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# Research Article
# Suckermouth Armored Catfish (*Pterygoplichthys pardalis*) as a Replacement for Fish Meal in Thai "Pradu Hang Dam" Native Chicken Diets

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## Abstract

**Background and Objective:** Fish meal is an expensive protein source in livestock feed. The present study investigated the effects of suckermouth armored catfish (*Pterygoplichthys pardalis*) as a replacement for fish meal in Thai native chicken diets. **Materials and Methods:** Two hundred Thai-native crossbred male and female "Pradu Hang Dam" chickens (21 day-old) were divided into 5 groups of 40 birds each. The birds were fed a basal diet with 0% (control), 25, 50, 75%,or 100% of the fish meal replaced with suckermouth armored catfish meal (SM).General production performance parameters and carcass characteristics were measured. **Results:** Average daily feed intake was not significantly different between any of the groups. However, average daily gain and feed conversion ratio in birds fed 25% SM were higher than the other groups ($p<0.01$). The carcass weight before being chilled or after being heated was not significantly different between any of the groups. In addition, the carcass weight after refrigeration for 12 h was not significantly different between any of the groups. The wing, breast, thigh and drumstick weights in all SM replacement groups when calculated to percent of chill weight were higher than the 0% SM group ($p<0.05$). The percentage of meat loss was not different, except for drip loss percentage of breast in the 50% SM group, which was higher than the other groups ($p<0.05$). The color b* level of breasts in the 25-100% SM groups were higher than the control group ($p<0.05$) and the L* level of thighs in the 25%SM group was also higher than that of the other groups ($p<0.05$). **Conclusion:** Replacing 25-50% of fish meal with SM in Thai native chicken diets had a positive effect on growth performance and some meat characteristics and represents a viable alternative dietary protein source.

Key words: Suckermouth armored catfish (*Pterygoplichthys pardalis*), fish meal, Thai native chicken, chicken diet, carcass

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

## INTRODUCTION

Fish meal (FM) is a main dietary protein source for monogastric animal due to its high amino and fatty acid content[1]. However, the high price of FM is a major problem when it is used in commercial feed. Therefore, many inexpensive and locally-sourced ingredients are being investigated as viable replacements for poultry diets[2], such assoybean and sunflower meal as well as blood meal, boiler offal and maggot meal[3-5].

Sucker mouth armored catfish (*Pterygoplichthys pardalis*) include several popular aquarium species that have become invasive in tropical, subtropical and warmwater regions around the world, commonly called armored sailfin catfish, janitor fish, pecesdiablos (devil fish), or "plecos," species of the genus *Pterygoplichthys* exhibit most of the characteristics that predispose certain fishes to successful invasion[6]. As an invasive species in Thailand[7], the spread of the suckermouth armored catfish is an increasing concern because non-native catfish are negatively impacting water resources[8]. Attempts to control their numbers and spread have included using them as a feed ingredient for livestock as they contain high levels of the essential amino acids, lysine and methionine[9].

While one study reported that the use of Sapu-Sapu (*Hyposarcus pardalis*) as a single protein source in laying Mojosari duck production was not beneficial for feed intake, feed conversion and egg production, mass and number[10], few studies have investigated the use of *P. pardalis* as a protein source for chickens. Therefore, the present study evaluated the effects of suckermouth armored catfish as a replacement for FM in the diet of the most popular Thai native chicken crossbreed, "Pradu Hang Dam."

## MATERIALS AND METHODS

**Animals, diets and management:** Suckermouth armored catfish meal (SM) was prepared by sun-drying and grinding whole fish before use it as experimental feed. Suckermouth armored catfish was obtained from the Phayao province, Thailand. The chemical composition of the SM was analyzed by standard methods[11]. Two hundred Thai-native crossbred male and female "Pradu Hang Dam" chickens (21 day-old) from northern Thailand were divided into five groups of 40 birds each (4 replications; 10 chicks per replication or cages). The birds were raised under standard management and open air housing. Birds were fed a basal diet with 0% (control), 25, 50, 75, or 100% of the FM replaced with SM after brooding and until slaughter (3-12 weeks; Table 1). Chicks were provided feeds and water *ad libitum*. Uniform management and vaccination schedules were followed for all birds.

**Animal characteristics measurements:** Body weight was recorded every week to determine weight gain and calculate the average daily gain. Feed intake was measured daily by weighing the remaining food after each meal and the feed conversion ratio was determined as the ratio of feed intake to increase body weight. At the end of the experiment, two male and two female birds from each treatment group were randomly chosen, weighed and slaughtered to determine the carcass quality according to a previous method[12]. After removing the feathers, the breast, wing, thigh and drumstick meat were collected to calculate the percent of carcass weight after 12 h of refrigeration. The loss in weight through storage and processing was determined as drip loss, thawing loss and cooking loss from the breast and thigh

