4[a]	17.8[ab]	38.4[a]	35.1[a]	8.7[a]
4	25	Import	64.9[a]	17.1[ab]	38.5[a]	33.6[a]	10.8[a]
8	50	Local	64.8[a]	15.1[ab]	38.5[a]	34.9[a]	11.5[a]
8	50	Import	65.7[a]	26.3[a]	31.6[a]	28.3[a]	13.8[a]
13	75	Local	64.3[a]	10.8[a]	35.3[a]	41.3[a]	12.6[a]
13	75	Import	65.2[a]	19.7[ab]	36.0[a]	32.0[a]	12.3[a]

[a,b] Means within a column with no common superscripts are significantly different ($p < 0.05$).
[1] Grade A = Egg weight > 65 g. C = Egg weight 56-60 g.
B = Egg weight 61-65 g. D = Egg weight < 56 g.

TABLE 5. ACTUAL AMINO ACID CONTENT IN THE DIET AND THE INTAKE DURING THE WHOLE EXPERIMENTAL PERIOD (252 DAYS)

Level of SSM (%)		Source	Lysine		Methionine + Cystine	
In diets	Substitute soybean meal	of SSM	In diets (%)	Intake/bird (g)	In diets (%)	Intake/bird (g)
0	0	–	0.80	229	0.56	160
4	25	Local	0.76	213	0.56	157
4	25	Import	0.79	227	0.59	169
8	50	Local	0.73	209	0.56	160
8	50	Import	0.77	221	0.62	178
13	75	Local	0.69	190	0.56	154
13	75	Import	0.76	222	0.65	190

might be due to the high zinc content of the commercial premix, 65 vs. 50 mg/kg recommended by NRC (1984). Interesting was the brown and watery excreta of the groups fed with local SSM. This might be due to the darker colour and the higher fiber content of the product compared to the imported material or SBM.

Conclusions

Essential amino acid content of either local or imported SSM was lower than the value reported by NRC (1984), especially Lys, Met + Cys and Thr of the local material which is only 32-59% of the imported product.

Imported SSM could be used in layer diet at 8% which is equal to the level of 50% substituted for SBM. Local SSM is not suitable for layer feed at any extent due to the inferior egg production. However, at the incorporation level, of not exceeding 8%, egg production of the group fed local SSM was comparable to the imported meal. No increased mortality rate was observed even at the highest (13%) incorporation level of either kind of SSM in layer diet.

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