The Effect of Phytoadditive Combination and Growth Performances and Meat Quality in Rainbow Trout (*Oncorhychus mykiss*)

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Abstract

Phytoadditives have been used for millennia in traditional human medicine but only recent in animals to improve the growth performances and to reduce disease outbreaks. The goal of the present experiment has been to determine the effect of phytoadditive combinations on growth performances and meat quality in rainbow trout (*Oncorhychus mykiss*). The phytoaditive combinations were represented by garlic (2%) + ginger (1%) – group 1E and oregano (1%) and Echinacea (0.5%) – group 2E. the dietary treatment with phytoadditive combinations led to a better body weight gain in all the experimental groups compared to the control. Also the specific growth rate and the FCR values were improved in the experimental groups, the best values being recorded in group 1E. the experimental groups also had a higher survival rate, the highest value being recorded in group 1E. meat quality was not significantly influenced by dietary treatment of phytoadditive combinations. The meat Selenium content significantly varied among all experimental groups, the highest value being recorded in group 1E and the lowest in the control group. Dietary treatment with phytoadditive combination had a positive influence on growth and consumption indices with no significant changes in meat quality but significantly influencing the meat Selenium content.

Keywords: Echinacea, garlic, ginger, oregano, selenium, trout

1. Introduction

Phytoadditives are fodder additives obtained from plants or plant extracts. Their beneficial effects in humans are known for millennia and recently they have been used on animals in order to enhance the productive performances and/or to control and fight disease.

A member of the *Liliaceae* family, garlic (A*llium sativum*) has been used for centuries as a spice but also in traditional medicine. Garlic is originating in Asia Minor and spontaneously grows in southern Europe, but in cultures can be found all over the word. It is a rich source of calcium, phosphorus and vitamin B_1; it has a high content of carbohydrates and as a consequence a high nutritive value. Garlic also contains the vitamin complex B, vitamins A, C and F [1]. Garlic is hypo-lipidemic [2], antimicrobial [3], anti-hypertensive [4], has hepato-protective and insecticidal effects [5] and also anti-fungal effects [6]. Also garlic reduces the cholesterol levels in blood serum [7, 8] by suppressing the lipid synthesis in liver [9] and increases the clothing time of blood [7]. S-allyl cysteine found in crushed garlic has inhibitory effects in tumor metabolism and enhances the immune response [2]. Allyl-sulphates enhance the S-transferase enzyme system, which plays a major role in liver

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detoxification from carcinogen substances. Garlic has immunostimulating activities that include the stimulation of lymphocyte synthesis, cytokine releases and stimulation of the phagocytosis [10].
Ginger is a root consumed as a delicacy, medicine or spice. Ginger is the rhizome of the *Zingiber officinale* plant, from *Zingiberaceae* family. Other notable members of this botanical family are turmeric (curcuma), cardamom and the galangal (blue ginger).
The medicinal form of ginger was called *Jamaica ginger*; it's considered as stimulant and carminative (efficient against flatulence) and was frequently used to treat indigestion, gastro paresis, constipation and cramps. The ginger lowers cholesterolemia and thins the blood, being indicated in the treatment of heart diseases; ginger also has anti-inflammatory effect. Recent researches suggest that ginger can be used in diabetes treatment [11,12]. Ginger also has analgesic, sedative, antipyretic (reduces fever) and anti-bacterial effects. In laboratory trials, ginger reduced the occurrence of skin cancer in mice and destroyed the ovary cancer cells [13,14,15].
Oregano is a species of the *Origanum* genus, *Lamiaceae* family. Spontaneously, it can grow in the temperate-warm regions of western and south-western Eurasia and in the Mediterranean region. Oregano has a strong antimicrobial and antioxidant action due to its high content of phenolic acids and flavonoids. The main chemical constituents are carvacrol, thymol, limonene, pinene, ocimene, caryophyllene. The leaves and flowers have a mild tonic effect. Oregano has a broad spectrum of use: antiseptic, antispasmodic, carminative, colagogue, emmenagogue and expectorant. Aqueous extracts, capsules or oil extracts are orally ingested in the treatment for cold, flu, mild fevers, fungal infections, indigestion and intestinal parasites. Also, oregano has a strong sedative effect, the use of high doses being counter indicated. Due to its high content of thymol, oregano is considered a very good antiseptic.
Echinacea is a genus comprised from 9 species of plants, belonging to the *Asteraceae* family. The plants have big composite flowers that bloom from the end of spring until the end of summer. From this genus, only 3 are used as medicinal plants: *Echinacea angustifolia*, *Echinacea pallida* and *Echinacea purpurea*. Echinacea extracts have immunostimulatory and anti-inflammatory properties, for this reason the different Echinacea species take up an important place in the medicinal plant products market.

