

## Onion powder as feed additive in *Procambarus clarkii* culture

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### Abstract

120 days trial was performed to evaluate the effect of dietary onion powder on the growth performance of red swamp crayfish *Procambarus clarkii*. Crayfish with initial body weight of  $1.37 \pm 0.13$  g were randomly stocked to experimental tanks. Four different onion powder levels in ratios of 10, 20, 30, and 40 g/kg were added to the formulated experimental basal feed and a control group was fed with basic feed. At the end of the study, final body weight, weight gain and survival rate improved with increasing in onion powder inclusion groups and they showed significantly difference compared to the control. In conclusion, 20-30 g/kg onion powder can be recommended used as an effective dietary supplement for red swamp crayfish culture.

**Keywords:** Feed additive, Growth, *P. clarkii*, Onion powder

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## Introduction

It is known that crayfish (Decapoda) have an important places among invertebrate groups in global aquaculture. The American originated *Procambarus* (swamp crayfish) genus is an acceptable culture animal as in yield than the genera which natural distribution area in Europe, Middle East, Asia, Far East and Australia.

It is need to conduct studies in culture condition to improve the feed conversion rate and growth especially in the highly demanded *Procambarus clarkii*, red swamp crayfish. Mainly the *P. clarkii* is preferred by consumers with delicious meat and rich nutrient content. It is the most important freshwater crayfish in the world and also accounted as 70 to 80% of the total crayfish production (Liu *et al.*, 2020). *P. clarkii* has become a highly demanded species over the past decade. Recently, the red swamp crayfish culture has been considered as a promising sector (Tian *et al.*, 2020). Feed additives, generally defined as non-nutritive ingredients included in formulations, to improve the growth performance of cultured species, is a subject that has been studied extensively in aquaculture (Dawood *et al.*, 2018

In recent years, onion powder (OP) from *Allium cepa* has gained interest as an effective feed supplement for cultured animals. The onion powder effectiveness is being studied in the crustacean culture (Safari and Paolucci, 2017), and also in higher vertebrates

such as fish (Cho and Lee, 2012; Akrami *et al.*, 2015; Saleh *et al.*, 2015; Anwer *et al.*, 2018; Fawole *et al.*, 2020), poultry (ur Rahman *et al.*, 2017; Omar *et al.*, 2020) and mammals including human (Lee *et al.*, 2008a,b).

OP has positive effects with free and glycosidically bonded quercetin and oxidized quercetin derivatives and cysteine sulfoxide (with S-propenyl -CSO as the dominant S compound of OP) (Amar and Faisan, 2011; Nabavi *et al.*, 2015). In addition, OP use with its antibacterial, antioxidant and/or anticancer effects (Ramos *et al.*, 2006) and it helps in reducing endogenous lipogenesis and also in increasing catabolism of lipids (Kumari and Augusti, 2007). Determining the effects of commercially available dietary additives to increase yield in aquaculture has become a focus.

In a previous study, *Astacus leptodactylus* showed a noticeable growth with onion powder supplemented diet (Safari and Paolucci, 2017).

Some studies (Dörr *et al.*, 2013; Xiao *et al.*, 2014; Mona *et al.*, 2015) have been carried out to determine the effects of feed additives in *Procambarus clarkii*. However, there is no information about the inclusion of onion powder in the diet as a growth promoter for *P. clarkii*. For this purposes, we aimed to evaluate the possibilities of using onion powder in red swamp crayfish growth for ensuring practically applicable feed additive to the aquaculture industry.

## Material and methods

Red swamp crayfish, *P. clarkii* were obtained from a local pet shop in Ankara. The trial was performed in the recirculating aquaculture system (RAS, Akuamaks RAS2000M1 research system model) at the Fisheries Research and Application Unit of the Agricultural Faculty of Ankara University, Turkey for 120 days.

Four different inclusion levels (10, 20, 30 and g/kg) of onion powder supplemented feed additives groups (OP10, OP20, OP30 and OP40) and a control group (C) without onion powder were constituted with triplicates each. 240 juvenile of *P. clarkii* ( $1.37 \pm 0.13$  g) were randomly stocked to the tanks (16 individual/45 L). Crayfish were fed twice a day, 08.00 and 16.00 and 12-h light and 12-h dark photoperiod conditions were maintained. During the trial, feeding was performed *ad libitum*.

