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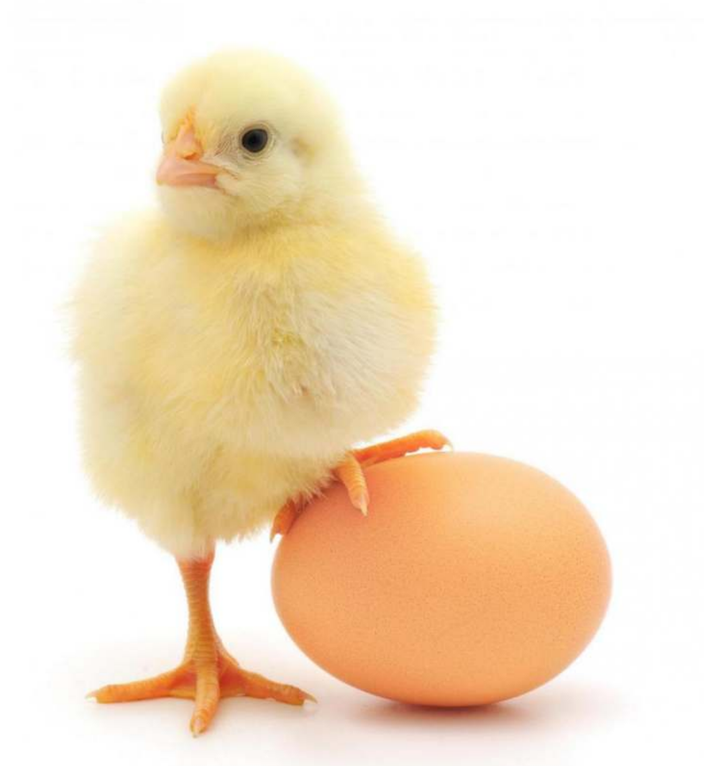

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Effects of Mao Pomace Powder as a Dietary Supplement on the Production Performance and Egg Quality in Laying Hens

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Abstract: This study investigated the effect of different mao pomace diets on the production performance and egg quality of laying hens. A total of 144 Chareon Pokphan Brown laying hens aged 31 weeks were used in a completely randomized design experiment with three treatments. The basal diet was supplemented with 0% mao pomace (control) while the other treatments involved 5 g/kg (0.05%) mao pomace from juice production (MPJ) and 5 g/kg (0.05%) mao pomace from wine production (MPW). Each treatment had 16 replicates with three laying hens each in an evaporative cooling housing system. The results showed that laying hens fed with 0.5% MPW had a significantly improved egg laying rate and feed cost per dozen eggs when compared to the control group ($p<0.05$) but there was no difference between the laying hens fed with the control and the 0.5% MPJ in the egg laying rate and feed cost per dozen eggs ($p>0.05$). There were no significant differences in production performance, egg quality and egg grading among the dietary treatments ($p>0.05$). The results showed that the mao pomace from juice and wine production did not reduce production performance and egg quality. From these results, it is suggested that a diet with 0.5% MPW can reduce the feed cost per dozen eggs of layer chickens due to an increased egg laying rate.

Key words: Laying hens, mao pomace, performance, egg quality

INTRODUCTION

The tropical climate and naturally fertile geography of Thailand is the home of some of the world's most exotic and delicious tropical fruits (Nuengchamnong and Ingkaninan, 2010). *Antidesma* sp. (know as mao in Thailand) is a tropical fruit distributed in Northeast Thailand (Hoffmann, 2005). The mao plant is a medium-sized evergreen tree or shrubby bush about 5 to 10 m height with a single main bole, while its branches develop into round-shaped bushes (Puangpronpitag *et al*., 2008) and it has round or ovoid fruits with a dark-red color (Jitjaroen *et al*., 2012). Morton (1987) reported the fruits are acidic like cranberries but are less acidic and slightly sweet when fully ripe. The ripened fruits are consumed fresh or can be processed into juice or a type of wine. These fruits are believed to be a good source of natural antioxidants (Nuengchamnong and Ingkaninan, 2010) and contain amounts of some nutrients such as catechin, epicatechin, rutin, quercetin, procyanidin B1, procyanidin B2, gallic acid and ferrulic acid (Bulkhup and Samappito, 2008). These phenolic compounds are well-known for health benefits. They also serve as plant defense mechanisms to counteract reactive oxygen species (ROS) in order to survive and prevent molecular damage (Vaya *et al*., 1997). Based on the benefits mentioned above, products such as mao juice and mao wine have become more popular in Thailand. This industry generates a number of wastes and by-products, most notably mao pomace. The mao juice and mao wine factories discard these residues and they become environmental pollutants. Thus, their inclusion in animal feed could be an alternative to reuse these residues. Previous study revealed that mao pomace is an excellent potential feed for ruminal animals (Suphanphuwong *et al*., 2012; Gunun *et al*., 2014). Vasupen *et al*. (2011) recommended 1.5% fresh mao pomace to improve the growth performance and feed conversion ratio of native (Kadon) pigs. Moreover, Sirilaophaisan *et al*. (2015a, b) suggested that a diet with 0.5% mao pomace could increase the growth performance and decrease cholesterol and triglyceride concentrations in Cherry Valley ducks. Even though several studies have focused on ducks, there are no known reports on the effect of mao pomace on laying hens.

