# EFFECT OF SILICA-BASED ADSORBANT ON OIL ABSORPTION/RETENTION AND DURABILITY OF ABERNATHY DRY SALMON DIET

by

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## ABSTRACT

A microfine silica product was used as an additive to the Abernathy salmon diet (A18-2) to evaluate its effectiveness for increasing oil retention and pellet durability. The silica product was added at either 0 or 3% of the diet to formulations containing either 0 or 3% added fish oil before pelleting. More fish oil was sprayed onto the feed after pelleting and oil retention-was' recorded. Pellet durability was determined by placing a feed sample in a modified paint shaker and calculating the percentage fines produced after a period of agitation. Addition of the silica to the formulation did not increase retention of sprayed-on fish oil in diets either with or without fish oil added to the formulation before pelleting. Addition of the silica improved pellet durability, as indicated by reduced percentage fines, particularly in the formulation to which the fish oil was added before pelleting.

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# INTRODUCTION

The energy level of salmon diets, one factor that determines the growth rate and feed conversion ratios of a formulation, can be increased or decreased mainly by changing the level of fish oil in the formulation. Lipids contain 8-8.5 Kcal/g, compared to about 4 Kcal/g for proteins and, when added to the diet, are the most cost-effective method to increase calories. However, the amount of fish oil that can be added to salmon diets is limited. The addition of fish oils to dry diets before pelleting reduces pellet hardness at a level of incorporation below that at which the optimum caloric value is reached. Soft pellets tend to disintegrate during shipping and storage, creating a high percentage of fine particulate matter (fines). Therefore, pellets are top-dressed with oil after pelleting to increase the energy content of the pellet without sacrificing pellet hardness. The amount of oil that can be retained by pellets after top-dressing is often less than desired.

In the study presented here, a new microfine silica product, Sipernat ®[1] (Degussa, Frankfurt, Germany), was evaluated as an additive to pellets to determine its effect on the retention of top-dressed oil. Pellet resistance to disintegration also was measured since Sipernat® is reported to allow an increase in the amount of oil that can be added to a formulation before pelleting without affecting pellet hardness.

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[1]Use of trade names in this publication does not constitute endorsement by the National Marine Fisheries Service.

## PROCEDURES

Four diet formulations were mixed and pelleted without steam using a laboratory California Pellet Mill (equipped with l/4-inch die). Each diet was a modification of the Abernathy salmon diet A18-2 (Table 1). All additions of oil or Sipernat® were made at the expense of the wheat middlings portion of the formula. The experimental design was as follows:

| Oil added before pelleting | Sipernat® 0% | Sipernat® 3% |
|---|---|---|
| 0% | Diet A | Diet B |
| 3% | Diet C | Diet D |

step 1. A 2-kg batch of each diet was mixed, pelleted, and allowed to cool to room temperature.

Step 2. The pellets were spread a single layer thick in a shallow aluminum pan and placed on a top-loading balance. Oil was then sprayed onto the pellets from a hand-held spray bottle warmed in heated water. When the appropriate weight of oil had been applied, the pellets were shaken in the pan for at least 2 minutes. The pellets were then scooped into plastic bags and allowed to "soak" for at least 24 hours. The remaining oil in the pan was weighed and the amount subtracted from the amount applied to obtain the net amount taken up by the pellets.

A possible source of error existed at step 2 in the procedure when the oil remaining in the pan was weighed and subtracted to obtain the net amount retained. Fines from the diet adhered to the oil in the pan and contributed

Table 1. Abernathy dry salmon diet (Al8-2).

| Ingredient | Percent |
|---|---|
| Fish meal, herring | 50.0 |
| Dried whey product | 10.0 |
| Wheat germ meal | 5.0 |
| Wheat middlings | 10.3 |
| Blood flour | 10.0 |
| Poultry by-product meal | 1.5 |
| Abernathy vitamin premix | 1.5 |
| Fish and Wildlife Service trace mineral premix #l | 0.1 |
| Ascorbic acid | 0.1 |
| Choline chloride solution (70%) | 0.5 |
| Lignin sulfonate | 2.0 |
| Fish oil | 9.0 |

to the weight subtracted. Oil also adhered to the scoop when removing the pellets from the pan, effectively lowering the net amount of oil applied.

Pellet durability was tested using a modified paint shaker. The l-quart shaker receptacle was loaded with 175 g of pellets of each diet and shaken vigorously for 3 minutes. The pellets were then separated from the fines using a No. 5 U.S. standard mesh screen. The pellets were reweighed and the percentage of total calculated. The percentage of fines was calculated by difference.