Nutrient composition and formulation of the experimental diet are presented in Table 1. In this study, 10% water exchange was applied weekly and water quality parameters were monitored every five days intervals (Water hardness:  $143.19 \pm 7.37$ , Dissolved oxygen:  $6.73 \pm 0.63$  ppm, pH:  $7.44 \pm 0.25$ , total ammonia-N:  $0.005 \pm 0.001$  ppm, nitrite-N:  $0.40 \pm 0.18$  ppm) for the desired values in *P. clarkii* culture. The weight gain, specific growth rate, feed conversion ratio and survival rate were calculated using the following formulas: Weight gain (WG) =  $(W_{\text{final}} - W_{\text{initial}}) / W_{\text{initial}} \times 100$   
Specific growth rate (SGR) =  $100 (\ln W_{\text{final}} - \ln W_{\text{initial}}) / \text{Time}$   
Feed conversion ratio (FCR) = feed intake (g) / weight gain (g)  
Survival rate (SR) =  $(N_{\text{final}} / N_{\text{initial}}) \times 100$

**Table 1: Ingredients of the feed and proximate analysis of diet (% dry matter).**

| Ingredients                    | OP0  | OP10 | OP20 | OP30 | OP40 |
|--------------------------------|------|------|------|------|------|
| Fish meal <sup>1</sup>         | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 |
| Soybean meal <sup>2</sup>      | 12.5 | 12.3 | 12.1 | 11.9 | 11.7 |
| Corn gluten <sup>3</sup>       | 13.0 | 12.8 | 12.6 | 12.4 | 12.2 |
| Wheat flour <sup>4</sup>       | 36.0 | 35.4 | 34.8 | 34.3 | 33.7 |
| Fish oil <sup>5</sup>          | 2.4  | 2.4  | 2.4  | 2.4  | 2.4  |
| Soy lecithin <sup>6</sup>      | 2.0  | 2.0  | 2.0  | 2.0  | 2.0  |
| Vitamins premix <sup>7</sup>   | 0.8  | 0.8  | 0.8  | 0.8  | 0.8  |
| Minerals premix <sup>7</sup>   | 0.2  | 0.2  | 0.2  | 0.2  | 0.2  |
| Vitamin C <sup>7</sup>         | 0.1  | 0.1  | 0.1  | 0.1  | 0.1  |
| Binder (guar gam) <sup>8</sup> | 3.0  | 3.0  | 3.0  | 3.0  | 3.0  |
| Onion powder                   | 0.0  | 1.0  | 2    | 3    | 4    |
| <b>Proximate analysis (%)</b>  |      |      |      |      |      |
| Crude ash                      | 6.0  | 6.0  | 6.0  | 5.9  | 5.8  |
| Crude protein                  | 38.1 | 38.0 | 38.1 | 38.1 | 38.1 |
| Crude lipid                    | 9.1  | 9.1  | 9.0  | 9.1  | 9.2  |
| Crude cellulose                | 1.5  | 1.5  | 1.5  | 1.6  | 1.6  |

<sup>1</sup>Anchovy fishmeal. Sursan Feed Mill Company, Samsun, Turkey

<sup>2</sup>Kırcı Soya Company, Balıkesir, Turkey

<sup>3</sup>Cargill, İstanbul, Turkey

<sup>4</sup>Ipek Wheat Company, Nevşehir, Turkey

<sup>5</sup>Anchovy fish oil. Sursan Feed Mill Company, Samsun, Turkey

<sup>6</sup>Sigma Aldrich Chemicals, St. Louis, MO, USA

<sup>7</sup>DSM Nutritional Products, Turkey

<sup>8</sup>Guar gum, Kartal Chemical Company, İstanbul, Turkey

## Results

The onion powder groups had significantly higher final weight, weight gain, SGR, and SR compared to the control group. Moreover, OP30 group was tended to show a difference in terms of final weight. Moreover, the best SGR value was obtained from

OP30. High inclusion OP level (OP40) had a better feed conversion ratio compared the control group. Survival rate was higher in all trial groups than that of the control group. In particular, the highest survival rate was recorded from the OP20 group (Table 2).