The inclusion of mao pomace from juice (MPJ) and wine (MPW) production in the diets of laying hens is an interesting alternative because mao residues are produced in large amounts. This study evaluated the effect of the inclusion of MPJ and MPW in the diet of laying hens on production performance and egg quality.

MATERIALS AND METHODS

Preparation of MPJ and MPW powder: MPJ was obtained as a waste product from the mao juice industry and similarly MPW was waste product from the wine industry. Both MPJ and MPW were collected at the plant of Wanawong Industry, Sakon Nakon provine, Thailand. The moa pomace samples were dried in a hot-air oven at 50°C for 2 days. Finally, they were ground using an electronic grinder and kept at room temperature until mixed with the basal diet. Dry matter, crude protein, crude fiber, crude fat and crude ash were determined by methods according to the Association of Official Ananlytical Chemists (AOAC, 1984) and shown in Table 1.

Birds and experimental design: The experiment was managed in accordance with the guidelines and rules for animal experiments, Kasetsart University, Thailand. One-hundred and forty-four Chareon Pokphan Brown laying hens were used in this study from 31 to 35 weeks of age. Hens were allocated randomly to three treatment groups of 48 hens each. Each group was distributed into 16 replicates with three hens per replicate. Hens were fed a basal diet based on corn and soybean meal (Table 1) which was balanced to meet the nutrient requirements for laying hens (NRC, 1994). The three treatment groups received the following diets: group (1) basal diet (control), group (2) basal diet+mao pomace from juice (MPJ) production (5 g/kg) and group (3) basal diet+mao pomace from wine (MPW) production (5 g/kg). The chemical composition of MPJ and MPW (Table 2) was measured. Feed and water were provided *ad libitum*.

Production performance and egg quality measurements: Body weight for individual birds was recorded at the beginning and end of the experiments (at 31 and 35 weeks of age, respectively). All eggs were collected and recorded on a daily basis. Egg laying rates were calculated. In addition, eggs were individually weighed and graded and the egg mass was calculated. Feed intake (in grams per hen per day), feed efficiency, feed intake per dozen eggs (in kilograms per dozen eggs), feed cost per dozen eggs (in baht per dozen eggs), mortality (in percent) and body weight gain (in grams) were calculated.

By the end of the experimental period, 30 eggs per treatment were used for measuring the egg quality. The length and width of the egg was determined using an egg shape measurer and the shape index was determined according to Anderson *et al.* (2004).

Specific gravity was determined using saline solutions, according to Voisey and Hunt (1974). The saline solutions used varied in specific gravity from 1.060 to 1.100 in increments of 0.005. The sample eggs were immersed into solutions with an increasing concentration of salt. The specific gravity was recorded as the density of the solution in which an egg floated. Eggs were broken and their contents were separated and weighed individually to determine eggshell membrane thickness and eggshell thickness. Eggshell membrane and eggshell thickness measurement were based on the average thickness measured at the air cell, equator and sharp end using a pair of micrometer calipers. For each egg, the shell membrane and shell were rinsed with warm water, dried at 60°C overnight and then weighed. Haugh units and yolk color were determined using an egg multi-tester instrument (EMT 7300, Tohoku Rhythm CO., LTD., Japan). The albumen and egg yolk width were measured using a pair of dividers. The albumen indices and yolk indices were then calculated according to Tilki and Saatci (2004).

The yolk was separated from the albumen and weighed. Then, the weight of the albumen was determined as the difference between the weight and the yolk and shell weights. The values of the yolk ratio, albumen ratio and eggshell ratio were calculated for each individual egg according to Tilki and Saatci (2004).

