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## Research Article

# Effect of Different Levels of Saponin on Growth Performance and Food Efficiency in Convict Cichlid (*Amatitlania nigrofasciata*)

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### Abstract

**Background and Objective:** Saponin is one of the most common compounds in plant that can have a wide biological effect on organisms. The aim of this study was to evaluate the effects of saponins on growth performance in male and female fish. **Materials and Methods:** Forty two male and female of convict cichlid (*Amatitlania nigrofasciata*) were fed with a diet containing three different levels of saponin (150, 300 and 700 mg kg<sup>-1</sup> of food) for 21 days. **Results:** Measurement of growth indices and food efficiency showed that saponin in high doses can change the growth performance and related indicators. In both sexes, the saponin has led to an increase in specific growth rate and improved body weight increasing and food efficiency. It was achieved at a level of 700 mg kg<sup>-1</sup> food for male, while for female, it at the level of 300 mg kg<sup>-1</sup> of food. **Conclusion:** The presence of saponin in the diet with certain amounts can improve the growth performance and food efficiency. Results showed some differences according to gender in several factors. So, it seems effect of saponin on growth performance and food efficiency is depends on gender and species.

**Key words:** Convict cichlid, food efficiency, saponin, food convention ratio, Specific Growth Rate (SGR)

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**Competing Interest:** The author has declared that no competing interest exists.

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

## INTRODUCTION

Sustainable aquaculture requires decreasing production costs and maintaining the quality and health of cultured food along with reducing environmental impacts. The most used strategy for sustainable aquaculture is the nutritional improvement of food ingredients<sup>1</sup>. Therefore, it is necessary to use the diet based on plant material in the aquaculture industry to increase the production of cold and warm water species for future aquaculture development. Such ingredients have bio-active compounds that can show positive or negative effects in organism<sup>2</sup>.

The use of synthetic materials, such as antibiotics and steroid hormones have been common place to increase the growth efficiency and food intake, which is currently banned in many countries. There is concern about the consumption of these natural substances as supplement and their biological function due to bioactive compounds that exist in plant sources<sup>3</sup>. For example, anti-nutritional factors such as; inhibitors of trypsin, lectin, anti-vitamins, saponins and phytic acid inhibit the use of soy products in fish diets. Among these, trypsin inhibitor's, lectin and anti-vitamin suppressors are sensitive to heat and are degraded by heat treatment. While others, such as; saponin are relatively resist and may be disturbed the digestive process and effect on food intake and growth performance<sup>4</sup>. Some of the studies have reported positive effects of saponin in fish diets. For example, the use of saponin supplements in the tilapia and common carp diets has been improved growth<sup>5</sup>.

Saponins are glycosides present in soybean meal and other plant feed stuffs that has several effects in living organisms: impaired protein digestion, interference with cholesterol metabolism and enterohepatic recirculation of bile salts, effects on the immune system, binding to cellular membranes with a consequential increase in cell permeability and inhibition of active transport<sup>6</sup>. In fish, it can decrease growth performance of rainbow trout (*Oncorhynchus mykiss*), tilapia (*Oreochromis mossambicus*), Atlantic salmon and Chinook salmon (*Oncorhynchus tshawytscha*)<sup>6,7</sup>. Saponins are found almost at a high concentration in some sources of plant protein. It has high toxicity to fish, when release to water<sup>8</sup>. Saponins have different biological effects depend on derived plant sources, due to the high diversity of their structure<sup>5</sup>. The high amounts of saponin in diet can reduce the food intake and weight, also it can cause bloating and sensitivity to light in ruminants, prevents absorption of active nutrients, including vitamins and minerals in the intestine, reducing fertility as well as protein digestibility<sup>3</sup>.

Today, using and replacing herbal sources in the aquatic diet is common. However, it should be noted that the use of these compounds can have adverse effects on aquatic growth<sup>5</sup>. Since various effects of saponin on fish diets have been reported. It is necessary to study the impacts of pure saponin concentrations in fish diets and its effects on growth and food performance. The aim of present work was to study the effect of purified saponin on growth performance and food efficiency in Convict Cichlid.

