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SUMMARY

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RESEARCH ON IMPROVING THE QUALITY OF FISHERY PRODUCTION OBTAINED IN SALMONID CULTURE AND ITS PROCESSING

THESIS CONTENTS

INTRODUCTION

Considerable changes in the formulation and composition of diets for farmed salmonids have occurred over the past 15 to 20 years. The nutrient composition of these diets has changed towards increased lipid (from 8–12% up to 30 or even 40%) and energy contents (>20 MJ/kg) and significant reduction in carbohydrate contents (from 40% down to 10–15%) (Hardy, 2002; Storebakken, 2002).

The same feeds are generally fed to various salmonid species (Cho, 1990; Cho, 1992) yet evidence suggests that different salmonid species utilize feeds of similar composition with different efficiencies (Berg and Bremset, 1998; Rasmussen and Ostenfeld, 2000; Refstie et al., 2000). Moreover, commercial feeds for salmonids vary widely in terms of proximate composition (protein, lipid, carbohydrate). To assist in feed composition choice for optimal feed utilization for each specific fish species, there is consequently a need to examine how efficiencies of feed, nutrient, and energy utilization are affected by species and feed composition.

Rainbow trout are one of the most important salmonid species of major economic interest for commercial culture worldwide and salmonid feed costs constitute more than 40% of the production costs. Over the last decade much effort has been and still is put into optimizing feed composition and feeding strategies for these species. Most of these studies have aimed at improving the dietary protein utilization for growth by replacing dietary protein by non-protein energy sources such as lipids and to a lesser extent digestible carbohydrates.

There is no doubt that non-protein energy sources can spare dietary amino acids from being utilized as energy sources, thereby improving efficiency of protein utilization For PD in rainbow trout (Cho & Woodward, 1989; Ruohonen et al., 1998; Steffens et al., 1999) These findings have been of major importance for the economical and environmental sustainable development of commercial culture of that salmonid.

The effect of feeding level on the efficiency of feed utilization in rainbow trout and other salmonids is the subject of controversy. It has been suggested that optimum feed efficiency is achieved at feeding levels below that required for maximum growth in salmonids (Brett et al., 1979; Elliot, 1976; Kolsater, 1995).

While important from a production point of view, feed efficiency can be a misleading expression of nutrient and energy utilization. Physical quantity of feed used is not a measure of biologically available nutrients and energy supplied to the animal. In addition, weight gain does not always accurately reflect protein, lipid and energy gains since the composition of weight gain is often variable. Protein deposition is associated with substantial water deposition whereas lipid depots contain little water. The ratio between protein and lipid deposition will have an impact on live weight gain and, consequently, feed efficiency.

Being poikilothermic animals, the metabolic rate, growth, energy expenditure and feed intake of fish are highly influenced by water temperature. It is, therefore, important to study how water temperature affects these parameters, as well as to determine the effect of temperature on the efficiency of nutrient and energy utilization. Studies have suggested that temperature can affect the efficiency of energy utilization in salmonids (Cho et al., 1987). The effects of water temperature on nutrient and energy utilization should be examined.

It is well known that PAHs occur in curing smoke and that they can deposit on the surface of, and migrate into, the food item being smoked. A number of factors in the smoking process influence the composition of the curing smoke and the uptake of PAHs in the food being smoked (Toth and Blaas, 1972a,b; Larsson, 1986). The combustion temperature during the generation of smoke seems particularly critical. According to Toth and Blaas (1972b), the

formation of PAHs in the smoke increases linearly with increasing combustion temperature in the temperature range 400-1000 ^{0}C.

Since April 2005 the EU maximum level for benzo[a]pyrene (BaP) in smoked meat and meat products and muscle meat of smoked fish and smoked fishery products is 5.0 µg/kg (Regulation (EC) No 208/2005). Where methods in use may cause high levels of PAH contamination, alternative or optimized methods should be investigated with the producers.

RESEARCH OBJECTIVES

IMPROVING QUALITY OF FISHERY PRODUCTION OBTAINED IN SALMONID CULTURE AND ITS PROCESSING

The main ojective of our research was improving quality of fishery production obtained in salmonid culture and its processing.

In order to achieve that objective we watched several secondary objectives such as :

- The monitoring of growth and whole body composition of brook trout during the initial 16 weeks of growth following first-feeding. This "early rearing" growth trial was exploratory in nature and provides new information on the patterns of growth and nutrient deposition in brook trout.
- The determination of the effects of DP/DE ratio, fish species and fish size on the efficiency of utilization of feed, nitrogen and energy for body weight gain, carcass yield and proximate composition, for juveniles from two salmonid species, brook trout and rainbow trout
- The study of the effects of different feeding regimes (satiation vs two lower levels of feeding) and water temperatures on growth and feed efficiency of rainbow trout
- The investigation of effects of different dietary protein/lipid ratios on growth and feed, nitrogen and energy utilization efficiency by rainbow trout and also was to investigate the effect of diet on the efficiency of utilization of feed, nitrogen and energy utilization for body gain, nitrogen and energy retention, respectively as fish grew.
- The conduct of a study regarding the amount of polycyclic aromatic hydrocarbons in smoked fish products from three smoke houses in Braşov county, in establishing best practice which have the effect of reducing it in the products concerned.

