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The application effects of natural zeolite in feed and water on production results of *Oncorhynchus Mykiss* (*Walbaum)*

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Abstract

The influence of zeolite type "Minazel" was researched, as a feed additive for trout, which is applied in a concentration of 1%. The influence of zeolit, type "Ambizel-V", was also researched, as a corrector of environmental conditions on production results of Rainbow trout (Oncorhynchus mykiss Walbaum). The research was done on 9816 fish (aged 1^+) divided into two groups with 4908 individuals in each pool within the period of 150 days. The experimental fish group O-I was fed with pellets which contained 1% zeolite and with simultaneously implement of "Ambizel-V" in the water of the experimental pool.

It is consolidated that zeolit ("Minazel"),as a food additive, had a positive effect on all analysed morphometrical index of speed of fish growth, on their final weight ($p<0.01$) and final length measures ($p<0.05$),as well as on their growth increase ($p<0.01$).The stimulating effect of "Minazel" is showed out in respect of the daily feed consumption (3.102%; 2.24%) and feed conversion ratio VSM and nutrition (- 13.62%; - 14.78%). Based on obtained research results it can be stated that zeolite "Ambizel-V" proved itself as reliable corrector of environmental conditions in experimental pool E-I, because it led to slight decrease of numerical values of: total water hardness (8,54 ^{o}dH); nitrate (1,22 mg/l); ammonia NH_3 (0.0 mg/l).

Keywords: *daily gain, Rainbow trout, feed conversion and nutrient, water, zeolite.*

Introduction

The nutrition of salmonidae with the sufficient amount of quality feed represents one of the crucial factors for successful fish production. The knowledge of the common principles of fish nutrition is a special nutritional-physiology_model which commits one of the crucial factors for successful fish production. Nowadays, the contemporary trout nutrition is, more and more, based on the usage of complex pellets' food, as well as the possibilities of adding the various additives in it. According to this, it has been approached in this work to study the influence of the natural zeolite (Serbian origin),known under the commercial name "Minazel", as a feed additive on the level of production results of Rainbow trout (*Oncorhynchus mykiss W.*).Because of the specific life conditions in which the fish live, the usage of zeolite "Ambizel V" has been investigated as a possible corrector of environmental conditions and its influence on fish productivity.

By the definition, zeolites are crystallized, hydrated alumosilicate alkaline and earth alkalnies cation which possess endless three-dimensional crystal structure. *(35,8,9,)* induce that zeolites are hard in water, insoluble substance that has a capability (thanks to tetrahedral structure alumosilicates skeleton clinoptilolites) to exchange its ions with suitable amount of other ions substance.. The process of ion's exchange is heterogeneous process, while the zeolite structure (the changer of ion) practically does not change.

The numerous reference data about zeolite importance as a feed additive are referred to its usage in poultry, pigs and ruminants nutrition. With the usage of zeolite as a feed additive there are numerous positive results, as a growth increase, the conversion nutrition improvement, mortality reduction, toxin elimination, as well as the improvement of common state of health of treated animals (poultry, pigs and ruminants). In accessible reference, till now, there were no enough experimental data about zeolite application as a feed additive for fish (30).

Materials and methods

All experimented researches in this work have been performed at the fish pond "Riboteks" - Serbia. Plantation material is characterized by the age of 1 + year, the average weight of 87,93g, total body length of 19,80cm and body height of 4,65cm.

The experiment is carried out within 9816 fish, divided in two pools (groups), Control group (Co) and Experimental group (E-I) with 4908 fish in each pool. Beginner's solidity of the set was 98 fish/m^3, i.e. 86 fish by the m^2 of useful water surface. The pools' dimension are 19,0 x 3,0 x 0,88 metres = 50,16m^3. The water entrance was 33,25 l/sec, i.e. 57,27 of water exchange in 24 hours. The experiment lasted for 150 days.

The control group of fish Co has been fed with pellets without adding zeolite and without usage of zeolite in water. The experimental group of fish E-I has been fed with pellets by adding zeolite of 1% ("Minazel"), and on the water dam has been put zeolite ("Ambizel - V") which was used in the amount of 60 kilos in a pool, with the granulation of 0,8 cm-2,5cm. The amount and the number of the daily meals has been determined according to (22), adapted with the experiences acquired within the fishpond "Riboteks".

The feed that is used for trout nutrition is chemically analysed on the beginning, in the middle and on the end of experiment. The feed was taken as a model and chemically analysed by the application of investigation standard methods. (*Wende method ;*Official Register RS, no. 15/89).In every 15 days the feed conversion ratio and nutrition have been determined, according to data with which the trout's growth and feed consumption are measured; the feed consumption has been noted every day.

The physical and chemical analyse of the water from the fishpond parameter understood sample taking before water dam, in the middle of the pool as well as at the water exit of the pool. The chemical water analyse has been done by the usage of standard investigation methods.