## RESULTS AND DISCUSSION

Comparison of diet A with B and of C with D shows that the inclusion of 3% Sipernat® to the batch mix had no effect on the pellet's ability to retain sprayed-on oil (Table 2). The maximum amount of sprayed-on oil retained was approximately 6% regardless of the formulation or amount of oil applied. Comparison of diet A with C and of B with D shows that the inclusion of 3% fish oil to the batch mix also had no effect on the maximum amount of sprayed-on oil retained by each formulation.

Both of the diet formulations containing 3% Sipernat@ produced pellets that were substantially harder than pellets produced by formulations without the inclusion of Sipernat@. Diet B produced the hardest pellet and this may explain why oil retention by pellets of diet B was less than that of the other diets. Diet B was also very difficult to pellet even under extreme pressure that caused the die to become very hot and reduced production considerably. This problem might have been due to a lack of lubrication available from the pelleted ingredients. No oil was added to diet B and the Sipernat@ may have entrapped any available oil from the other ingredients.

Table 2. Percentage of fish sprayed on each batch of Abernathy diet, and the percentage of fish oil retained by the pellets.

| ( Diet code | % Sipernat@ | % Oil added before pelleting | % Oil sprayed on pellets | % Oil retained by pellets after spraying |
|---|---|---|---|---|
| Al | 0 | 0 | 0 | - - - |
| A 2 | 0 | 0 | 3 | 2.5 |
| A3 | 0 | 0 | 6 | 4.0 |
| A4 | 0 | 0 | 9 | 6.3 |
| Bl | 3 | 0 | 0 | - - - |
| B2 | 3 | 0 | 3 | 2.0 |
| B3 | 3 | 0 | 6 | 3.5 |
| B4 | 3 | 0 | ,9 | 5.8 |
| Cl | 0 | 3 | 2 | 1.8 |
| C2 | 0 | 3 | 4 | 3.4 |
| C3 | 0 | 3 | 6 | 4.9 |
| C4 | 0 | 3 | 9 | 6.2 |
| Dl | 3 | 3 | 2 | 1.8 |
| D2 | 3 | 3 | 4 | 3.5 |
| D3 | 3 | 3 | 6.2* | 5.1 |
| D4 | 3 | 3 | 8 | 6.1 |

* Mismeasured + 0.2%.

The durability of the product, based on percent fines, was in each comparison improved with the use of Sipernat. Comparing the percent fines of diets A with B and C with D shows that the addition of Sipernat@ had a significant influence on pellet durability in diets formulated with identical oil content (Table 3).

Although diet B proved to be the most durable, it was also by far the hardest pellet. This may prove to be unacceptable to the fish fed the diet. For this reason and because of the extremely high pressure required to pellet the diet and the low retention of sprayed oil, this modification of the Abernathy diet should not be considered a practical diet but should be used for comparison only. The most promising diet modification was diet D. Although in diet D the addition of 3% Sipernat had no effect on oil retention, an average three-fold increase in durability was realized over the same diet (C) without the addition of Sipernat.

## CONCLUSIONS

Sipernat@ microfine silica used as a feed additive did not increase retention of top dressed oil. Therefore, the simple addition of Sipernat@ to existing formulations is not likely to improve the oil content of the finished product when oil is added by top dressing.

The addition of Sipernat@ to the formulation did improve pellet durability. Furthermore, this improved durability extended to diets in which the formulated oil content was high enough to affect the hardness and durability of the pelleted product. By using both Sipernat@ and additional oil-in the batch formulation prior to pelleting, a physically and chemically improved product can be produced. Feeding trials with salmonids would be

Table 3. Percent of fines separated from diets after durability test

| Diet code | % Sipernat@ | % Oil added before pelleting | % Oil sprayed on pellets | % Fines | Average fines for each diet (% ± SD) |
|---|---|---|---|---|---|
| A1 | 0 | 0 | 0 | 6.2 | |
| A2 | 0 | 0 | 3 | 6.0 | 6.8 ± 0.9 |
| A3 | 0 | 0 | 6 | 7.4 | |
| A4 | 0 | 0 | 9 | 7.7 | |
| B1 | 3 | 0 | 0 | 0.2 | |
| B2 | 3 | 0 | 3 | 3.8 | 1.3 ± 1.7 |
| B3 | 3 | 0 | 6 | 1.1 | |
| B4 | 3 | 0 | 9 | 0.2 | |
| C1 | 0 | 3 | 2 | 19.3 | |
| C2 | 0 | 3 | 4 | 14.3 | 15.4 ± 2.6 |
| C3 | 0 | 3 | 6 | 13.9 | |
| C4 | 0 | 3 | 8 | 14.0 | |
| D1 | 3 | 3 | 2 | 4.8 | |
| D2 | 3 | 3 | 4 | 7.3 | 5.7 ± 1.1 |
| D3 | 3 | 3 | 6 | 5.6 | |
| D4 | 3 | 3 | 8 | 5.1 | |

required to determine if the diet modifications discussed above improve the nutritional quality of the diets.