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Effect of Dry Giant Mimosa Leaves Pellet on Digestibility Efficiency and Skin Color in Ornamental Fish

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Digestibility efficiency of dry giant mimosa leaves pellet and skin colour were investigated in fancy carp and goldfish. The feed were included the basal feed (0 g. of giant mimosa; T1) and mixed with giant mimosa leaves of 50 g (T2), 100 g (T3), and 150 g (T4). Fancy carp and goldfish with an initial weight of 26.54±6.39 and 20.69±0.26 g were used for those experiments. Two groups' fish were separated into the 70 litter aquarium glasses with 5 fish/aquaria and triplicate per treatment. Digestibility efficiency (DE) of trial feeds were investigated by indirect method. Skin colour of that fish was measured by the colour reader (Konica Minolta model CR-10). The result showed that different consequence DE in fancy carp and goldfish. Fancy carp displayed that significant difference ($p<0.05$) in DE of protein, lipid, fiber and NFE. DE of protein and lipid had high value in T3 as 68.32±9.1 and 63.40±8.4%, respectively. DE of fiber and NFE were high in T1 as 7.08±0.6 and 45.11±3.3%, respectively. The data of color parameters (*L**, lightness, *a** and *b** chromaticity) of fancy carp and goldfish were not significant difference ($p>0.05$). However, the *b** value showed the difference in the final time. That fish fed with T3 had higher value than the other with 37.71±0.28. The chromaticities of that fish were slight changed from initial to final time. These researches concluded that dry giant mimosa leaves meal can use in fancy fish and goldfish up to 100 g kg^{-1} with not affect to DE. Moreover, the skin colour in term of *L**, *a** and *b** showed high value in that fish fed with 100 g kg^{-1} dry giant mimosa leaves.

Keywords: giant mimosa leaves pellet, digestibility efficiency, skin colour, ornamental fish.

Introduction

Giant mimosa (*Mimosa pigra*) is a native weed to tropical America, where it occurs in a wide belt extending from Mexico through Central America to Northern Argentina (Walden *et al*., 1999). It is now widespread throughout the tropics and is an invasive weed in Africa, India, and South-East Asia; for

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example Cambodia, Vietnamese and Thailand, (Lonsdale, 1992). In Thailand, *M. pigra* has become a serious weed over the past 30 yrs. Its spread has been particularly rapid in the north of the country, where it infests waterways, ditches, reservoirs and roadsides. Since *M. pigra* is an invasive wetland shrub, measures to control this weed are warrented. Integrating herbicide and mechanical treatments with fire and biological control to manage the invasive, *M. pigra* were reported by Paynter and Flanagan (2004). In isolation, herbicide, bulldozing and fire were not effective, but several combinations of techniques cleared mimosa thickets and promoted the establishment of competing vegetation that inhibited mimosa regeneration from seed. Depending on the species, biological control agent abundance on surviving mimosa plants was either unchanged or increased following herbicide and/or bulldozing treatments. All agents recolonized regenerating mimosa within 1 year of the fire treatment, and *Neurostrota gunniella* increased dramatically. *Carmenta mimosa* abundance, however, was reduced by fire.

Although, *M. pigra* is a weed, that in the family Fabaceae and show the nutrition without prison (mimosine). The proximate analysis of *M. pudica* showed that its moisture, protein, fat, ash, crude fiber, and cCarbohydrate content was 9.67±0.15, 8.37±0.15, 1.43±0.01, 3.57±0.06, 3.30, and 73.7%, respectively (Abidemi, 2013). Particularly, carotenoid content of *M. pigra* treated with distilled water solvent extract showed a high value between 0.585-0.804 mg/L (Koodkaew, 2007). Up to date, natural carotenoids can be used for pigment enhancing in ornamental: e.g. instance carrot, sweet potato and pumpkin (Sornupharp, 2017 in prep.). Moreover, natural pigment sources (tea, mulberry, and cassava) can be added at specific portions to achieve a total carotenoid (TC) concentration in the diet of 25 mg kg^{-1}. Fancy fish that were fed with tea leaves showed higher TC and skin redness (a^*) than with the other treatments, $p \leqslant 0.05$ (Yuangsoi *et al*. 2010).

Objectives: To estimate the effects of dietary components that included dried giant mimosa leaves on digestibility efficiency and skin colour in fancy carp and goldfish.

