

Effect of cinnamon (*Cinnamomum verum*) extract on productive traits, economic efficiency and blood biochemical parameters of rainbow trout (*Oncorhynchus mykiss* W.)

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Abstract

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The aim of the present study was to evaluate the effect of the dietary cinnamon extract supplement on the survival rate, weight gain, feed conversion ratio (FCR), economic efficiency (ECR) and blood biochemical parameters of rainbow trout, cultivated in a recirculation system. One hundred and twenty rainbow trout were distributed in two experimental variants, with two replicates of 30 fish per each. The average initial live weight of fish from the control group (K) and experimental group (F) were 41.55 ± 7.96 g and 41.48 ± 7.95 g, respectively ($P > 0.05$). The feed of fish from group F was supplemented with 1% powdered cinnamon extract, after lubricating the pellets with 5 ml sunflower oil per 100 g feed. Control group received the same amount of sunflower oil-lubricated feed. Fish were fed 3 times/daily with the diet, based on 3% of biomass. The trial period was 60 days. The inclusion of cinnamon extract had no significant effect on growth parameters of fish from two experimental groups ($P > 0.05$). Survival rates were 100% from control and experimental groups. The final live weight of the rainbow trouts of the control and experimental groups was as followed: K – 117.25 ± 19.15 g and F - 121.42 ± 19.39 g, but the differences were not significant ($P > 0.05$). The average weight gain of rainbow trouts in the control group was 75.70 ± 11.53 g and it was lower than the values of fish from the experimental variant F with 5.59% ($P > 0.05$). FCR of the control group was 1.08 ± 0.03 and it was higher than that of the group F with 4.85% ($P > 0.05$). The economic efficiency of feed with extract of cinnamon in the experimental group had better coefficient of economic efficiency 1.46, which is lower by 3.31% compared to the coefficient of the controls. Blood biochemical parameters of the fish from the two experimental groups did not differ substantially.

Keywords: survival rate; weight gain; feed conversion ratio; economic conversion ratio

Introduction

The ban on using nutritional antibiotics in livestock husbandry increased the quest for their alternative substitutes. As such, many plants, parts of plants and plant extracts are tested. The effects of phytoextracts on different fish species, were investigated mainly in carps and rainbow trouts with numerous plant extracts as curcumin, paprika, thyme, oregano, garlic (Georgieva et al., 2018, 2019), nutmeg (Zhelyazkov et al., 2018), *Achillea millefolium* (Koshinski, 2019), *Taraxacum officinale* (Sirakov et al., 2019; Koshinski 2020), *Acorus calamus* (Velichkova et al., 2019) etc. The utilisation of plant extracts is promising for feed industry practice not only as they are relatively cheap, but also safe both for fish and for men as ultimate consumers (Gabor et al., 2010; 2011).

Cinnamon (*Cinnamomum verum*) is a tropical evergreen shrub, whose dried bark is used as spice. It contains a lot of vitamins, minerals and phenolic compounds. It is

established that cinnamon possesses anti-inflammatory, antimicrobial, antibacterial, antineoplastic, cardiovascular, cholesterol-reducing, immunomodulatory, larvicidal and antioxidant properties (Charles, 2012).

The effect of cinnamon in growing Dedi et al. (2016) and fattened carps Stoyanova et al. (2018) are limited. Biologically active compounds in plant extracts could have either a positive or a negative impact on different fish species, so they have to be tested for the specific species.

The aim of the present study was to evaluate the effect of the dietary cinnamon extract supplement on the survival rate, weight gain, feed conversion ratio (FCR), economic efficiency (ECR) and blood biochemical parameters of rainbow trout, cultivated in a recirculation system.

Material and Methods

Ethical approval

All applicable international, national, and/or institution-

al guidelines for the care and use of animals were followed by the authors.

Experimental design: One hundred and twenty rainbow trouts were distributed in two experimental variants – control (K) and experimental (F) with two replicates of 30 fish per each. The average initial live weight of fish was 41.55 ± 7.96 g (K) and 41.48 ± 7.95 g (F). Fish were farmed in a recirculation system, in concrete pools with effective volume 0.8 m^3 . Fish were fed extruded feed “Aqua garant

UNI” with pellet size 2 mm, manufactured by Garant-Tiernahrung Gesellschaft m.b.H.-Austria. Through feed lubrication with sunflower oil (5 ml/100 g feed), the feed of trouts from group F was supplemented with 1% powdered cinnamon extract (produced by P.I.C.Co LTD), while control fish received only sunflower oil-lubricated feed. The ration was 3% of fish’ live weight distributed manually to 3 daily portions. The trial period was 60 days. The nutritional content of feed of both groups shown in Table 1.