**Table 2: Effects of dietary OP on growth performance of red swamp crayfish (120 days trial).**

|             | Control                 | OP10                    | OP20                     | OP30                    | OP40                     |
|-------------|-------------------------|-------------------------|--------------------------|-------------------------|--------------------------|
| IW (g)      | 1.38±0.11               | 1.37±0.12               | 1.38±0.16                | 1.37±0.13               | 1.37±0.13                |
| FW (g)      | 15.40±3.12 <sup>a</sup> | 19.39±4.49 <sup>b</sup> | 21.39±4.87 <sup>bc</sup> | 24.31±5.06 <sup>c</sup> | 21.26±3.65 <sup>bc</sup> |
| WG (g)      | 14.03±3.14 <sup>a</sup> | 18.02±4.47 <sup>b</sup> | 20.01±4.88 <sup>bc</sup> | 22.94±5.07 <sup>c</sup> | 19.89±3.59 <sup>bc</sup> |
| DWG (g)     | 0.12±0.03 <sup>a</sup>  | 0.19±0.05 <sup>bc</sup> | 0.21±0.05 <sup>c</sup>   | 0.25±0.06 <sup>d</sup>  | 0.17±0.03 <sup>b</sup>   |
| SGR (%/day) | 2.61±0.23 <sup>a</sup>  | 2.86±0.26 <sup>b</sup>  | 2.96±0.31 <sup>bc</sup>  | 3.11±0.27 <sup>c</sup>  | 2.97±0.17 <sup>bc</sup>  |
| FCR (g)     | 2.54±0.23 <sup>b</sup>  | 2.20±0.08 <sup>ab</sup> | 2.21±0.14 <sup>ab</sup>  | 2.23±0.43 <sup>ab</sup> | 2.06±0.02 <sup>a</sup>   |
| SR (%)      | 56.25±1.17 <sup>a</sup> | 68.75±1.00 <sup>b</sup> | 81.25±2.00 <sup>d</sup>  | 75.00±3.61 <sup>c</sup> | 68.75±2.65 <sup>b</sup>  |

Different letters in line; indicates significant differences among the groups ( $p < 0.05$ ). The values were given as mean  $\pm$  standard deviation.

## Discussion

Recently, interest in the use of onion powder as a feed additive has increased due to its positive effect. However, the effect of onion powder may vary on different species, including mammals and poultry. Lee *et al.* (2008a), stated that the freeze-dried onion powder (OP) can be rich in quercetin (22 mg/10 g onion) and when used as a food supplement may decrease the risk of hyperlipidemia by reducing cholesterol level. They also considered these lipid reducing effects of OP in blood as possible functional food for human. Lee *et al.* (2008b) studied on the effect of onion powder supplementation on lipid metabolism in male (lab variety Sprague Dawley) rats as a mammalian animal which fed a high fat and high cholesterol diet. They stated that onion powder intake was more influential than

quercetin supplementation. Researchers suggested that onion powder can be used to control body weight gain and also total cholesterol in the liver for rats.

In one of the previous studies showing the usability of onion supplements in broiler feed; the onion additives groups were recorded as significantly increased in growth performance regarding the weight gain and feed consumption and also a positive impact on intestinal microflora and histomorphology (ur Rahman *et al.*, 2017). Moreover, Omar *et al.*, (2020) stated that the dietary onion extracts (1, 2 and 3 g/kg) can improve the good health and growth rate of broiler chicken.

Previous studies showing the effectiveness of onion powder fortified diets on fish can be interpreted as similar to results typically obtained

from other higher vertebrates. However, among these studies, the results reported to have positive effects on growth, especially for African catfish and European sea bass, are considered promising.

