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Effect of Rapeseed Press Cake on Extrusion System Parameters and Physical Pellet Quality of Fish Feed

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Abstract : The demand for fish from aquaculture is constantly growing. Concurrently, due to a shortage of fishmeal caused by extensive overfishing, fishmeal substitution by plant proteins is getting increasingly important for the production of sustainable aquafeed. Several research studies evaluated the impact of plant protein meals, concentrates or isolates on fish health and fish feed quality. However, these protein raw materials often require elaborate and expensive manufacturing and their availability is limited. Rapeseed press cake (RPC) – a side product of de-oiling processes – exhibits a high potential as a plant-based fishmeal alternative in fish feed for carnivorous species due to its availability, low costs and protein content. In order to produce aquafeed with RPC, it is important to systematically assess i) inclusion levels of RPC with similar pellet qualities compared to fishmeal containing formulations and ii) how extrusion parameters can be adjusted to achieve targeted pellet qualities. However, the effect of RPC on extrusion system parameters and pellet quality has only scarcely been investigated. Therefore, the aim of this study was to evaluate the impact of feed formulation, extruder barrel temperature (90, 100, 110 °C) and screw speed (200, 300, 400 rpm) on extrusion system parameters and the physical properties of fish feed pellets. A co-rotating pilot-scale twin screw extruder was used to produce five iso-nitrogenous feed formulations: a fish meal based reference formulation including 16 g/100g fishmeal and four formulations in which fishmeal was substituted by RPC to 25, 50, 75 or 100 %. Extrusion system parameters, being product temperature, pressure at the die, specific mechanical energy (SME) and torque, were monitored while samples were taken. After drying, pellets were analyzed regarding to optical appearance, sectional and longitudinal expansion, sinking velocity, bulk density, water stability, durability and specific hardness. In our study, the addition of minor amounts of RPC already had high impact on pellet quality parameters, especially on expansion but only marginally affected extrusion system parameters. Increasing amounts of RPC reduced sectional expansion, sinking velocity, bulk density and specific hardness and increased longitudinal expansion compared to a reference formulation without RPC. Water stability and durability were almost not affected by RPC addition. Moreover, pellets with rapeseed components showed a more coarse structure than pellets containing only fishmeal. When the adjustment of barrel temperature and screw speed was investigated, it could be seen that the increase of extruder barrel temperature led to a slight decrease of SME and die pressure and an increased sectional expansion of the reference pellets but did almost not affect rapeseed containing fish feed pellets. Also changes in screw speed had little effects on the physical properties of pellets however with raised screw speed the SME and the product temperature increased. In summary, a one-to-one substitution of fishmeal with RPC without the adjustment of extrusion process parameters does not result in fish feed of a designated quality. Therefore, a deeper knowledge of raw materials and their behavior under thermal and mechanical stresses as applied during extrusion is required.

Keywords : extrusion, fish feed, press cake, rapeseed
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