Table 1. Nutrient content in the extruded feed for rainbow trout (*Oncorhynchus mykiss* W.)

№	Item	Groups	
		K	F
1	Crude protein, %	45.00	45.00
2	Crude lipids, %	16.00	16.00
3	Crude fiber, %	2.40	2.40
4	Crude ash, %	8.00	8.00
5	Ca, %	1.60	1.60
6	P, %	1.20	1.20
7	Cinnamon extract, %	-	1
8	ME, MJ/kg	18.50	18.50

* 1 kg feed contains: vitamin A – 10000 IE; vitamin D₃ – 1500 IE; vitamin E – 200 mg; vitamin C - 150 mg

** 1 kg feed contains: Fe – 62 mg; Mn – 26 mg; Cu – 5 mg; Zn – 103 mg; I – 2.6 mg; Se – 0.3 mg

Hydrochemical analysis

Water chemical parameters of the recirculation system during the experiment with rainbow trout (*Oncorhynchus mykiss* W.) were determined as followed:

- Water temperature - °C; dissolved oxygen - mg.l^{-1} , pH and electric conductivity - $\mu\text{S.cm}^{-1}$ with MultiLineP4 equipment (Xylem Analytics Germany Sales GmbH & Co. KG, WTW);

- Ammonia, mg.l^{-1} – BSS ISO 7150-1:2002;

- Nitrates, mg.l^{-1} – BSS ISO 7890-3:1988;

- Nitrites, mg.l^{-1} – BSS ISO 26777:1997;

Orthophosphates, mg.l^{-1} – BSS EN ISO 6878:2005.

Water temperature, dissolved oxygen, pH and electric conductivity were monitored at a daily basis, whereas ammonia, nitrates, nitrites and orthophosphate contents – on weekly basis.

Determination of growth performance

To evaluate the effect of dietary cinnamon extract in extruded feed on rainbow trout weight gain and feed conversion in the recirculation system, fish were weighed in the beginning, middle and end of the experimental period. Body weight (g) was determined individually. By the end of the trial, survival rate (%), weight gain (g) and feed conversion ratio (FCR) were determined.

Economic analysis

The analysis of the economic efficiency of dietary cinnamon extract supplementation of rainbow trouts in a recirculation system was performed with data for feed conversion ratio, survival rate and weight gain. These traits were compared between the experimental groups and extruded feed costs were calculated. The cost of 1 kg weight gain was determined. The economic conversion ratio (ECR) was

calculated according to Piedecausa et al. (2007):

$$\text{ECR} = \text{Cost of Diet} \times \text{Feed Conversion Ratio (FCR)}.$$

Determination of blood biochemical parameters

Blood samples were obtained through caudal vessels puncture using EDTA containers. Glucose (GLU), urea, creatinine (CREA), total protein (TP), albumin (ALB), ASAT, ALAT, alkaline phosphatase (ALP), calcium (Ca), phosphorus (P), magnesium (Mg), triglyceride (TG), and cholesterol (CHOL) concentrations were determined by means of BS-120 Chemistry Analyzer (Mindray, China).

Statistical analysis

Statistical analysis was performed using STATISTICA 6.0 software (StatSoft Inc., 2002). Mean, standard deviation and t-test were performed. The statistical significance was determined at $P < 0.05$.

Results

Hydrochemical analysis

Hydrochemical parameters in the recirculation system were maintained within the optimum ranges for rainbow trout farming throughout the experiment (Table 2). There were no statistically significant differences between groups ($P > 0.05$) with respect to these parameters. The temperature of water during the 60-day period varied between $12.5 \text{ }^\circ\text{C}$ and $15.5 \text{ }^\circ\text{C}$, with average value $14.00 \text{ }^\circ\text{C}$. Dissolved oxygen exceeded 9 mg.l^{-1} , and water pH in control (K) and experimental (F) groups was 7.64 ± 0.56 and 7.72 ± 0.48 , respectively. Water electric conductivity was $485 \mu\text{S.cm}^{-1}$. The content of ammonia, nitrates, nitrites and orthophosphates in the recirculation system was determined on a weekly basis, and measured values were significantly lower than maximum allowances set by Regulation No. 4/2000 (Table 2).

