Processing aquatic feeds
to optimize nutritional and pellet characteristics

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Introduction

Aquatic feeds are primarily processed by extrusion systems to not only include nutritional value but also develop desirable physical product characteristics. Starch gelatinization, floating/sinking properties, fat uptake and durability in water are critical characteristics in the industry that impact nutritional and physical pellet considerations. Starch gelatinization of aquatic feed during extrusion is important as it affects feed digestibility in some species and contributes to water stability in all feeds. Floating/sinking properties of the feed are species specific and affect feed efficiency through proper presentation for consumption. Feed not immediately consumed must be water stable to protect the nutrients in the feed but also water quality. Extrusion process variables such as SME (specific mechanical energy) impact these important product properties. The purpose of this study was to describe the effects of extrusion SME on starch gelatinization and to investigate the correlation between feed bulk density and floating/sinking characteristics and the potential to absorb fat coatings through vacuum infusion and atmospheric coating techniques.

Figure 1. Effect of Extrusion SME on Starch Gelatinization

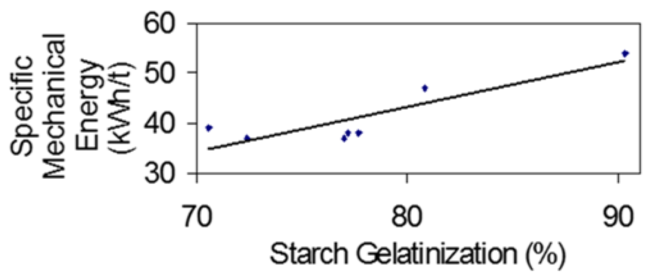
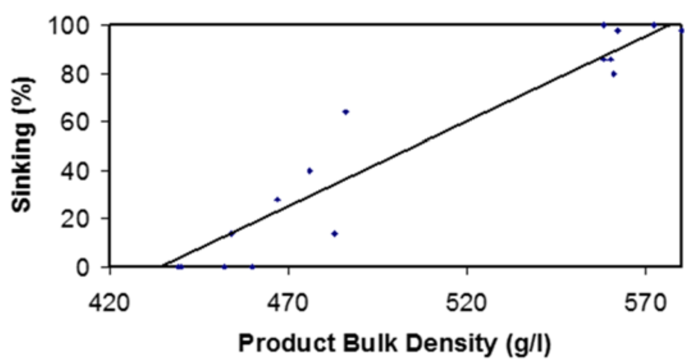