The analyse of the production results has been included 15 times a day measurement of the following parameters: average weight; average of total body length; growth of weight; growth of total body length; the condition factor; the production index, The condition factor and the total growth coefficient are calculated according to Fulton's formulas (*25*), and the production index according to formula (*18*).

Obtained experiment results are classified into appropriate series. They are also processed on the computer by the usage of common mathematical-statistical treatments which

understood analyse of variance and the mark of the importance of received results (the differences) by the usage of the test known as *Tukey honest significant difference test*.

Results and discussions

The data about the feed quality is presented in **Table 1.** According to data, it is obvious that the feed of both group contained all necessary chemical and nutritional parameters for its nutrition. The numerical values of each registered parameter of investigated mixture are showed over their average values in airy dry substance. The feed that is used in this experiment in sight of the contents of total proteins has the value from 41,61% in E-I (with 1% of zeolite additive) to 41,74% in Co fish group (without zeolite additive). The values of carbohydrates (cellulose + BEM) have been moved from 32,66% in E-I to 33,91% in Co group. The fat abstract was from 6,08% in E-I to 6,12% in Control fish group. In sight of the contents of digestible (SE) and metabolical (ME) energy the lower values in E-I are noted, and they present 13,370 MJ SE/kilos and 12,411 MJ ME/kilos, while the highest values are noted in Co and that is 13, 390 MJ SE/ kilos and 12, 430 MJ ME/kilos.

Table 1. The average chemical food structure (%), VSM and production index on the end of experiment

PARAMETRE	**GROUP**	
	Control Co	**Experimental E-I**
Trout mortality (%) for all experimental period from 0 - 150 days		
The number of fish on the beginning of experiment	4908	4908
The number of fish on the end of experiment	4683	4755
Mortality (the number of fish)	225	153
Mortality in %	4.58	3.12
Index	100	68.00
The difference		-32.00
The average values of condition coefficient (FK)		
Condition coefficient (FK)	1.133	1.154
Index %	100	101.85
The difference		+1.85
Production index according to groups		
Production index	371.84	494.40
Index%	100	132.96
The difference		+32.96
The average chemical structure of used feed (%), VSM		
Water	9.33	8.95
Ashes	9.28	10.32
Protein	41.74	41.61
Cellulose	1.44	1.35
Fat	6.12	6.08
BEM	32.47	31.31
Total solits (TS)	90.67	91.05

Calcium	2.3	2.34
Total phosphorus	1.52	1.50
Metabolic energy ME MJ/kg	12.43	12.41
Digestible energy DE MJ/kg	13.39	13.37

The protein abstract in used feed completely satisfies the protein needs of the breed trout. It is coincided with the researches of (*13, 16, 24,31,)*, They concluded that the best achieved production results within trout (aged 1+) can be reached under the protein concentration in feed from 35% to 43%.

Table 2. Parallel view of production results

The average trout' weight (g) by the period of age			
Time of the day	**Index**	**GROUP**	
		Control Co	**Experimental E-I**
	Body weight (g)	238.41	265.63
	Index (%)	100	111.42
150	**The difference (%)**		+11.42
			**p<0,01
The average trout' total body length (cm) by the period of age			
	Total body length (cm)	27.23	28.17
	Index (%)	100	103.45
150	**The difference (%)**		+3.45
			*p<0,05
The average trout' weight growth (g)			
	Total (g)	150.480	177.70
	Daily (g)	1.003	1.184
	Index (%)	100	118.04
	The difference (%)		+18.04
0 - 150			**p<0,01
The average daily increase of the total trout' body length (cm)			
	Total (cm)	7.440	8.400
	Daily (cm)	0.050	0.056
	Index (%)	100.00	112.00
	The difference (%)		+12.00
0 - 150			*p<0,05
Daily feed consumption (g), airy total solits			
	Total (g)	275.637	284.133
	Daily (g)	1.837	1.849
	Index (%)	100	103.102
0 - 150	**The difference (%)**		+3.102
Daily protein consumption (g)			
0 - 150	**Total (g)**	126.889	129.848
	Daily (g)	0.846	0.865
	Index (%)	100	102.24

	The difference (%)		+2.24
Feed conversion (g/g), airy total solits			
0 - 150	**Conversion (g/g)**	1.91	1.65
	Index (%)	100	86.38
	The difference (%)		-13.62
Protein conversion (g/g)			
0 - 150	**Conversion (g/g)**	0.88	0.75
	Index (%)	100	85.22
	The difference (%)		-14.78

The abstract of lipids in trout's feed according to statements of (*2,20,,28)*, can be different and it presents from 5% to 25%. Every fat increase in food over the mentioned maximum values according to (*11,19)*, has a depressive effect on feed usage, production results, and also the appearance of health disturbance as a fat infiltration of liver and kidneys. According to Unison and associates (*7,32,)*,and others, the trots best use the feed with the fat abstract of 10%, so according to this, used food in our experiment satisfied this criterion.

