

Circular Aquaculture: Utilizing Processed Meat Waste to Enhance Growth, FCR, and Economic Efficiency in Tilapia and African Catfish Production

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Abstract

This study comprehensively evaluates the feasibility of upcycling industrial sausage by-products (head and tail trimmings) as a sustainable and cost-effective protein source in aquaculture feeds for Nile tilapia (*Oreochromis niloticus*) and African catfish (*Clarias gariepinus*). As feed costs typically account for 50% to 70% of variable production expenses, finding alternative ingredients is critical for industry sustainability. Experimental diets were formulated with specific protein levels to match developmental stages: 15%, 20%, and 25% for Nile tilapia, and 25%, 30%, and 35% for African catfish. Sausage by-products successfully replaced conventional protein sources by up to 50%. Over a five-month feeding trial, fish fed sausage-blended diets consistently exhibited superior growth performance. Adult Nile tilapia achieved a maximum weight gain of 321.86 ± 4.44 g/fish and an optimal Feed Conversion Ratio (FCR) of 1.42 ± 0.00 . Similarly, adult African catfish recorded a maximum weight gain of 339.65 ± 3.74 g/fish with a significantly improved FCR of 1.66 ± 0.01 . The sausage-blended diets featured a high lipid content (~13.3%), allowing dietary proteins to be efficiently partitioned for somatic growth. Furthermore, *in vitro* assays confirmed high protein and carbohydrate digestibility, indicating that the pre-denatured protein matrix in the processed meat waste is highly bioavailable. Economically, incorporating sausage by-products drastically reduced overall feed production costs by 29% to 44% relative to commercial feeds. Conclusively, upcycling industrial meat waste offers a highly digestible, cost-effective alternative that promotes circularity and zero-waste initiatives in intensive aquaculture.

Keywords: Upcycling, Sausage by-products, Aquaculture feeds, Nile tilapia, African catfish, Protein source, Feed Conversion Ratio