Table 1: Composition of chicken feed provided after brooding until slaughter (3-12 weeks)

| Ingredients (%) | 0% SM | 25% SM | 50% SM | 75% SM | 100% SM |
|---|---|---|---|---|---|
| Corn | 36.00 | 36.00 | 36.45 | 36.45 | 36.45 |
| Rice bran | 31.45 | 31.45 | 31.00 | 31.00 | 31.00 |
| Soybean meal | 16.00 | 16.00 | 16.00 | 16.00 | 16.00 |
| Fish meal | 10.00 | 7.50 | 5.00 | 2.50 | 0.00 |
| Sucker mouth armored catfish meal (SM) | 0.00 | 2.50 | 5.00 | 7.50 | 10.00 |
| Plant oil | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| Dicalcium phosphate | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Salt | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Premix[1] | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| **Calculated nutrient levels** | | | | | |
| Protein (%) | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| Metabolizable energy; ME (kcal $kg^{-1}$) | 2800.00 | 2800.00 | 2800.00 | 2800.00 | 2800.00 |
| Ca (%) | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 |
| Available P (%) | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 |

[1]The premix provided following per kg of diet. Vitamin A: 36,000 IU, Vitamin D3: 7200 IU, Vitamin E: 10.9 mg, Vitamin K3: 3.8 mg, Vitamin B1: 0.37 mg, Vitamin B2: 7.75 mg, Nicotinic acid: 64 mg, Calcium pantothenate: 10 mg, Vitamin B6: 0.09 mg, Choline chloride: 1250 mg, Fe: 10 mg, Mn: 20 mg, Zn: 20 mg

meat. The colors L*, a* and b* of breast and thigh meat after slaughter were measured using a Minolta Chroma Meter (Model CR-400, Minolta Camera Co., Ltd., Osaka, Japan).

**Statistical analysis:** Experimental data were analyzed by one-way analysis of variance using SAS statistical software. The results were expressed as Means±standard error. A $p<0.05$ was considered statistically significant.

## RESULTS

Chemical composition analysis of SM showed it contained 62.28% crude protein, 6.40% lipids and 3900 kcal $g^{-1}$ gross energy. The effects of replacing FM with SM on bird performance are shown in Table 2. The average daily intake was not significantly different between any of the groups. However, the average daily weight gain and feed conversion ratio in the 25% SM group were significantly greater than that of the other groups ($p<0.01$). The carcass weight before being chilled or after being heated was not significantly different between any of the groups. In addition, the carcass weight after refrigeration for 12 h was not significantly different between any of the groups. The chilled wing, breast, thigh and drumstick weights in the 25-100% SM food groups were significantly higher than those of the 0% SM group ($p<0.05$).

The percentage of weight loss through storage and processing did not significantly differ between any of the groups (Table 3), with the exception of breast drip loss in the 50%SM group, which was significantly higher than the other groups ($p<0.05$). Breast and thigh meat color is described in Table 4. The b* levels of breasts in the 25-100% SM food

Table 2: Effects of replacing fish meal with sucker mouth armored catfish meal (SM) on Thai "Pradu Hang Dam" chickens

| Total performance (3-12 weeks) | 0% SM | 25% SM | 50% SM | 75% SM | 100% SM | p-value |
|---|---|---|---|---|---|---|
| Feed intake (g $day^{-1}$) | 72.22±3.78 | 73.78±3.79 | 72.87±4.64 | 72.74±4.77 | 72.84±5.17 | 0.637 |
| Average daily weight gain (g $day^{-1}$) | 12.83±3.46$^{a}$ | 15.68±3.60$^{b}$ | 12.53±3.15$^{a}$ | 13.02±1.97$^{a}$ | 13.25±2.47$^{a}$ | <0.001 |
| Feed conversion ratio | 4.95±0.86$^{bc}$ | 4.03±0.95$^{a}$ | 4.86±0.97$^{bc}$ | 5.28±0.50$^{c}$ | 4.77±0.55$^{b}$ | <0.001 |
| **Carcass characteristics** | | | | | | |
| Hot carcass weight (kg) | 1.22±0.05 | 1.30±0.01 | 0.98±0.06 | 1.09±0.01 | 0.99±0.02 | 0.187 |
| Chill carcass weight (kg) | 1.26±0.03 | 1.31±0.04 | 1.05±0.05 | 1.15±0.01 | 1.02±0.02 | 0.181 |
| **Percentage of chill carcass** | | | | | | |
| Wing | 11.11±0.36$^{a}$ | 12.20±0.09$^{ab}$ | 12.38±0.02$^{b}$ | 12.16±0.40$^{ab}$ | 11.76±0.33$^{ab}$ | 0.036 |
| Breast | 15.08±0.49$^{a}$ | 16.03±0.21$^{ab}$ | 16.18±0.31$^{ab}$ | 16.52±0.19$^{b}$ | 16.66±0.12$^{b}$ | 0.017 |
| Thigh | 10.31±0.16$^{a}$ | 12.98±0.07$^{bc}$ | 12.37±0.19$^{b}$ | 13.90±0.30$^{cd}$ | 14.71±0.43$^{d}$ | <0.001 |
| Drumstick | 12.70±0.46$^{a}$ | 14.50±0.21$^{c}$ | 13.33±0.31$^{ab}$ | 13.90±0.14$^{ab}$ | 13.73±0.29$^{ab}$ | 0.014 |