The consolidated values for carbohydrates are in accordance to (*5,23,)*, because, according to them the optimal abstract of total carbohydrates in roughage substances for trots is maximum 30-48%%.

By the end of the experiment the highest final weight **(Table 2)** accomplished the fish from E-I group (with 1% of zeolite adding in food + zeolite in water) 265,63g, while the lowest final weight accomplished Co group with 238,41g. Achieved difference in final weight between E-I group and Co group, was 27,22g,i.e. E-I group achieved higher weight than Co group for 11,42%,m ; statistically it is high significance ($p<0,01$).

As shown by the relative indicators-I group of fish achieved higher final total body length than Co group for 3,45%, which caused the existence of statistically important difference in the middle value of total body length ($p<0,05$).

In comparison with the average daily growth of the weight in Co group of fish, it can be stated that E-I group achieved higher daily growth for 18,04%. The significant test of accomplished daily weight growth shows to an existence of high significant differences ($p<0,01$). In investigations, (*26)*, in which the zeolite has been used in amount of 1% in fish food, it is stated that the daily mass growth from 10% to 18%. The zeolite usage, (*29)* in concentration of 1-4% has been contributed to increase of weight growth from 3% to 19,5%. *(33)*, say that zeolite "Minazel" adding of 0,5% in trout's feed has brought to the increase of weight growth of trots for 12,7% in comparison to Co group. *(34)* concluded that the zeolite usage in concentration of 0,7% contribute to increase of trout's weight growth for 27,97%.

The numerical values of the total body length of fish in E-I group were higher for 12% according to values of this parameter of Co group, which indicates on existence of significant differences ($p<0,05$). *(24)*, announcement that during their experiment the average monthly increase of total body length of the trots was 1,67cm and the water temperature was 10 C. According to (*14,21,)*, the values of an increase of the total body length during the change of water / day was 0,030cm - 0,065cm

The experimented group E-I accomplished higher daily feed consumption than Co group for 3,102%. *(8,33)*,emphasized that zeolite hasn't got protein and energy value, so its usage as a food additive leads to increase of the consumption food value.*(34)*, established in their researches that adding the zeolite to trout's feed in concentration from 0,7% to 0,8% increases the feed consumption of 2,16%. In comparison to Co group of fish, the average

daily protein consumption in E-I group of fish was higher for 2,24. The protein needs of the breed fish were satisfied, which is in accordance (*13, 23,24,).*

If we compare the VSM feed conversion ratio values in E-I group of fish with the accomplished value in Co group of fish, it can be concluded that E-I group accomplished better feed conversion ratio than Co group for 13,62. In (*29)*, including zeolite in fish feed in concentration from 1% to 4%, led to improvement feed conversion ratio from 4% to 12%. *(33)*, established that adding the zeolite to trout's feed (0,5%) influences on feed consumption decreasing for one kilo of growth, for 10,52%. In researches *(34)*, it is concluded that the usage of zeolite in concentration of 0,7%, has led to feed conversion ratio improvement for 20,21% in comparison to Co group. The fish from E-I group accomplished better protein conversion that Co group of fish for 14,78%.