## MATERIALS AND METHODS

The Convict Cichlids (*Amatitlania nigrofasciata*) used for the study was obtained from the local ornamental fish Farm, Malayer, Iran. The fish were acclimated for 48 h before starting feeding trial in the fisheries laboratory of Malayer University, Iran. The 42 adult fish of the same generation and the same age with an average weight of  $7.349 \pm 0.35$  g were fed with diet containing different amounts of saponin for 21 days from 1-21 July, 2017. The temperature of all aquariums, during the test period was  $28.5 \pm 0.5$  °C.

**Experimental diets:** The fish of this study were divided into 4 groups: control, treatment 150 (150 mg saponin in 1 kg diet), treatment 300 (300 mg saponin in 1 kg diet) and treatment 700 (700 mg saponin in 1 kg diet) with 3 replications for each treatment. The foods of each treatment were daily prepared based on 2-4% by weight of fish (until full) and they were fed 3 times a day. Saponin (8047-15-2-Sigma-Aldrich) considered in each treatment was measured according to the weight of required food and it was sprayed on the food, after dissolution in distilled water. During the period, all the fish were biometry individually and on a weekly basis in order to examine the parameters related to the growth of fish.

**Calculations:** Body Weight Increase (BWI), Condition Factor (CF), Specific Growth Rate (SGR), Feed Conversion Ratio (FCR) and Feed Efficiency (FE) were calculated using recommended formula<sup>9</sup>:

$$FCR = \frac{\text{Feed consumption (dry matter)}}{\text{Live weight gain}}$$

$$SGR = \left\{ \frac{(\ln \text{ final weight} - \ln \text{ initial weight})}{\text{Experimental period (days)}} \right\} \times 100$$

$$CF = \left( \frac{\text{Whole body wet weight}}{\text{Length}^3} \right) \times 100$$

$$BWI (\%) = \left\{ \frac{\left( \frac{\text{Average of final weight} - \text{Average of initial weight in every tank}}{\text{Average of initial weight in every tank}} \right)}{\text{Average of initial weight in every tank}} \right\} \times 100$$

$$FE = \frac{\text{Achieved biomass}}{\text{Consumed food}}$$

**Statistical analysis:** The collected data were analyzed by one-way analysis of variance (ANOVA) using the SPSS package version 19 and means from the various treatments were compared for significant differences ( $p < 0.05$ ) using Duncan's Multiple Range Test (DMRT).

## RESULTS

After 21 days of feeding fish with diet containing different amounts, the results showed that the use of different levels of saponins in the diet can affect the growth indices.

**Food conversion:** According to Fig. 1, the food conversion ratio among the experimental groups also showed no significant difference. Also, the value of this coefficient was similar in both males and females. The lowest FCR was related to the group fed with 700 mg kg<sup>-1</sup> saponin diet, which showed a significant difference with the control group. However, this difference was not significant among treatments.

**Specific growth rate:** The results of data analysis showed that saponin containing diet had no effect on specific growth rate in comparison with the control group in different sexes. Compared to females, the results indicated that the growth rate in males followed a different pattern and in comparison with the control, the highest growth rate was observed in the treatment of 300 mg kg<sup>-1</sup>, while the highest specific growth rate in males was obtained in treatment of 700 mg kg<sup>-1</sup>. However, these differences did not show statistically significant differences with other treatments (Fig. 2).

**Condition factor:** Figure 3 illustrates the results of the analysis of the Condition Factor (CF) in fish fed with different levels of saponin. The comparison of the average of the data obtained from the calculation of CF did not show any significant difference among all experimental groups.

**Body weight increasing:** The highest rate of body weight increasing was observed in females fish fed with diet containing 300 mg kg<sup>-1</sup> saponin and males fish fed with ratios

containing 700 mg kg<sup>-1</sup> saponin (Fig. 4). Compared to other treatments, this increase in both sexes did not show a significant difference, but there was significant difference compared to the control group.

