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THE EFFECT OF COMMERCIAL DRY DIET SUPPLEMENTATION WITH ORGANIC & INORGANIC ACIDS ON COMMON CARP PERFORMANCE

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Introduction & Methods

A 60-day experiment at 25°C in RAS was designed to assess whether the acidification of a commercial dry diet AF using hydrochloric acid (HCl), mimicking the action of gastric juice, or two organic acids (citric acid and acetic acid) may be beneficial for common carp juveniles. Fish were fed 5 times daily with the intensity of 3.5% of fish biomass a day and the addition of each acid to the feed was 1.5%. Fish diets in experimental groups: **CON** - non-altered commercial dry diet AF, **HCL** - dry diet AF supplemented with 1,5% HCl, **CIT** - dry diet AF with 1,5% citric acid, **ACE** - dry diet AF with 1,5% acetic acid.

Results

Survival rates in all groups were 100%. Rearing results are presented Table 1 - the biggest fish with the lowest incidence of body deformities were obtained in HCL group. The addition of HCl had also a positive effect on the ash and P content in the fish body.
The highest intestinal folds in all three gut sections were observed in fish from the control and HCL groups (Table 2). In the foregut total enterocyte height and supranuclear height were significantly higher in groups CON and ACE, than in HCL and CIT. Transmission electron microscopy (TEM) revealed that enterocytes in the control group had shorter microvilli than in the remaining three groups (Table 2, Fig. 1).
No serious histopathological changes were found in the gut of all the studied fish. In group CON small foci of inflammation were present in the submucosa in the foregut. Meanwhile, in the CIT group, inflammation occurred not only at the base of folds, but also in the mucosa itself, along with local detachment of epithelium from the basement membrane. In groups HCL and ACE, a marked widening of the submucosal layer and dilation of the middle lamina in the peak sections of the intestinal folds were also observed (Fig. 2).

Conclusions

The use of HCl which is much cheaper than the organic acids brought the best growth of common carp juveniles and reduction of the incidence of body deformities so can be recommended for practical purposes. Although the acidification of commercial feed using hydrochloric acid adversely affected intestinal morphology of juvenile common carp, it was not to the same severe extent as it was observed in the groups given feed acidified with citric and acetic acids.

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TABLE 1. Growth, incidence of body deformities and body chemical composition of juvenile common carp fed with a commercial dry diet supplemented with 1.5% organic acids and hydrochloric acid

Parameter/Group	CON (Commercial dry diet AF)	HCl (AF with HCl)	CIT (AF with citric acid)	ACE (AF with acetic acid)
TL (mm)	115.1 ± 0.9^{b}	**118.7 ± 1.0^{a}**	114.8 ± 0.9^{b}	115.0 ± 1.5^{b}
BW (g)	23.5 ± 0.2^{b}	**25.7 ± 0.4^{a}**	24.1 ± 0.4^{b}	24.0 ± 0.6^{b}
Fish with deformities (%)	16.7^{a}	**1.1^{b}**	**1.1^{b}**	**2.2^{b}**
Protein (% w.m.)	14.17 ± 1.22	14.97 ± 0.48	15.36 ± 0.23	14.24 ± 0.59
Fat (% w.m.)	8.12 ± 1.46	7.40 ± 1.87	6.81 ± 0.37	7.88 ± 0.87
Ash (% w.m.)	1.89 ± 0.51	2.10 ± 0.52	2.29 ± 0.48	1.87 ± 0.14
Phosphorus (g/kg)	4.03 ± 0.56^{ab}	**4.55 ± 0.54^{a}**	4.10 ± 0.51^{ab}	3.48 ± 0.28^{b}

The best results are in bold.