Figure 2. Effect of Bulk Density on Sinking Properties



Materials and Methods

An aquatic feed diet consisting of 77.7% Menhaden fish meal, 11.0% wheat flour,

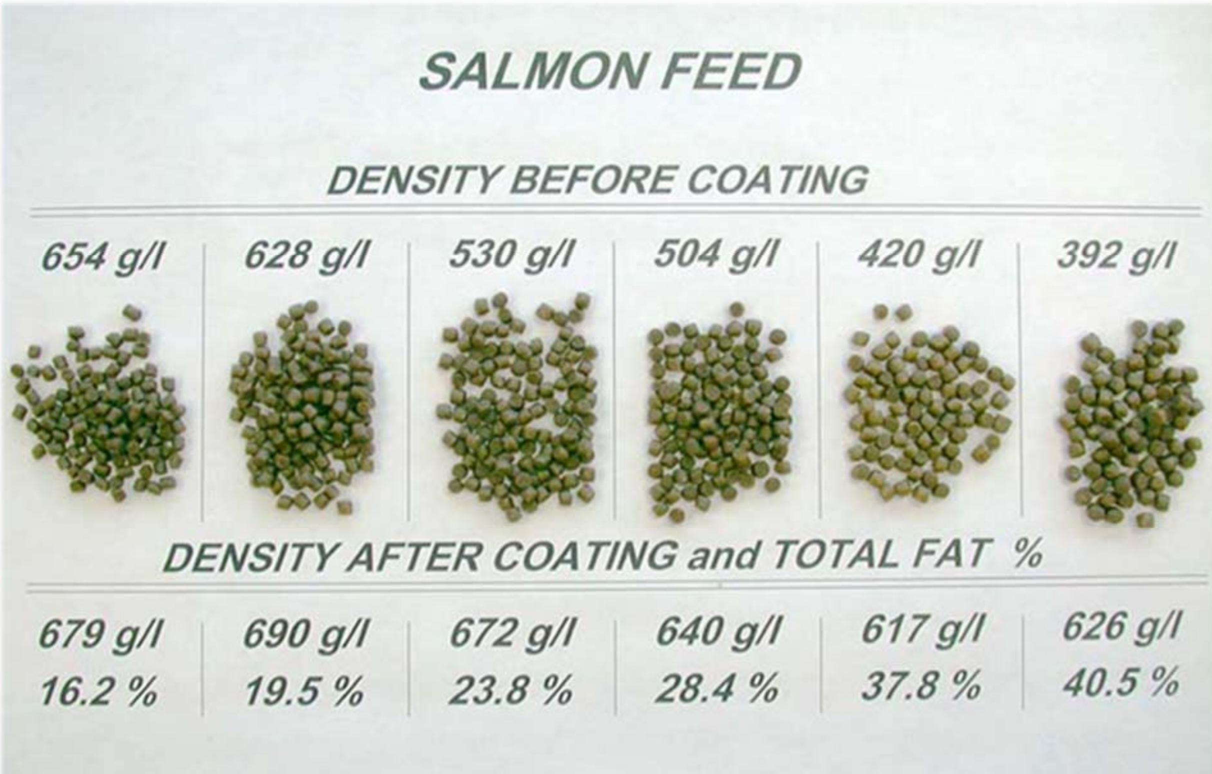


Photo 1. Densities and coating levels of salmon feeds

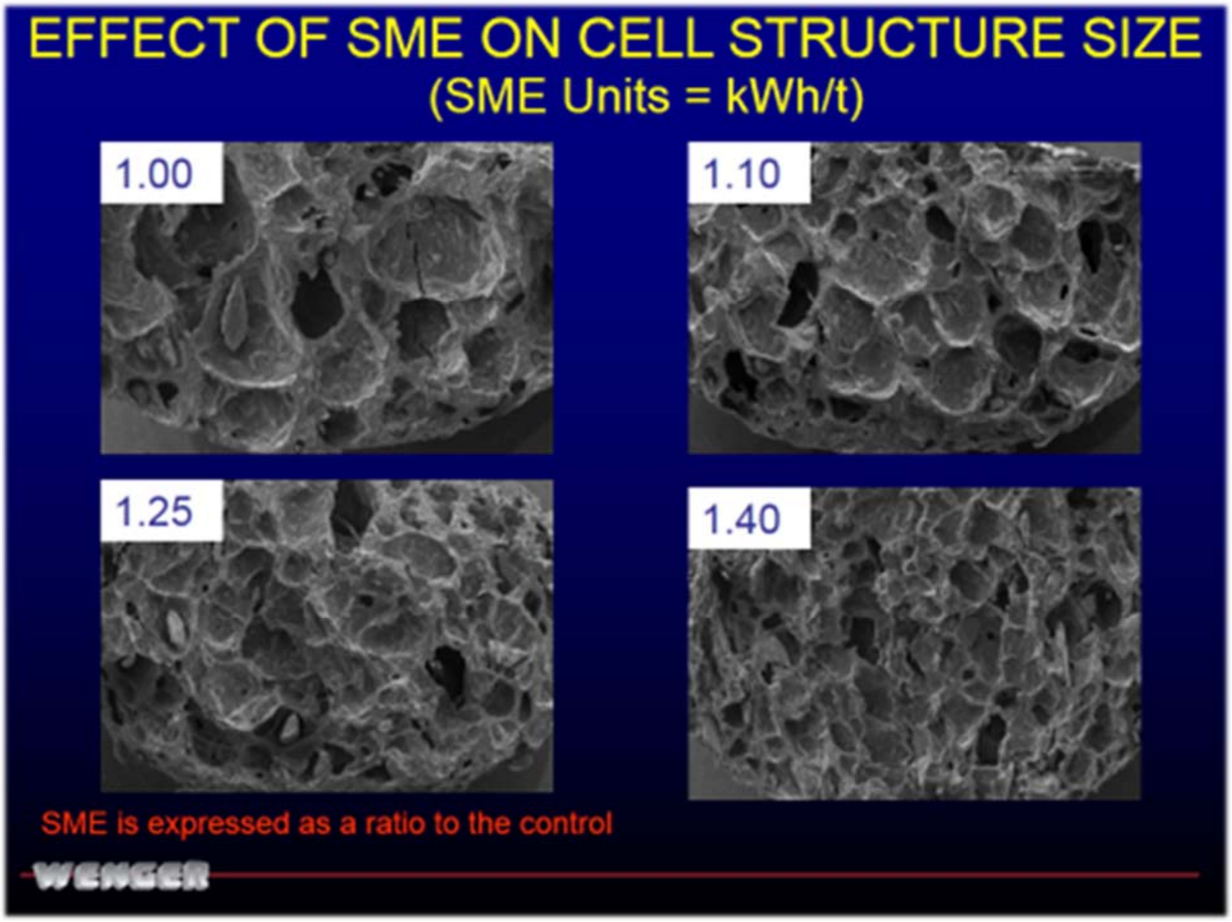
9.0% tapioca starch, and 2.3% soybean meal was ground through a 1500 micron screen and then extruded on a Model 8.1 C2TX co-rotating, conical twin screw extruder (Wenger Mfg., Inc.) Starch gelatinization was evaluated on the aquatic feed extruded at six different SME inputs. SME was adjusted by varying extruder screw speed and the orifice opening size in a backpressure valve (BPV). Starch gelatinization values were determined by the modified glucoamylase method. The bulk densities of extruded and dried samples were measured before and after maximum fat absorption.