2. Materials and methods

The research has been carried out in the ICAS farm from Gilau, Cluj County on a total number of 600 rainbow trout (*Oncorhynchus mykiss*) distributed in 3 groups (one control group and 2 experimental groups) consisting of 200 fishes/group. The mean initial weight at the beginning of the experiment was 91.90g. The fish were reared in concrete tanks (L/W/H = 4/1/1.5), in the same rearing conditions (water quality, rearing density, feeding regimes, fodder quantity/quality). The experimental period was 95 days (25.06.2010 – 27.09.2010). the additives were purchased from the local market, dried and grounded to a fine powder. The fodder used was purchased from Skretting (41% crude protein, 12% crude fat, 7.8% ash). The fodder was supplemented with the additives combinations as follows: control group – base diet, group 1E – garlic (2%) + ginger (1%) and group 2E – oregano (1%) + Echinacea (0.5%). During the experimental period the body weight evolution, the weight gain, the growth rate, the feed conversion ratio (FCR) and the survival rate were monitored. At the end of the experimental period meat samples were collected for determination of crude chemical composition of meat and meat Selenium content. The meat Selenium content was carried out using the Atomic Absorption Spectroscopy method. The data collected were statistically analyzed by means of ANOVA (Tukey test). Data are expressed as mean ± standard error of mean. All analyses were made using the GraphPad Software, (v3.05).

3. Results and discussion

Dietary use of phytoadditives combinations had a beneficial effect on body weight gain (Table 1), the highest value being recorded in group 1E (247.08g) and the lowest in the control group (227.1g). The body mass evolution was constant throughout the experimental period, with no regressions, indicating that there were no stressing

factors such as manipulations or change in feed (at the beginning of the experiment). The specific growth rate was also enhanced in all the experimental groups, the highest value being recorded in group 1E (2.60 g/day) and the lowest in the control group (2.39 g/day). FCR recorded in the experimental groups was lower than the FCR recorded in the control group; the lowest value was recorded in group 1E (1.455:1), followed by group 2E (1.472:1); the control group presented the highest FCR value (1.518:1). These results can be explained by the various effects of the additives used: garlic enhances the performances of the intestinal microbiota [16] while oregano and ginger stimulate the appetite [17,18]. Enhancements of the growth and consumption parameters were also reported by Metwally [19]

Table 1. Growth and consumption indices recorded throughout the experimental period

Issue	C	L1E Garlic+ginger	L2E Oregano+Echinacea
Initial weight (25.06.2011)	91.90	91.90	91.90
July (26.07.2011)	169.20	152.44	161.93
August (27.08.2011)	239.42	256.53	245.94
Final weight (27.09.2011)	319.00	338.98	323.98
Weight gain (g)	227.1	247.08	232.08
Specific growth rate (g/day)	2.39	2.60	2.44
FCR	1.518	1.455	1.472

The combined use of phytoadditives led to the improvement of the survival rates and subsequently to reduced losses in both the experimental groups compared to the control group (Table 2). The highest survival rates were recorded in group 1E (92.5%) followed by group 2E (87.5%); the control group had the lowest survival rate (86.5%). This fact can be explained by the content of the phytoadditives in various active substances (allicin, zingerone, thymol, carvacrol, phenols, etc.), these results cionfirming the data reported by Salah (2008) [20], Metwally (2009) [19] and Zheng *et al.* (2009) [21].