TABLE 2. Selected parameters of histomorphometric analysis of fore-, mid- and hindguts of juvenile common carp

Parameter [µm]/Group	CON (Commercial dry diet AF)	HCl (AF with HCl)	CIT (AF with citric acid)	ACE (AF with acetic acid)
Foregut fold height	**978.1±174.1^{a}**	**918.6±93.6^{ab}**	847.4±168.8^{b}	869.9±165.3^{b}
Foregut enterocyte height	51.5±5.2^{a}	42.9±5.9^{c}	45.0±6.7^{b}	52.9±4.5^{a}
Foregut supranuclear height	28.3±3.3^{a}	21.7±2.6^{b}	22.3±3.39^{b}	28.1±3.9^{a}
Foregut enterocyte microvilli	1.37±0.20^{c}	**1.52±0.21^{ab}**	**1.55±0.23^{a}**	**1.51±0.21^{b}**
Midgut fold height	768.3±281.0^{a}	668.5±158.4^{b}	634.4±132.7^{b}	632.2±99.4^{b}
Hindgut fold height	814.7±107.8^{a}	763.7±124.2^{a}	785.6±119.3^{a}	796.4±113.9^{b}

The best results are in bold.

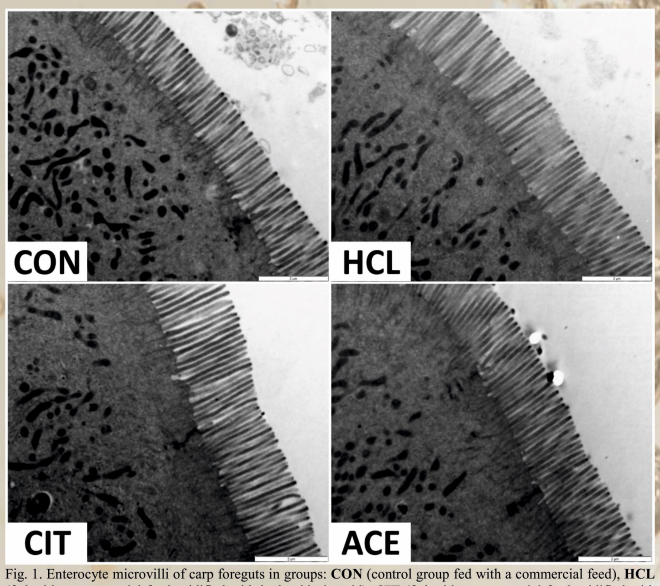

Fig. 1. Enterocyte microvilli of carp foreguts in groups: **CON** (control group fed with a commercial feed), **HCL** (fed with a commercial feed acidified with hydrochloric acid), **CIT** (fed with a commercial feed acidified with citric acid) and **ACE** (fed with a commercial feed acidified with acetic acid). TEM images, scale bars = 2 µm.

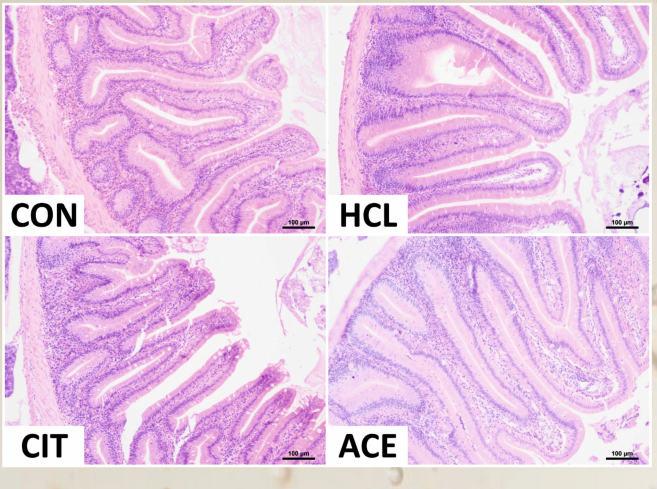

Fig. 2. Transverse sections of carp foreguts from groups: **CON** (control group fed with a commercial feed), **HCL** (fed with a commercial feed acidified with hydrochloric acid), **CIT** (fed with a commercial feed acidified with citric acid) and **ACE** (fed with a commercial feed acidified with acetic acid). HE stain, scale bars = 100 µm.