Materials and Methods

Experimental fish

Juvenile fancy carp (*Cyprinus carpio* L.) and goldfish (*C. auratus* L.) with an initial weight of 21.07±0.39 and 26.54±6.39 g were obtained from Andaman Aquarium House (Buriram, Thailand). The fish were acclimated for 2 weeks in 150-L tanks. During the acclimating period the fish were fed with

floating commercial fish feed at a level of 4% of the initial weight. The fish were randomly put in 24 aquaria (2 groups of fish and 5 individuals per aquaria in 3 replicates) and fed with self-prepared chromic oxide free sinking feed pellets twice a day at 9.00 am and 3.00 pm for 7 days to visual saturation. One day prior to this feeding trial the fish were starved.

Experimental diet

The diets were including control feed (basal diet without *M. pigra*; T1) and mixed with giant mimosa leaves providing 50 g (T2), 100 g (T3), and 150 g (T4) providing a composition as in Table 1. Levels of crude protein and gross energy in all diets were maintained at the level of 35%, by deduction of fish meal, soybean meal, and wheat flour levels. The dried ingredients of each diet were mixed in a Hobart mixer (Tong Hor Machine Lex Product model L.N.K. 532, Taipei, Taiwan) for 15 min to ensure homogeneity. Chromic oxide (Cr_2O_3) at 0.5% was added in all formulated diets as an inert marker for evaluating digestibility (Shiau and Shy, 1998). Diets were pelleted using a mincer pelleting machine through a 2.00 mm sieve. These were then passed away and dried in a hot air oven at 60 ℃ for 12 h. The feed was then crushed, sieved to obtain a pellet size of 0.9-1.2 mm, and stored at -20 ℃ to avoid oxidation of carotenoids until use.

Diet and feces analyses

Four diet samples were collected before the feeding trials for proximate analyses. The dried feeds were finely ground using a grinder before analysis. The quantities of the feeds used in the treatments were determined according to proximate analyses methods (AOAC, 2000). Crude protein was determined by the micro-Kjeldahl method. Crude lipid was determined by the ether-extraction method. Moisture was determined by oven drying at 105 ℃ for 24 h. Crude fiber was determined by the fritted glass crucible method and ash was determined by a muffler furnace, exposing the samples to 550 ℃ for 4 h. Nitrogen-free extract (NFE) was calculated by the difference between crude protein, moisture, crude fiber, and ash. Chemical compositions of the experimental diets are given in Table 1. Fish feces were collected daily for 15 days in the morning before feeding. The samples were collected by hand-siphoning the water into a collector sieve (100 μm) using a plastic pipette of 2 cm diameter (Davis and Arnold, 1994). Fecal matter was rinsed with distilled water and dried at 60 ℃ in a hot air oven for 12 h. The samples were held in aluminum foil and stored at -20 ℃ until the analysis. Fish feces were analyzed

for ADCs with respect to crude protein, crude lipid, moisture, crude fiber, and nitrogen-free extract. ADC was calculated by an indirect method according to Cho *et al*., (1982).

Table 1. Feed ingredients and proximate composition of experimental diets.

Feed Ingredients (100 g)	T 1	T2	T3	T4
Fish meal	22.42	21.46	20.38	19.36
Soybean meal	22.42	22.42	22.42	22.42
Corn meal	19.87	17.83	15.73	13.75
Wheat flour	19.36	17.32	15.30	13.35
Yeast	5.09	5.09	5.09	5.09
Mimosa leave meal	0.00	5.09	10.19	15.28
Modified starch	5.09	5.09	5.09	5.09
Soybean oil	3.05	3.05	3.05	3.05
Squid oil	2.03	2.03	2.03	2.03
Vitamin premix	0.05	0.50	0.50	0.50
Ascorbic acid	0.1	0.1	0.1	0.1
Cromix oxide	0.50	0.50	0.50	0.50
Moisture	7.29	10.75	10.4	10.78
Ash	7.43	9.63	9.79	9.79
Protein	35.14	35.73	35.86	35.52
Lipid	2.99	3.9	3.34	3.5
Fiber	2.59	3.2	4.62	5.09
Nitrogen free extract	44.56	36.79	35.99	35.32

Skin color measurements

Skin coloration was measured on both lateral body side skin zones using a tristimulus colorimeter model Minolta Chroma Meter CR-10, Minolta, Osaka, Japan. The color parameters were *L**, lightness, which ranged from 0 for black to 100 for white, *a** for red/green chromaticity and *b** for yellow and blue chromaticity, in accordance with the recommendations of the International Commission on Illumination (CIE, 1976).