Table 2. Survival rate and losses recorded during the experimental period

Issue	C	L1E Garlic+ginger	L2E Oregano+Echinacea
Initial number	200	200	200
Final number	173	185	175
Losses	27	15	25
Survival (%)	86.5	92.5	87.5

Regarding the crude chemical composition of meat (table 3) an non-significant increase in dry matter (DM) content can be observed in the experimental groups (25.43±0.39–L1E, 25.43±0.23 – L2E) compared to the control group (24.98±0.29). The increase of body water content was also reported by Shalaby et al (2006) and Metwally (2009) after dietary treatment with garlic and by Zheng et al., (2009) after dietary treatment using oregano essential oil. The crude protein (CP) content varied non-significantly, lower values being recorded in both experimental groups compared to the control group (19.76±0.34%). Shalaby et al (2006) [22] and Metwally (2009) [19] reported an increase in the protein content after dietary application of garlic; Zheng et al (2009) [21] reported the same trend using oregano essential oil. The crude fat (CF content varied non-significantly, the values recorded in the experimental groups (5.14±0.28% – L1E, 5.47±0.31% – L2E) being higher than the control group (4.85±0.23%). A decrease in the crude fat content was also reported by Shalaby et al (2006) [22] and Metwally (2009) [19] after dietary application of garlic on African catfish (*Clarias lazera*) and Nile tilapia (*Oreochromis*

niloticus) and by Zheng et al., (2009) [21] after administering oregano essential oil on channel catfish (*Ictalurus punctatus*). Al-Salahy (2002) [23], after dietary application of onion and garlic juices in African catfish, reported an increase of the crude protein content in meat, although the levels of plasma total lipids lowered. The ash content varied non-significantly among the treatment groups, the highest value being recorded in group 2E followed by the control group; group 1E had the lowest value of ash content among all the treatment groups.

Table 3. Chemical composition of rainbow trout meat

Issue	M	1E Garlic+ginger	2E Oregano+Echinacea
DM (%)	24.98 ± 0.29	25.43 ± 0.39	25.43 ± 0.23
CP (%)	19.76 ± 0.34	19.22 ± 0.28	19.50 ± 0.22
CF (%)	4.85 ± 0.23	5.14 ± 0.28	5.47 ± 0.31
Ash (%)	1.58 ± 0.03	1.56 ± 0.02	1.64 ± 0.11

The Selenium content of meat varied non-significantly among the treatment groups, the highest value being recorded in group 1E (176.68±8.47 µg/kg) followed by group 2E (140.06±3.17 µg/kg); the lowest value was recorded in the control group (112.66±3.24 µg/kg). These results can be explained by the amount of Selenium found in each additive (garlic–0.4µg/g, ginger–0.7µg/100g, oregano–0.1µg/g)

Table 4. Selenium content of meat at the end of the experimental period

Issue	M	1E Garlic+ginger	2E Oregano+Echinacea
Se µg/kg	112.66 ± 3.24	176.68 ± 8.47	140.06 ± 3.17
Table of significance			
	Difference of means	q	p
M vs 1E	-64.020	11.540	P<0.001 ***
M vs 2E	-27.400	4.939	P<0.05 *
1E vs 2E	36.620	6.601	P<0.01 **

4. Conclusions

The combined use of phytoadditives had a positive effect on the growth and consumption indices, leading to increased body weight gain, a superior growth rate and a lower FCR; the survival rate was also improved by the phytoadditives treatment.

The meat quality was non-significantly influenced by the use of phytoadditives combinations by increasing the dry matter content and the crude fat content and the decreasing the crude protein content of meat.

The meat Selenium content varied significantly in all treatment groups, highlighting the contribution of these phytoadditives in Selenium assimilation; these additives can be a source of Selenium, setting up the basis for a functional food.

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