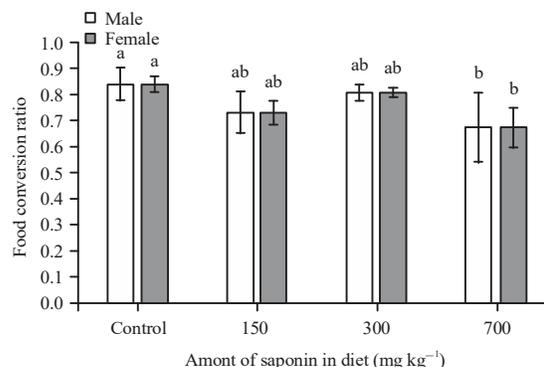


Fig. 1: Changes in food conversion ratio in fish fed with different amounts of saponin  
Significant differences are indicated with letters ( $p < 0.05$ ), Data is presented as Mean ± SEM (n = 3)

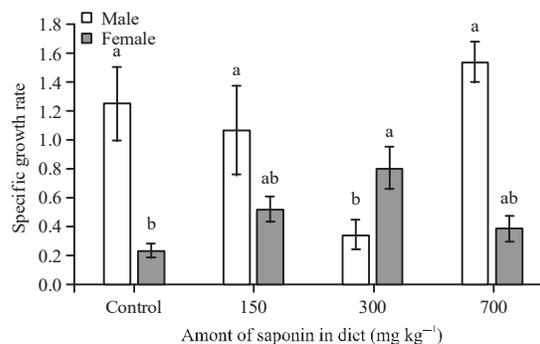


Fig. 2: Effect of different levels of saponin added to the diet on the specific growth rate  
Significant differences are indicated with letters ( $p < 0.05$ ), Data is presented as Mean ± SEM (n = 3)

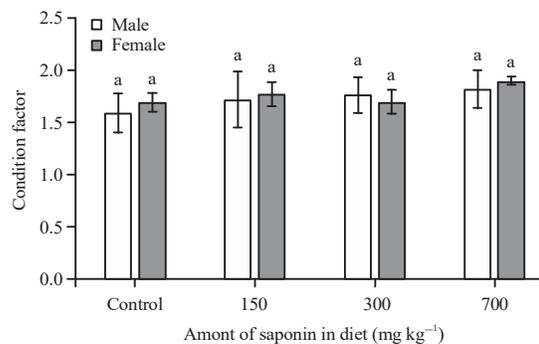


Fig. 3: Effect of different levels of saponin added to the diet on the condition factor  
Significant differences are indicated with letters ( $p < 0.05$ ), Data is presented as Mean ± SEM (n = 3)

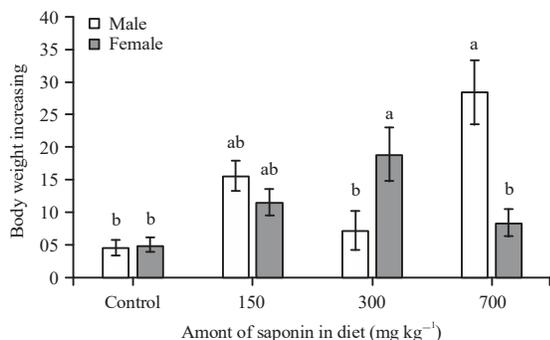


Fig. 4: Effect of different levels of saponin added to the diet on the BWI

Significant differences are indicated with letters ( $p < 0.05$ ), Data is presented as Mean  $\pm$  SEM ( $n = 3$ )

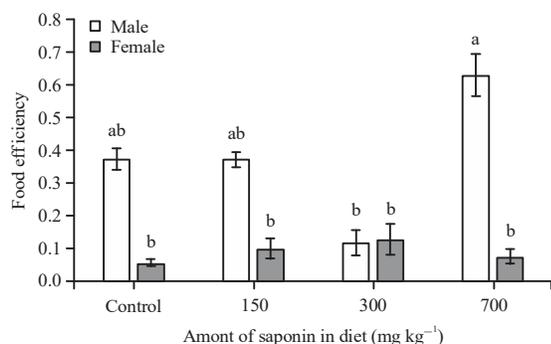


Fig. 5: Effect of different levels of saponin added to the diet on the FE

Significant differences are indicated with letters ( $p < 0.05$ ), Data is presented as Mean  $\pm$  SEM ( $n = 3$ )

**Food efficiency:** According to Fig. 5, food efficiency in fish fed with different amounts of saponin and control group did not show any significant difference in each sex. However, in comparison with male and female, the male food efficiency rate was higher than that of females and there was a significant difference in diet level of 700 mg kg<sup>-1</sup> saponin with other groups. In female fish, the highest rate of this coefficient was observed in the treatment of 300 mg kg<sup>-1</sup> of food.