$^{a,b,c}$Different superscripts within each row are significantly different ($p<0.05$)

Table 3: Effects of replacing fish meal with suckermouth armored catfish meal (SM) on Thai "Pradu Hang Dam" chicken meat quality

| | 0% SM | 25% SM | 50% SM | 75% SM | 100% SM | p-value |
|---|---|---|---|---|---|---|
| **Drip loss (%)** | | | | | | |
| Breast | 9.30±2.36$^{ab}$ | 7.15±1.23$^{b}$ | 10.42±1.49$^{a}$ | 7.75±1.65$^{ab}$ | 7.34±0.63$^{ab}$ | 0.043 |
| Thigh | 10.06±0.68 | 9.25±1.03 | 10.44±1.67 | 9.92±0.44 | 10.34±0.61 | 0.141 |
| **Thawing loss (%)** | | | | | | |
| Breast | 1.72±1.07 | 1.58±1.04 | 1.21±1.05 | 1.69±0.90 | 1.40±0.83 | 0.317 |
| Thigh | 3.70±3.68 | 3.75±1.22 | 3.25±3.30 | 3.71±1.47 | 3.90±4.37 | 0.164 |
| **Cooking loss (%)** | | | | | | |
| Breast | 18.32±9.53 | 20.91±2.04 | 20.64±3.52 | 18.09±2.72 | 21.91±3.38 | 0.175 |
| Thigh | 23.13±2.67 | 22.38±2.38 | 23.13±4.35 | 18.47±0.76 | 21.78±1.94 | 0.136 |

$^{a,b}$Different superscripts within each row are significantly different ($p<0.05$)

Table 4: Effects of replacing fish meal with suckermouth armored catfish meal (SM) on Thai "Pradu Hang Dam" chicken meat color

| | 0% SM | 25% SM | 50% SM | 75% SM | 100% SM | p-value |
|---|---|---|---|---|---|---|
| **Breast** | | | | | | |
| L* | 58.69±5.10 | 59.15±5.83 | 57.99±5.77 | 59.35±5.58 | 58.89±1.04 | 0.625 |
| a* | 3.26±2.88 | 3.81±1.46 | 3.79±1.50 | 3.84±0.89 | 3.27±0.93 | 0.212 |
| b* | 6.39±4.45$^{a}$ | 14.29±2.02$^{b}$ | 15.82±1.18$^{b}$ | 13.71±0.69$^{b}$ | 13.84±2.28$^{b}$ | 0.001 |
| **Thigh** | | | | | | |
| L* | 52.99±2.41$^{ab}$ | 55.43±2.08$^{b}$ | 49.73±4.67$^{ab}$ | 47.23±2.57$^{a}$ | 48.28±2.04$^{a}$ | 0.006 |
| a* | 5.57±1.58 | 4.02±1.28 | 5.33±1.94 | 5.08±1.88 | 4.90±1.67 | 0.148 |
| b* | 9.13±3.80 | 8.86±3.17 | 8.78±4.14 | 8.99±2.73 | 8.45±4.45 | 0.266 |

$^{a,b}$Different superscripts within each row are significantly different ($p<0.05$)

groups were all higher than that of the 0% SM group ($p<0.05$). Furthermore, the L* levels of thighs in the 25% SM food group was significantly higher than that of the other groups ($p<0.05$).

## DISCUSSION

FM is a good protein source for animals[13] because it contains a high level of essential amino acids, such as methionine, lysine and phenylalanine, which are important for growth. However, FM is expensive. The present study is the first to examine the effects of using SM as a replacement for FM in Thai native chicken ("Pradu Hang Dam") diets. Importantly, substitution of feed with 25-50% SM had positive effects on production performance and some meat characteristics.

Since FM and SM have very similar crude protein levels (63% versus 62.28%, respectively) and amino acid profiles high in lysine and methionine, SM is a viable and more cost effective alternative to FM in chicken feed. Moreover, the apparent metabolizable energy content of SM is 2890.52 kcal $kg^{-1}$, with 64.80% digestible protein on a dry matter basis[9]. In contrast, a study by Indarsih *et al.*[10] reported that feeding SM as a single protein source in duck feed had significantly non beneficial effects ($p<0.001$) on feed intake, feed conversion ratio, egg production, weight, total number of eggs and mass.

To date, few studies have explored the effects of SM on poultry or other livestock animal production. Instead, studies have focused on the use of other materials to replace FM. Alternative supplements with beneficial effects include black soldier fly larvae in laying hens[14], grass hopper meal in broilers[15] and up to 25% Gliricidia leaf protein concentrate in broilers[16]. In contrast, co-extruded soybean poultry by product meal in shrimp did not have a significant effect on production[17].

## CONCLUSION

The results of the current study demonstrate the potential of using 25–50% SM as a replacement for FM in Thai native chicken ("Pradu Hang Dam") feed. Use of SM may not only reduce production costs, but may also have additional beneficial effects on growth performance and some meat characteristics.

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