Table 2. Water parameters in the recirculation system during the experiment with rainbow trout (*Oncorhynchus mykiss* W.)

Parameter	n	K	F	Significance	Optimum values (Regulation No 4/2000)
		$\bar{x} \pm SD$	$\bar{x} \pm SD$		
Temperature, °C	60	14.00±1.50	14.00±1.50	NS	12.0-16.0
Dissolved oxygen, mg.l ⁻¹	60	9.68±0.28	9.75±0.35	NS	> 9
pH	60	7.64±0.56	7.72±0.48	NS	6.0-9.0
Electric conductivity, µS.cm ⁻¹	60	485±35.24	485±47.18	NS	-
Ammonia, mg.l ⁻¹	8	0.65±0.23	0.64±0.25	NS	< 1.0
Nitrates, mg.l ⁻¹	8	0.35±0.04	0.31±0.07	NS	< 2.0
Nitrites, mg.l ⁻¹	8	0.007±0.001	0.006±0.001	NS	< 0.01
Orthophosphates, mg.l ⁻¹	8	0.253±0.136	0.266±0.138	NS	<0.40

NS=Non-significant

Determination of growth performance

The average initial body weight of fish from the two replication of groups K and F was 41.55±7.76 g and 41.48±7.95 g, respectively, with statistically insignificant differences (P>0.05) (Table 3). By the middle of the period, fish from group F tended to have a higher average body weight - 72.47±11.77 g, which was by 7.69% higher than control fish yet statistically insignificant (P>0.05) (Table 3). The same tendency was preserved at the end of the experimental period, when fish supplemented with

cinnamon with their diet had a insignificantly higher live weight live body weight (P>0.05) by 3.56% than control fish from group K (117.25±19.15 g) (Table 3). Survival rate in both groups was 100% (Table 3). Average individual weight gain of fish from group G was 79.93±11.89 g, e.g. by 5.29% higher than fish from group K (P>0.05) (Table 3). Better feed conversion ratio (FCR) was calculated in the group supplemented with 1% cinnamon extract - 1.03±0.03, by 4.85% lower than FCR of control fish (P>0.05) (Table 3).

Table 3. Fish production parameters

Parameter	n	K	n	F	Significance
		$\bar{x} \pm SD$		$\bar{x} \pm SD$	
Initial body weight, g	60	41.55±7.76	60	41.48±7.95	NS
Body weight in the middle of the trial, g	60	66.90±14.77	60	72.47±11.77	NS
Final body weight, g	60	117.25±19.15	60	121.42±19.39	NS
Survival rate, %		100		100	
Average individual weight gain, g	60	75.70±11.53	60	79.93±11.89	NS
FCR	60	1.08±0.03	60	1.03±0.03	NS

Economic analysis

The price of extruded feed for rainbow trouts was 1400.00 €/t (VAT excluded). The feed of the experimental group F was supplemented with 1% cinnamon extract which resulted in higher feed cost by 20

€/t VAT excluded (Table 4).

A better economic conversion ratio of 1.46 was detected in the group whose diet was supplemented with 1% cinnamon extract compared to non-supplemented controls, whose ECR was 1.51 (Table 4).

Table 4. Economic efficiency of the cinnamon extract supplementation in the feed

Item	K	F
Price, €/t feed (VAT excluded)	1400.00	1420.00
Price, €/kg feed (VAT excluded)	1.400	1.420
ECR	1.51	1.46*

*The lowest value shows the best ECR. ECR=Economic conversion ratio

Determination of blood biochemical parameters

The health status of rainbow trouts from both groups was monitored through evaluation of blood biochemical

parameters. There were no statistically significant differences between the groups ($P>0.05$) with regard to all studied 13 blood biochemical parameters (Table 5).

Table 5. Blood biochemical parameters of rainbow trouts (*Oncorhynchus mykiss* W.)