## DISCUSSION

Regarding to the results, adding saponin to the diet can affect some growth characteristics of the Convict Cichlid fish and cause changes in the parameters such as CF, specific growth rate, BWI and food efficiency. Also, comparing of the average of the data obtained from this survey showed that the pattern of these changes varies depending on the type of fish in some indices and does not follow the same trend. Studies have shown that using appropriate amounts of saponins can

affect fish growth performance. For example, the addition of high levels of saponin (3.2 g kg<sup>-1</sup> or above) to Japanese flounder diet significantly depressed the feed intake and growth responses<sup>4</sup>. A similar result was obtained in some of the parameters has been studied in the present study. It was determined by increasing the amount of dietary saponin in male and female diet, the food conversion rate in both treatments shows the same reduction pattern. It seems that adding saponin to the diet can affect the dietary characteristics. However, these differences did not show statistically significant difference. Similar results have been expressed about the lack of total saponin influence on the food conversion rate in the Rainbow Trout larva. Whereas in Carp, the increase in saponin leads to decrease in this rate. This difference can be attributed to species differences in the two studied species<sup>8,10</sup>. According to the results, the specific growth rate in the fish fed with different amounts of saponin is affected by the sex of the fish. As in males, the highest rate of this coefficient was observed in males fed 700 mg kg<sup>-1</sup>. whereas in females fish, this rate was observed in female fish fed with 300 mg kg<sup>-1</sup>. However, the increase in this coefficient in both genders compared to the control group indicated the effect of this substance on the specific growth rate, which this increase, of course, depends on the concentration and species of fish<sup>7</sup>. The destruction of the intestinal mucosa in fish fed with high amounts of saponin has previously been stated<sup>11</sup>.

This study showed that the increasing saponin levels in the diet could lead to change in body weight gain and food efficiency. In males, the highest rate was observed in fish fed 700 mg kg<sup>-1</sup> of food. Similar results have been reported in Carp and Tilapia fish fed with similar values<sup>7,8,12</sup>. The overall positive effects of saponin added to the diet may be due to the potential of saponin in altering the permeability of the intestinal membrane and its intervention in the absorption of essential nutrients. Changing the permeability of the intestinal membrane can result in the absorption of nutrients<sup>13</sup>. With regard to the results, it seems that females are more sensitive to the amount of consuming saponin and respond in lower amounts to the addition of this substance to the diet. Because in both samples, the females showed the highest levels in the group fed with 300 mg kg<sup>-1</sup> of food. A similar result was reported in Nile Tilapia fed with 300 mg kg<sup>-1</sup> of saponin. This increase can be attributed to the possible effects stated on saponin applied to the diet, as saponin significantly increases the average survival rate of energy, visible fat conversion, carcass fat, energy and a significant decrease in the average amount of unutilized visible energy and the volume of carcasses ashes<sup>7</sup>.

Regarding to the results, it was found that the presence of proportional amounts of saponin in the diet can affect the growth and food efficiency of the Convict Cichlid fish. These effects are related to sex in some aspects, in which the female sex is more sensitive to the presence of higher amounts of saponin and shows the growth in the lower range. In fish, it has been stated that macromolecules, such as intact proteins, penetrate into the intracellular space, subcutaneous tissue and plasma, in Tinca and Carp, respectively<sup>8,12</sup>. Therefore, this "effect of saponins on increasing the permeability of macromolecules in the intestine of higher animals" can also be used in the present study<sup>14</sup>. Hence, the increased growth rate and food efficiency in some treatments, may be due to increasing the efficiency of absorption of digested food in the intestine of fish.

### CONCLUSION

Present study conclude that appropriate rate of saponin in feed may increase the growth of Convict Cichlids. Although, this study had shown, it can be varied depend on gender. So, the saponin level in diet suggested 700 and 300 mg kg<sup>-1</sup> food for male and female, respectively. The present study discovered that saponin can be used as a growth enhancer in fish diets.

### SIGNIFICANCE STATEMENT

The inclusion saponin to improve growth performance and food efficiency used for the present study appeared to significantly influence the Body Weight Increase (BWI), Condition Factor (CF), Specific Growth Rate (SGR), Feed Conversion Ratio (FCR) and Feed Efficiency (FE). Some researchers posited that saponin had adverse effect on growth and fish health. The result of present study has however clearly shown that with the appropriate saponin up to 700 mg kg<sup>-1</sup> diet we can get the best growth performance in cichlids. However, more than that could be adverse effect on fish performance.

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