Statistical analyses: All parameters considered were subjected to an analysis or variances using the proc GLM software program (SAS Institute, 1997). Differences

Table 1: Chemical composition of mao pomace from juice (MPJ) and wine (MPW) production

Chemical analysis	Mao pomace from juice production (MPJ)	Mao pomace from wine production (MPW)
Dry matter (%)	96.72	97.05
Crude protein (%)	10.97	11.61
Crude fiber (%)	14.59	14.74
Crude fat (%)	2.80	2.62
Crude ash (%)	4.11	5.20

Table 2: Ingredients and nutrients composition of the basal diet

Ingredients	g/kg
Corn	556.70
Defatted rice bran oil	60.00
Soybean meal	229.80
Fish meal	50.00
Rice bran oil	10.50
Oyster shell	78.50
Dicalcium phosphate	4.50
Salt	3.50
DL-methionine	1.50
Premix[a]	5.00
Total	1,000
Chemical composition (g/kg)	
Crude protein	175.00
Crude fiber	37.60
Crude fat	82.00
Calcium	35.10
Available phosphorus	3.50
Lysine	9.60
Methionine	7.50
Metabolizable energy (MJ/kg)[b]	11.51

[a]Concentrate mixture including (per kg of diet): vitamin A 10000 IU; cholecalciferol 2000 IU; vitamin E 0.25 IU; vitamin K_3 2 mg; vitamin B_{12} 10 µg; choline 250 mg; folacin 1 mg; niacin 30 mg; pantothenic acid 10 mg; pyridoxine 3 mg; riboflavin 6 mg; thiamin 2 mg; ethoxyquin 125 mg; choline 1500 mg; copper 10 mg; iron 60 mg; iodine 0.5 mg; iodine 0.5 mg; manganese 40 mg; zinc 50 mg; selenium 0.2 mg; preservative 6.54 mg and feed supplement 26 mg

[b]Calculated values

between treatments were tested using Duncan's new multiple range test (significance, p<0.05; Steel and Torrie, 1980). The results of the statistical analysis were shown as mean values with standard error in the tables.

RESULTS AND DISCUSSION

The effects of MPJ and MPW on the production performance and egg quality of laying hens are shown in Table 3. There were no differences in the feed intake, feed efficiency, egg mass, egg weight, feed intake per dozen eggs, feed cost per dozen eggs and body weight gain among the treatments. The dietary MPJ and MPW had no significant effect on the shape index, yolk index, albumen index, specific gravity, Haugh units, eggshell membrane thickness, eggshell thickness, yolk ratio, albumen ratio, eggshell ratio, yolk color and egg grade (Table 4 and 5). Consideration of the current egg quality parameters suggests that MPJ and MPW would have no detrimental effects on egg quality at 0.5% addition to the basal diet. All birds were healthy and there was no mortality in this experiment. However, the egg rating rate was increased in the group fed the diet supplemented with 0.5% MPW group compared to the control group (p<0.05). The feed cost per dozen eggs decreased in the group fed the diet supplemented with 0.5% MPW compared to the control group (p<0.05). Consequently, the 0.5% MPW group with the lower feed cost per dozen eggs resulted in a higher egg rating rate. As the nutritional composition of diets in all groups was almost the same, the better egg rating rate seems to have been induced by MPW. No information is available about dietary MPW and MPJ on the production performance and egg quality of laying hens. The higher egg laying rate in laying hens fed with the 0.5% MPW diet may have been due to phytochemicals in the waste from the mao wine industry. Mao in the wine industry consists of seeds and marcs, accounting for approximately 25% of the fresh weight of the mao (Sirilaophaisan *et al*., 2015b). Puangpronpitag *et al*. (2008) reported that mao seed and mao marcs were an abundant source of

Table 3: Performance (mean±SEM) of laying hens from 31 to 35 weeks of age fed with 5 g/kg mao pomace from juice (MPJ) and wine (MPW) production

Traits	Control	5 g/kg MPJ	5 g/kg MPW	p-value
Egg laying rate (%)	92.93±6.48[b]	93.61±4.00[ab]	96.94±2.35[a]	0.0361
Feed intake (g/hen/day)	115.12±2.14	115.36±1.68	115.25±3.04	0.9226
Feed efficiency	1.97±0.21	1.98±0.10	1.97±0.12	0.0652
Egg mass (g/hen/day)	58.36±5.72	57.24±3.13	58.31±2.83	0.9873
Egg weight (g)	61.80±2.05	62.95±0.99	62.91±1.57	0.0787
Feed intake per dozen eggs (kilogram/dozen egg)	1.60±0.13	1.57±0.07	1.53±0.04	0.0692
Feed cost per dozen eggs (Baht/dozen egg)	19.63±1.58[a]	19.17±0.90[ab]	18.74±0.48[b]	0.0392
Mortality (%)	0	0	0	-
Body weight gain (g)	0.10±0.09	0.08±0.11	0.05±0.08	0.2510