Maximum fat absorption for each extruded aquatic feed sample was determined by two methods – vacuum infusion and atmospheric coating. The vacuum infusion method consisted of submerging in a closed vessel a known mass of aquatic feed in excess fish oil heated to 60º C. A vacuum of 7.0 kg/m² was maintained for two minutes in the system and then released. The feed sample was removed from the oil bath, excess oil drained for two hours, and then the feed reweighed to determine fat absorption.

% Fat absorption = (final weight – initial weight)/ initial weight x 100

The atmospheric coating method was identical to the vacuum infusion method except no vacuum was applied to the system. Bulk density was determined by measuring the mass of a one-liter sample. The "% sinking" value for each sample was determined by placing 100 aquatic feed pellets in 3.5% salt water at 20º C and recording the number of pellets that sank within 30 seconds.

Photo 1 shows the dry density before coating, the density after coating and the relative oil uptake. Notice that some of the feeds were not at sinking densities before coating, the oil filled the air pockets in the



Photos 2. Effect of SME on Cell Structure Size

pellets and thus density increased to above sinking requirements.

Photos 2 depicts the relationship between SME and pellet cell structure. Cell Structure is a critical element in oil uptake and the pellet holding the oil until delivery to the fish. Cell structure also is related to pellet durability and strength. The Larger cell structure holds less oil and softens in water faster. The smaller cell structure hold more oil and is also more durable in water. Pellet softening in water has been a recent topic for select fish. Pellets that soften in water are more desirable to some fish species. Specific processes are available for making sinking or floating softer feeds. These techniques would involve semi moist extrusion technology.

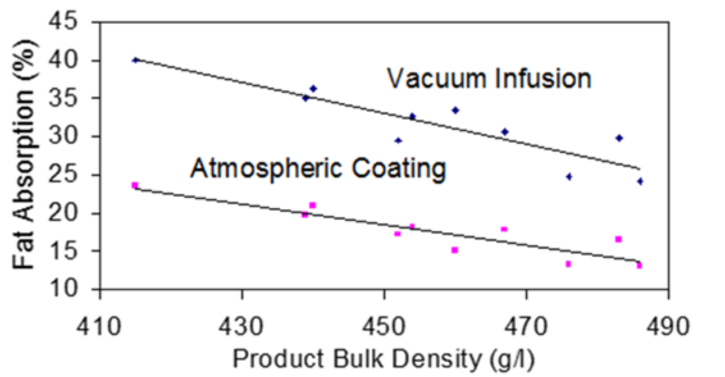
Results

As the SME level was increased during extrusion, the starch gelatinization in the aquatic feed increased as seen in see Figure 1. Figure 2 indicates a direct correlation between product bulk density and sinking properties of aquatic feed in seawater. An aquatic feed bulk density of at least 580 g/l was required to achieve 100% sinking properties. As aquatic feed bulk density before coating increased, fat absorption via vacuum infusion and atmospheric coating decreased in Figure 3 also seen in Photo 1.

Conclusion

Extrusion SME can be an effective process variable to control starch gelatinization in aquatic feed production. Although not a part of this study, an increase in extrusion SME also improves water stability of extruded aquatic feeds. Final product density correlated well with sinking properties of aquatic feeds. Bulk density before coating of aquatic feeds can be used as an indicator of the potential fat absorption properties.

Figure 3. Effect of Bulk Density on Fat Absorption by Vacuum Infusion and Atmospheric Coating



More information

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