Statistical analysis

All data were analyzed using one-way analysis of variance. Significant differences among means ($p<0.05$) were ranked by Duncan's new multiple range test (Steel and Torrie, 1980) and the results are presented as means ± S.D.

Results

Digestibility efficiency (DE)

The approximation of digestibility efficiency in fancy carp and goldfish provided different results of DE for both fish (Table 2.). Fancy carp showed significant differences ($p<0.05$) in DE of protein, lipid, fiber, and NFE. DE of protein and lipid had high values in T3 as 68.32±9.1 and 63.40±8.4% for fancy carp, respectively. DE of fiber and NFE were high in T1 as 7.08±0.6 and 45.11±3.3%, respectively.

Table 2. Digestibility efficiency of dry giant mimosa leaves pellet in fancy fish and goldfish.

Diets[1]	Fancy carp				Goldfish			
	CP	CL	CF	NFE	CP	CL	CF	NFE
T1	57.47±6.2[b]	22.41±2.9[c]	7.08±0.6[a]	45.11±3.3[a]	61.97±3.7[a]	65.52±0.2[b]	7.92±0.2[b]	57.88±2.5[a]
T2	61.42±6.2[b]	44.11±1.6[b]	5.25±6.2[b]	44.58±3.0[a]	62.32±7.1[a]	71.53±0.1[a]	8.10±3.3[ab]	26.16±3.1[c]
T3	68.32±9.1[a]	63.40±8.4[a]	5.76±1.5[b]	37.13±2.8[b]	54.29±7.5[b]	63.20±0.1[b]	9.16±4.8[a]	33.68±1.6[b]
T4	50.73±5.3[c]	61.21±6.3[a]	3.44±3.4[c]	32.84±2.6[b]	65.87±0.7[a]	55.23±0.8[c]	9.71±3.2[a]	39.09±0.5[b]

[1]/ CP=crude protein, CL=crude lipid, CF=crude fiber and NFE= nitrogen-free extract
/ means in the same row, different letters indicate significant differences according to Duncan's new multiple range test.

In goldfish, DE of protein and fiber showed a high value when fish were fed with T4 with 65.87±0.7 and 9.71±3.12%, respectively. Nevertheless, the DE of lipid and NFE had high values in T2 and T1 with 71.53±0.1 and 57.88±2.5%, respectively.

Skin colour

The data of color parameters (L^*, lightness, a^* and b^* chromaticity) were demonstrated in Table 3 and 4. L^* and a^* value of fancy carp was not significantly different ($p>0.05$). However, the b^* value show a difference at the final check. The fish fed with T3 had higher values than the other with 37.71±0.28. Skin color of goldfish at the last checking of L^*, a^* and b^* chromaticity were not significantly different ($p>0.05$). The chromaticities of the fish slightly changed from the initial to the last period.

Table 3. Skin color of fancy fish fed with dry giant mimosa leave pellets.

Diets	*L*		*a*		*b*	
	Initial	Final	Initial	Final	Initial	Final
T1	24.55±0.63[a]	74.37±1.17[a]	1.56±0.24[a]	5.04±1.70[a]	7.05±0.75[a]	29.28±0.06[c]
T2	24.99±0.38[a]	73.51±0.73[a]	1.58+0.18[a]	5.28±1.78[a]	7.62±0.99[a]	34.00±1.15[b]
T3	24.20±0.12[a]	73.65±3.31[a]	1.36±0.52[a]	6.44±3.46[a]	7.98±0.58[a]	37.71±0.28[b]
T4	24.84±1.32[a]	74.38±3.96[a]	1.97±0.29[a]	3.61±0.98[a]	7.44±0.34[a]	34.17±0.17[a]

means in the same row, sharing the different letter are significant difference according to Duncan's new multiple range test

Table 4. Skin color of goldfish fed with dry giant mimosa leave pellets.