Table 3. Physical-chemical analyse of the water parameter, Control group Co

	The beginning of the experiment			The middle of the experiment			The end of the experiment		
	Entrance	Middle	Entrance	Entrance	Middle	Entrance	Entrance	Middle	Entrance
Control group Co									
The flow l/sec	33.25	33.25	33.25	33.25	33.25	33.25	33.25	33.25	33.25
C°	11.4	11.4	11.5	13.9	14	14	11.8	11.8	11.8
pH	7.4	7.35	7.34	7.51	7.46	7.43	7.4	7.38	7.35
CO_2 mg/l	0.89	1.18	1.39	1.4	1.88	2.3	1.2	1.68	2.15
°dH	8.92	8.73	8.8	8.98	8.88	8.71	8.91	8.82	8.65
O_2 mg/l	11.1	10.8	10.6	10.85	10.6	10.4	11.09	10.6	10.5
BPK_5 mg/l	1.09	1.4	1.8	1.1	1.58	1.84	1.08	1.59	1.9
$KMnO_4$ mg/l	5.1	5.9	6.2	5.05	5.38	6.7	5.10	5.60	6.2
NO_2 mg/l	0.0	0.001	0.001	0.0	0.0	0.001	0.0	0.0	0.0
NO_3 mg/l	0.6	0.69	0.74	0.28	0.41	0.75	0.52	0.63	0.77
NH_3 mg/l	0.01	0.01	0.01	0.01	0.01	0.02	0.0	0.0	0.01
PO_4 mg/l	0.0	0.0	0.01	0.0	0.0	0.01	0.0	0.0	0.02
Experimental group E - I									
The flow l/sec	33.25	33.25	33.25	33.25	33.25	33.25	33.25	33.25	33.25
C°	11.4	11.5	11.4	13.9	14.0	14.0	11.80	11.80	11.90
pH	7.42	7.34	7.30	7.52	7.46	7.42	7.40	7.36	7.29
CO_2 mg/l	0.89	1.10	1.35	1.40	1.80	2.30	1.20	1.70	2.00
°dH	8.95	8.31	8.47	8.99	8.55	8.60	8.96	8.81	8.59
O_2 mg/l	11.2	10.90	10.40	10.80	10.60	10.40	11.10	10.80	10.50
BPK_5 mg/l	1.08	1.34	1.92	1.20	1.80	1.90	1.10	1.80	2.15
$KMnO_4$ mg/l	5.10	5.90	6.0	5.0	5.30	6.50	5.40	5.70	6.95
NO_2 mg/l	0.0	0.0	0.001	0.0	0.0	0.0	0.0	0.0	0.001
NO_3 mg/l	0.58	0.40	0.56	0.32	0.20	0.48	0.49	0.65	0.78
NH_3 mg/l	0.01	0.0	0.0	0.01	0.0	0.01	0.0	0.0	0.02
PO_4 mg/l	0.0	0.0	0.01	0.0	0.0	0.01	0.0	0.0	0.02

The usage of zeolite in feed and water of the experimental group E-I, contributed to decrease the fish mortality in comparison to Co group for 3,12%,i.e. with the difference of 32%. *(29)*, announced that with the zeolite additive in trout's feed comes to decreasing the fish mortality for 5%-17,5%. *(6)*, reported that the usage of zeolite in water decreases the percentage of young fish dying for 3% to 6%. *(33)*, concluded that the usage of zeolite

"Minazel" in trout's nutrition (0,5%) has influenced on decreasing the fish mortality for 2,50%. The condition factor (CF) as a demonstrator of fatten up fish in our experiment, was higher with the E-I group of fish in accordance to Co group for 1,85%. According to *(24)*, the variation interval at CF for salmonidae is 1,107-1,155. The production index (PI) as an index of the whole production had better values in comparison to Co group of fish for 32,96%.

All analysed physical and chemical factors of the water environment, during the experiment lasting, had balanced values, which moved in optimal border for trout breeding.

Starting with a fact that the zeolite is a solid adsorbent of toxic substances from the water, about what we can find data in (*4,8,9,12,35)*, researches, they joined the analyse of the effect of this adsorbent on the changes of water parameters (1). According to our analyse, we conclude that zeolite has been showed insignificant influence on decreasing numerical values of the abstract of nonionic ammoniac, nitrate and total water hardness. "Abizel-V" caused the decrease of its values, in experimental pool E-I, which can be seen from the data showed in **Table 3**. (*3,10,1517,27,)*, researches indicate that zeolite has certain adsorption ability of toxic in water, but primarily of ammoniac and nitrate and it affect on the decrease of the water hardness. They emphasize that the value of these parameters is considerably decreased in the presence of zeolite, and the adsorption effect of usage of this remedy is efficient at the very beginning of its usage in water.

Conclusion

The influence of zeolite, as a feed additive, used in a concentration of 1% in pellets feed for trout, in this experiment, had the positive effect on all analysed morphometrical index of fish growth speed, both their final command mass and final length measurements, as well as their growth. Consolidated differences between Co and E-I group of fish were statistically important ($p<0.01$ i $p<0.05$).

The usage of zeolite as a feed additive also had a simulative effect in daily feed consumption and nutrition. The fish from E-I group accomplished higher daily feed consumption than Co group for 3,102%,and daily protein consumption was higher for 2,24%. The presence of zeolite in feed, positively affected on accomplishment the lower conversion of the feed as well as the nutrition in accordance to fish from Co group, where zeolite wasn't used as a feed additive. E-I group accomplished better feed conversion ratio than Co group for 13,62, i.e. better protein conversion for 14,78%.

Zeolite, as a feed additive and a corrector of environment conditions, has also showed the stimulating effect on common production index of fish breeding in our experiment. The fish mortality in E-I group in comparison in Co group was lower for 3,12%; CF had higher values for 1.85%, i.e. PI for 32.96%.

The influence of zeolite, type "Ambizel-V", as a corrector of environment conditions in water of experimental pool E-I, had a positive influence on decreasing the numerical values of total water hardness, nitrates and ammoniac, adsorption effect of usage of this additive in water was especially efficient on the beginning of its usage in experimental pool of E-I.

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