Utilization of duckweed as fish meal replacement in common carp (*Cyprinus carpio*) (Verwertung von Wasserlinsen als Fischmehlersatz durch Karpfen (*Cyprinus carpio*)

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Duckweed, the family Lemnaceae, comprises a group of around 40 different aquatic flowering plant species. They can grow very fast, producing higher biomasses compared to terrestrial plants (up to 79 t DM ha^{-1} a^{-1}, Leng et al. 1995). Furthermore, they are very efficient in uptake of nitrogen and phosphorous and are producing protein of high quality (Stadtlander et al. 2019). Protein contents usually range between 25 to 35% of DM (dry matter) but have been reported to be as high as 45% of DM. Duckweed (*Spirodela polyrhiza*) has been successfully grown on diluted cow slurry and been fed to rainbow trout fry (Stadtlander et al. 2019). Common carp (*Cyprinus carpio*) is among the most important cultured fish species in the world, with a production of 4.13 mio t in 2017, and cyprinids (carp-like fish) in general contribute around 50% of global aquaculture fish production. In this study, we tested two different duckweed (*S. polyrhiza*) meals, one dried (DWD) and one fermented (DWF), in three different concentrations in the diet of carp fry and compared results to a duckweed free control (C).

Methods: The control diet contained 40% fish meal while in the experimental diets 15, 30 and 45% of fish meal protein were replaced by DWD (DWD15, DWD30 and DWD45) and DWF (DWF15, DWF30 and DWF45) protein. Diets were composed to contain 45% crude protein (CP), 12.5% crude lipids (CL) and 17 kJ g^{-1} digestible energy (estimated). The feeds were extruded on a single screw extruder, dried and crumbled. Twenty carp (0.69 g $fish^{-1}$) were put into 10 L aquaria of a recirculation system and the seven different feeds allocated to four replicated aquaria each. Two initial groups of around 60 g fresh mass (~120 fish per group) were sacrificed (150 mg L^{-1} MS-222, buffered with 300 mg L^{-1} NaH_2CO_3) for proximate analysis (baseline data). During six weeks, fish were fed 5% of their body mass per day for 6 days before fasting them for one day, group weighing all fish of each aquarium and adapting feeding rations. At the end of the experimental feeding, all fish were sacrificed and analyzed for proximate composition. Specific growth rate (SGR), relative body mass gain (BMG [%]), feed conversion ratio (FCR), protein productive value (PPV) and lipid productive value (LPV) were evaluated and compared to the control group. Results were compared by ANOVA followed by a Tukey HSD post-hoc test with a significance level of $\alpha = 0.05$.

Results: The DWD diets were similarly palatable as the control diet, whereas the acceptance of DWF diets was inversely correlated to the proportion of fermented duckweed level. After few days, however, even DWF45 was completely eaten by all fish. All carp groups receiving DWD or DWF15 were growing equally well as the control. The BMG [%] ranged between 123 and 128% and SGR between 1.63 and 1.69. The carp receiving DWF45 were significantly inferior in growth to all other groups with BMG of 74% and SGR of 1.13. Growth of carp fed DWF30 were in between, both in terms of SGR and BMG. Feed conversion ratio, PPV and LPV followed the same pattern with C, DWD15, DWD30, DWD45 and DWF15 fed carp being superior to DWF45. Fish fed with DWF30 showed FCR, PPV and LPV ranging between the superior and inferior groups.

Conclusion: The results show clearly that dried duckweed is a suitable source to replace up to 45% fish meal protein without impairing any of the evaluated performance parameters in common carp. Fermented duckweed, however, was competitive to fish meal only in the lowest concentration (15% fishmeal replacement) while performance was reduced with increasing concentrations.

References

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