Diets	*L*		*a*		*b*	
	Initial	Final	Initial	Final	Initial	Final
T1	66.34±2.42[a]	66.67±0.59[a]	15.30±3.55[a]	22.32±1.97[a]	48.93±8.01[a]	49.36±0.98[a]
T2	62.33±3.56[a]	68.82±3.21[a]	15.91±2.44[a]	19.29±2.33[a]	47.66±5.41[a]	47.42±2.96[a]
T3	64.71±3.24[a]	67.89±3.07[a]	17.84±3.18[a]	18.93±2.93[a]	47.98±4.88[a]	48.39±5.19[a]
T4	63.93±3.59[a]	68.51±1.43[a]	18.40±5.79[a]	20.62±6.13[a]	48.63±9.98[a]	50.20±9.47[a]

means in the same row, sharing the different letter are significantly different according to Duncan's new multiple range test

Discussion

Digestibility efficiency (DE)

Sullivan and Reigh (1995) suggested that nutrient digestibility varied depending on the composition of ingredients. The differences between the apparent digestibility coefficients of the experimental diets were affected by the methodologies used to collect feces, the formulation and processing of feeds and ingredients (McGoogan and Reigh, 1996). Documents in the use of dried *M. pigra* leave meal in fish diets are limited. Digestibility efficiency values, as observed in the present study found different results for both fish. Fancy fish showed significant differences ($p<0.05$) in DE of protein. Paticulary, when that fish fed the pellet conclude dry *M. pigra* of 100 g^{-1}. These results are similar to the apparent digestibility coefficients of protein sources for carp, *Cyprinus carpio* (Degani *et al*., 1997a) where DE of protein from soybean meal was 69.8%. That was a significantly higher digestibility than that of poultry meal with 47.2%. The ability of carp to digest proteins is, therefore, very high, and that they can utilize proteins as the main component of their diet. Besides

protein, the digestibility of lipid for common carp, *C. carpio* was reported by Degani *et al.* (1997b). In this study, wheat meal lipids showed an apparent digestibility of 80%. The apparent digestibility of corn was 90% for lipid, while for barley the figure was 67%. Correspondingly, El-shafai *et al*. (2004) demonstrated that ADC in Nile tilapia had high values in all diets (88.4-93.9%) when using fresh and dried duckweed as feed ingredients.

In goldfish, DE of protein and fiber showed higher values when the fish were fed with 150 g kg^{-1} of dry *M. pigra* in the pellet. Similarly, Yanar *et al.*, (2008) indicated that 40% of crude protein was a suitable dietary level of 15% alfalfa to ensure good pigmentation, acceptable growth, and feed utilization in goldfish (*C. auratus*). The growth and dietary utilization of goldfish revealed that during the growth phase, feed with 42.53% animal protein (fish meal) exhibited better daily net weight gain, percentage weight gain, and specific growth rate (Bandyopadhyay *et al*., 2005). The apparent digestibility coefficient provides an estimate of the potentially available energy and nutrients for maintenance, growth and reproduction of an animal. The levels of indigestible nutrients provide aquaculture wastes (Cho, 1993). Estimates of nutrient availability can help optimizing the nutritive values and costs of formulated diets (Fagbenro, 1999).

Skin color

Carotenoids are dietary in origin, but their distribution and intensity are apparently under genetic control. Typically, the chromatophores in fish include melanophores, xanthophores, erythrophores, leucophores, and iridophores that are responsible for the revelation of skin pigmentation in fish (Fujii, 2000). Conversely, pigment patterns in fish predominantly result from the positioning of different colored chromatophores. Theoretically, pigment cell patterning might result from long-range patterning mechanisms or from interactions between neighboring chromatophores (Kelsh, 2004). Although, the data of color parameters *L**, *a**, and *b** chromaticity of fancy fish were not significant difference ($p>0.05$), that fish fed with 100 g^{-1} had higher values than others. Skin color of goldfish in the end of period interm of *L**, *a** and *b** chromaticity slightly changed from the initial to the final measurement. However, the effect of dried giant *M. pigra* leaves meal as a feed ingredient for the enhancement of pigmentation in fancy fish and goldfish has not been reported as yet. There are related studies on other ingredients with variable results. Yuangsoi *et al*. (2011) demonstrated that pigmentation response of skin redness of fancy carp fed with diets combined with lutein and β-carotene at 25:25, 50:50 mg kg^{-1} final pellet

food and lutein 50 mg kg^{-1} were higher than in other treatments ($p<0.05$), but they were similar to fish fed with a diet amendment of 25 mg kg^{-1} astaxanthin.

Our researches implied that dry giant mimosa leave meal can be used in fancy fish and goldfish up to 100 g kg^{-1} with not effect on DE. Moreover, the skin color in terms of *L**, *a** and *b** show high values in the fish fed with 100 g kg^{-1} dry giant mimosa leaves. Such applications indicate the use of weeds as feed supplements in the future.

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