[a,b]Means within the same row with different letters are significantly different (p<0.05)

Table 4: Egg quality (mean±SEM) of laying hens from 31 to 35 weeks of age fed with 5 g/kg mao pomace from juice (MPJ) and wine (MPW) production

Traits	Control	5 g/kg MPJ	5 g/kg MPW	p-value
Shape index	76.92±2.39	76.94±2.32	76.92±2.37	0.7238
Yolk index	39.97±2.89	39.22±3.75	37.91±4.54	0.1081
Albumen index	41.04±9.89	40.99±12.14	39.76±12.21	0.8874
Specific gravity	1.104±0.00	1.104±0.00	1.104±0.00	1.0000
Haugh units	81.28±9.04	80.00±10.65	79.93±1.57	0.4210
Eggshell membrane thickness (mm)	0.05±0.0034	0.05±0.0316	0.05±0.0038	0.4157
Eggshell thickness (mm)	0.37±0.022	0.37±0.018	0.37±0.18	0.5096
Yolk ratio (%)	26.09±2.15	25.75±1.96	26.06±1.78	0.7618
Albumen ratio (%)	64.43±2.36	64.91±2.33	64.61±1.79	0.2510
Eggshell ratio (%)	9.46±0.70	9.33±0.88	9.32±0.69	0.7250
Yolk color	8.88±1.38	8.01±1.56	8.75±1.58	0.0632

Table 5: Egg grade (mean±SEM) of laying hens from 31 to 35 weeks of age fed with 5 g/kg mao pomace from juice (MPJ) and wine (MPW) production

Egg grade (%)	Control	5 g/kg MPJ	5 g/kg MPW	p-value
0 (>70 g)	3.68±2.58	3.93±1.88	5.31±5.06	0.3802
1 (65 to 70 g)	15.42±5.54	16.31±5.81	16.76±4.84	0.7284
2 (60 to 65 g)	46.87±12.37	51.56±7.85	42.43±10.51	0.0650
3 (55 to 60 g)	33.56±10.43	31.75±11.68	35.75±15.72	0.6785
4 (50 to 55 g)	10.31±7.86	8.37±3.96	8.62±6.16	0.6333
5 (45 to 50 g)	0.75±1.53	1.50±3.35	0.50±0.82	0.4043
6 (<45 g)	0.06±0.25	0.18±0.40	0.12±0.34	0.5185

polyphenols (97.32 to 130 mg gallic acid equivalents/g) and proanthocyanidins. Furthermore, Dechayont *et al.* (2012) found that dried mao marc contained the highest phenolic contents (85.77±0.34 mg GAE/g). These high total phenolic contents correspond to strong antioxidant activity.

Commercial mao wines often show a succinic acid content (Jitjaroen *et al.*, 2012), which has been reported to have a positive influence on the growth performance of piglets and poultry (Dibner and Buttin, 2002). The potential of hydrogen (pH) properties, stimulation of growth, increased protein digestibility and/or a limited number of pathogens (Partanen and Mroz, 1999; Vasupen *et al.*, 2011), reduced digestion pH, increased pancreatic secretion and trophic effects on the gastrointestinal mucosa (Dibner and Buttin, 2002). Sirilaophaisan *et al.* (2015a) have been reported with mao pomace included in a duck at 0.5% level producing increases body weight, body weight gain and productive index. Furthermore, Kukongviriyapan *et al.* (2013) found that dietary mao may be useful to prevent oxidative stress and hypertension in rats. The MPW would also enhance the stimulation on digestive enzymes and thereby increase digestion and absorption, resulting in an improved egg laying rate and feed cost per dozen eggs.

Conclusion: Supplementing the diet of laying hens with 0.5% MPW significantly improved the egg laying rate and feed cost per dozen eggs. The improved egg laying rate was attributed to the beneficial effects of phytochemicals and organic acids on gut health which further enhanced nutrient absorption efficiency. The results of the present study are beneficial to farmers and increase the value of mao waste products.

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