Parameters	n	K	F	Significance
		$\bar{x} \pm SD$	$\bar{x} \pm SD$	
GLU, mmol/l	6	5.12±0.46	5.23±0.38	NS
UREA, mmol/l	6	0.82±0.08	0.86±0.14	NS
CREA, μ mol/l	6	15.58±1.15	15.35±1.46	NS
TP, g/l	6	41.85±1.64	42.16±1.19	NS
ALB, g/l	6	18.86±1.57	19.04±1.28	NS
ASAT, U/l	6	248.19±23.40	257.56±20.82	NS
ALAT, U/l	6	34.73±3.24	35.94±3.48	NS
ALP, U/l	6	555.89±80.67	543.54±78.85	NS
Ca, mmol/l	6	2.30±0.14	2.42±0.18	NS
P, mmol/l	6	5.68±0.49	5.74±0.61	NS
Mg, mmol/l	6	0.69±0.08	0.65±0.12	NS
TG, mmol/l	6	1.88±0.03	1.91±0.05	NS
CHOL, mmol/l	6	6.17±0.54	6.08±0.48	NS

Discussion

The analysis of hydrochemical parameters data in the recirculation system during the experimental period showed that they were within the optimum ranges for the farmed species without statistically significant between-group differences ($P>0.05$). This was mainly attributed to the filtration unit of the recirculation system and the daily addition of fresh water in amount of 10% of system's effective volume for compensation of evaporation losses.

In the middle of the experimental period, a tendency towards higher body weight in rainbow trouts supplemented with 1% cinnamon extract was observed in comparison to control fish. This tendency was preserved until the end of the experiment although differences were insignificant ($P>0.05$) (Table 3). Our results confirmed previous reports by Stoyanova et al. (2018) and Dedi et al. (2016) in carps about higher body weight of fish after dietary cinnamon extract supplementation.

The survival of fish from experimental and control groups was 100%, demonstrating that the addition of 1% cinnamon extract to extruded feeds for rainbow trouts reared in a recirculation system did not influence this parameter (Table 3). This finding was in line with 100% survival rate reported by Stoyanova et al. (2018) in fattened carps and insignificantly higher than rate obtained in growing carps by Dedi et al. (2016) (93.3-100%).

The average individual weight gain of rainbow trouts from group F was by 5.29% higher compared to that of fish from group K although statistically insignificantly ($P>0.05$) (Table 3). These data support those published by Stoyanova et al. (2018) in fattened carps and Dedi et al. (2016) in growing carps.

At the end of the experimental period, the group

supplemented with 1% cinnamon extract showed a better FCR, by 4.85% compared to the control group ($P>0.05$) (Table 3). This is also in line with results of Stoyanova et al. (2018) in fattened carps and Dedi et al. (2016) in growing carps. The tendency towards better results in growth performance traits in the group supplemented with 1% cinnamon extract with extruded feed are due, in our belief, to high content of vitamins, minerals and phenolic compounds in cinnamon extract and to improved flavour and digestibility of the feed.

The better economic conversion ratio in the group that received 1% cinnamon extract is a reflexion of slower rate and lower feed conversion rate value in this group, in agreement with ECR reported by Stoyanova et al. (2018) in fattened carps.

Age, feeding, sexual maturity, photoperiod, water quality, water temperature and method for blood sampling are factors influencing blood biochemical parameters in fish (Coşkun et al., 2016; Fazio et al., 2016). The present study showed that the addition of 1% cinnamon extract to the feed did not influence substantially ($P>0.05$) the analysed 13 biochemical blood indices in rainbow trouts (Table 5). So far, no data are reported on effects of dietary cinnamon extract supplementation on blood biochemical parameters in fish. The addition of *Achillea millefolium* and *Taraxacum officinale* extract to rainbow trout feeds was reported to have no effect on blood biochemistry (Koshinski, 2019; 2020) which is also supported by our results. On the contrary, Sirakov et al. (2019) demonstrated significantly higher blood TG and CHOL concentrations in carps supplemented with *Taraxacum officinale* through the feed, whereas Velichkova et al. (2019) reported considerably elevated blood calcium levels in the same species after supplementation with *Acorus calamus*.

Conclusion

Growth performance traits and economic efficiency of rainbow trout farming were positively influenced by supplementation of feed with cinnamon extract. The tested dietary supplement had no effect on studied blood biochemical parameters. Better results in fish that received a ration supplemented with cinnamon were probably due to the high content of vitamins, minerals and phenolic compounds in the cinnamon extract, as well as to improved organoleptic quality of feed and its digestibility.

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