No significant zootechnical development for olive flounder (*Paralichthys olivaceus*) in survival, weight gain, or feed efficiency reported. However, the lysozyme activity in olive flounder fed with 0.5 g/kg OP diet was evaluated as higher (Cho and Lee, 2012).

The use of onion powder additives (10 g/kg) in the feed was created as positive effects on growth and immune parameters for sea bass (*Dicentrarchus labrax*) fry (Saleh *et al.*, 2015). Similarly, for grass carp (*Ctenopharyngodon idella*) fed with 1% and 2% OP diet study declared that significant improvements were observed in weight gain, specific growth ratio and feed conversion ratio (Anwer *et al.*, 2018).

Based on the result of one of the previous study on African catfish (*Clarias gariepinus*) showed that dietary POP was no significant impact on the zootechnical performance of fish (as 2.5, 5 and 10 g/kg diet, 1:1 pawpaw seeds, *Asimina triloba*: onion powder, *Allium cepa*) but at the same time they stated that the positive effects were observed in the blood biochemistry and antioxidant responses of fish (Fawole *et al.*, 2020).

The significantly positive effects of dietary onion powder (30-40 g onion powder /kg diet) on the growth

parameters were recorded in *Astacus leptodactylus* (Safari and Paolucci, 2017).

The present preliminary study showed that the 20-30 g/kg of dietary onion powder had a positive effect on the growth performance of *Procambarus clarkii*. In this sense, the fact that the feed additive dose suggested by Safari and Paolucci (2017) for *Astacus leptodactylus* was found similar for *P. clarkii* can be interpreted that onion powder had a similar effect in the Decapoda order.

It is thought that this preliminary study will make an important contribution to the literature, as it is known that there are limited studies on the use of dietary onion powder supplements in crustaceans. As a result, it may be suggested to investigate the effects of onion powder usage on haemolymph, immune and antioxidant parameters in the culture conditions of *P. clarkii* in the future.

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### References

**Akrami, R., Gharaei, A., Mansour, M.R. and Galeshi, A., 2015.** Effects of dietary onion (*Allium cepa*) powder on growth, innate immune response and hemato-biochemical

- parameters of beluga (*Huso huso* Linnaeus, 1754) juvenile. *Fish and shellfish immunology*, 45(2), 828-834.
- Amar, E.C. and Faisan Jr, J.P., 2011.** Efficacy of an inactivated vaccine and nutritional additives against white spot syndrome virus (WSSV) in shrimp (*Penaeus monodon*). *Bamidgeh*, 63, 529– 538.
- Anwer, I., Hafeez-ur-Rehman, M., Abbas, F., Javid, A., Hussain, A., Khan, N., Akmal, M. Abbas, G., Rasool, F. and Azmat, H. 2018.** Effect of onion powder as feed additive on the growth, hematology and biochemical profile of grass carp (*Ctenopharyngodon idella*). *Pakistan J. Zool. Suppl.* 13, 58-64.
- Cho, S.H. and Lee, S.M. 2012.** Onion powder in the diet of the olive flounder, *Paralichthys olivaceus*: effects on the growth, body composition, and lysozyme activity. *Journal of the World Aquaculture Society*, 43(1), 30-38.
- Dawood, M.A., Koshio, S., Esteban, M.Á., 2018.** Beneficial roles of feed additives as immunostimulants in aquaculture: a review. *Reviews in Aquaculture*, 10(4), 950-974.
- Dörr, A.J.M., Abete, M.C., Prearo, M., Pacini, N., La Porta, G., Natali, M. and Elia, A. C., 2013.** Effects of selenium supplemented diets on growth and condition indexes in juvenile red swamp crayfish, *Procambarus clarkii*. *Environmental Toxicology and Pharmacology*, 36(2), 484-492.
- Fawole, F.J., Adeoye, A.A., Tihamiyu, L.O., Samuel, F.C., Omosuyi, O.M. and Amusa, M.T. 2020.** Dietary combination of pawpaw seed and onion peel powder: Impact on growth, haematology, biochemical and antioxidant status of *Clarias gariepinus*. *Aquaculture Research*, 51(7), 2903-2912.
- Kumari, K. and Augusti, K.T., 2007.** Lipid lowering effect of S-methyl cysteine sulfoxide from *Allium cepa* Linn in high cholesterol diet fed rats. *Journal of Ethnopharmacology*, 109(3), 367-371.
- Lee, K.H., Kim, Y.H., Park, E.J. and Cho, S.R., 2008a.** Study on dietary habit and effect of onion powder supplementation on serum lipid levels in early diagnosed hyperlipidemic patients. *Journal of the Korean Society of Food Science and Nutrition*, 37(5), 561-570.
- Lee, K.H., Kim, Y., Park, E. and Hwang, H.J., 2008b.** Effect of onion powder supplementation on lipid metabolism in high fat-cholesterol fed SD Rats. *Journal of Food Science and Nutrition*, 13(2), 71-76.
- Liu, F., Qu, Y.K., Geng, C., Wang, A.M., Zhang, J.H., Chen, K.J., Liu, Bo., Tian, H.Y., Yang, W.P. and Yu, Y.B., 2020.** Effects of hesperidin on the growth performance, antioxidant capacity, immune responses and disease resistance of red swamp crayfish (*Procambarus clarkii*). *Fish and Shellfish Immunology*, 99, 154-166.
- Mona, M.H., Rizk, E.S.T., Salama, W.M. and Younis, M.L., 2015.**