- Implementation of the Quality Management System at SC Doripesco Prod SRL

Growth and whole body composition of brook trout *(Salvelinus fontinalis)* **from first-feeding to 16 weeks post first-feeding**

Yet, little information exists in the literature on the patterns of growth and whole body composition for these species under hatchery conditions. Such information may be useful for the development of feed requirement and waste output models for these fish species. Growth and whole body composition of brook trout (initial body weight ca. 0.2 g) were monitored from first-feeding to 16 weeks post first-feeding. Fish were reared in fry troughs, at ambient water temperature (8^oC) and fed salmonid starter feeds (ca. 53% crude protein. 17% lipid) in excess. Live body weight was determined every 28 days and whole body samples taken every 28 days for analysis of proximate composition. Final body weights were 2.5. 3.3, and 4.1 g. Final whole body moisture, crude protein, lipid, ash and phosphorus contents were 80 %, 10-15%, 2-5%, 1-2% and under 0,5%.. Changes in whole body contents (absolute basis, g gfish $^{-1}$) with increasing body weight were best described by a series of linear ($R^2 > 0.98$) equations. This data can now be used to modify existing feed requirement and waste outputs models; improving their applicability to stocks of brook trout.

Growth, of juveniles from two salmonid species from the Berivoi Farm of Fratu Com SRL, diet and size effects

The effect of dietary digestible protein/digestible energy (DP/DE) ratio on growth, feed efficiency (FE) and body composition of juveniles from two salmonid species reared in freshwater was investigated in a series of trials. Another objective of this study was to investigate how the FE changed as fish grew.

Four diets were formulated to be isoenergetic (DE=20 MJ/kg) but contain different DP/DE ratios, 23, 21, 19, and 17 g./MJ, achieved through reduction of DP level and increase of lipid level. Diets were hand-fed to near-satiety to triplicate groups of lake trout (initial body weight (IBW), 50 g) for 252 days at 13°C and rainbow trout (IBW, 50 g) for 112 days, at 13 ºC.

Within species, weight gain was not affected by DP/DE. However, a significant decrease in FE was observed with decreasing DP/DE for all species. More research is needed in order to gain further insight into size effects on feed and nutrient utilization.

Effects of feeding level and water temperature on growth and feed efficiency of rainbow trout (*Oncorhynchus mykiss)*

A study was carried out to determine the effect of feeding level and water temperature on growth and feed efficiency, nutrient and energy utilization and waste outputs of rainbow trout. A practical diet was fed to near-satiation to groups of fish reared at 6, 9, 12 and 15 °C. At each temperature, the feed intake of other groups of fish was restricted to about 80 % or 65 % of the amount of feed consumed in the previous week by the fish fed to near-satiation. Total feed intakes over 12 weeks were, on average, 72 % and 60 % of total feed intake of the near-satiety group for Rl and R2, respectively. Reducing the feed allocation resulted in significantly lower weight gains compared to feeding to near-satiation regardless of the rearing temperature. Increasing temperature resulted in an increase in the apparent digestibility of dietary dry matter, nitrogen and energy. A highly significant linear relationship was observed between metabolizable energy (ME) intake above basal metabolism and recovered energy. The efficiency of ME utilization for growth (K_{pf}) was 0.61 and this coefficient was not affected by feed intake or water temperature. Protein and lipid were deposited in a constant ratio (1 kJ protein gain: 1.4 kJ lipid gain) regardless of ME intake or water temperature.

Growth and feed utilization of large size rainbow trout *(Oncorhynchus mykiss)*:**diet and effects**

Four diets differing in crude protein/crude lipid concentrations (CP/CL), 56/20; 51/21; 45/23 şi 42/25 (g./kg. dry diet) were fed to near-satiety to rainbow trout (initial body weight, 1BW = 250 g,) for 280 days to determine the effect of diets, and fish size on efficiency of feed, nitrogen (N) and energy utilization. Weight gain, feed efficiency (FE), and energy retention efficiency (ERE, E gain/E intake) were not affected by diet. N retention efficiency (NRE, N gain/N intake) increased linearly with decreasing CP/CL. There was a significant linear decrease in FE as fish grew, regardless of diet. NRE linearly decreased and lipid to protein deposition ratio (LD/PD) increased as trout grew.

Polycyclic aromatic hydrocarbons (PAHs) in smoked fish from three smoke-houses in Braşov county

Fifteen samples of smoked fish were analysed for BaP and other polycyclic aromatic hydrocarbons (PAHs). The high resolution gas chromatography–mass spectrometry (HRGC–MS) method employed was elaborated and validated for the control programme. The method complies with the criteria for official control according to Commission Regulation (EC) No 333/2007. Six samples of smoked fish had BaP levels exceeding 5.0 μg/kg, the concentrations ranging from 0,6 to 8.4 μg/kg. These samples were produced by traditional smoking, where the food is directly exposed to hot smoke from a burning log fire. Samples of fish smoked by indirect technique, using smoke from an external smoke generator, all had BaP levels below the limit of quantification, i.e., 0.3 μg/kg.

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