- Efficacy of probiotics, prebiotics, and immunostimulant on growth performance and immunological parameters of *Procambarus clarkii* juveniles. *The Journal of Basic and Applied Zoology*, 69, 17-25.
- Nabavi, S.F., Russo, G.L., Daglia, M. and Nabavi, S.M., 2015.** Role of quercetin as an alternative for obesity treatment: you are what you eat!. *Food Chemistry*, 179, 305-310.
- Omar, A.E., Al-Khalaifah, H.S., Mohamed, W.A., Gharib, H.S., Osman, A., Al-Gabri, N.A. and Amer, S.A., 2020.** Effects of phenolic-rich onion (*Allium cepa* L.) extract on the growth performance, behavior, intestinal histology, amino acid digestibility, antioxidant activity, and the immune status of broiler chickens. *Frontiers in Veterinary Science*, 7, 728.
- Ramos, F.A., Takaishi, Y., Shirotori, M., Kawaguchi, Y., Tsuchiya, K., Shibata, H., Higuti, T., Tadokoro, T., Takeuchi, M., 2006.** Antibacterial and antioxidant activities of quercetin oxidation products from yellow onion (*Allium cepa*) skin. *Journal of Agricultural and Food Chemistry*, 54(10), 3551-3557.
- Safari, O. and Paolucci, M., 2017.** Effects of dietary onion (*Allium cepa*) powder on growth performance, hemolymph indices and fillet organoleptic properties of juvenile narrow-clawed crayfish, *Astacus leptodactylus leptodactylus* Eschscholtz, 1823. *Aquaculture Nutrition*, 23(6), 1418-1428.
- Saleh, N.E., Michael, F.R. and Toutou, M.M. 2015.** Evaluation of garlic and onion powder as phyto-additives in the diet of sea bass (*Dicentrarchus labrax*). *The Egyptian Journal of Aquatic Research*, 41(2), 211-217.
- Tian, H., Yang, C., Yu, Y., Yang, W., Lu, N., Wang, H., Liu, F., Wang, A. and Xu, X., 2020.** Dietary cholesterol level affects growth, molting performance and ecdysteroid signal transduction in *Procambarus clarkii*. *Aquaculture*, 735198.
- ur Rahman, S., Khan, S., Chand, N., Sadique, U. and Khan, R.U. 2017.** In vivo effects of *Allium cepa* L. on the selected gut microflora and intestinal histomorphology in broiler. *Acta Histochemica*, 119(5), 446-450.
- Xiao, X., Han, D., Zhu, X., Yang, Y., Xie, S. and Huang, Y., 2014.** Effect of dietary cornstarch levels on growth performance, enzyme activity and hepatopancreas histology of juvenile red swamp crayfish, *Procambarus clarkii* (Girard). *Aquaculture*, 426, 112-119.