Effectiveness of Oil Carrier for Antioxidants in Fish Concentrate

J.L. CHUANG and NATHOLYN D. HARRIS, Department of Food and Nutrition, Florida State University, Tallahassee, Florida 32306

ABSTRACT

Two levels of antioxidants, 0.02% and 0.002%, were added to a concentrated fish product. Two ways of incorporating antioxidants into fish oil were studied. The oxidation rate of the samples was measured by using an oxygen analyzer and the thiobarbituric acid test. The concentrated fish prepared from fresh mullet was stored for 0 hr, 48 hr, and 96 hr. The use of antioxidants in a vegetable oil carrier did significantly slow the breakdown reaction of fish oil and lowered the oxidation rate of the sample. When vegetable oil was used to serve as an antioxidant carrier, the high level of antioxidant (0.02%) stabilized the fatty product more efficiently than the lower level (0.002%) did. At the level of 0.02% antioxidants, using soybean oil to serve as antioxidant carrier, the fish product was quite stable during storage under the conditions of this study.

INTRODUCTION

The only fish protein concentrate products which have met Food and Drug Administration approval are prepared by chemical methods. The approved product, fish protein concentrate, is prepared with organic solvents, and it contains less than 0.5% fat.

A similar dried fish product can be prepared by biological methods, being digested by proteolytic enzymes. Rutman (1) obtained a patent for such a product which he called "high energy fish protein concentrate." The enzyme digested product has a stronger, distinctive flavor which is preferred by certain populations (2). Moreover, the product has good solubility (3,4), and it does not contain the toxic solvent residues which sometimes are found in products prepared by chemical methods (5,6). All of these attributes, added to the fact that the biological methods are the more economical means of production (7,8), cause one to reason that the biological methods are superior to the chemical methods of production. On the negative side, fish concentrates prepared by biological methods contain a high amount of fat. Because of the strong flavors which result from changes in the fat, the product probably would not be acceptable in the U.S. In certain other countries, the strong fish flavor is more acceptable, and the high fat content of the product could add needed calories for certain groups.

Little information is available on the effectiveness of adding antioxidants to carriers prior to introducing them into a high lipid food system. A product, such as concentrated fish, with a fat content of ca. 27% seemed ideal for testing this effectiveness. The purpose of this study was to compare the effectiveness of antioxidants added to a dried fish product by two methods: (A) dispersion of antioxidants in vegetable oil prior to their addition to the dried fish product and (B) addition of antioxidants to the fish slurry without previous dispersion in oil.

EXPERIMENTAL PROCEDURES

Sample Preparation

Fresh mullet fillets were ground and mixed thoroughly to get a homogeneous fish slurry. Three-hundred-and-twenty mg or 32 mg antioxidant mixture, butylated hydroxyanisole, butylated hydroxytoluene, gallic acid, and citric acid (10:10:6:6), was added to 1 g soybean oil. Tween 80 (300 mg) and 40 ml water were combined with the oil-antioxidant mixture to get mixtures for batches one and three. In parallel to preparing the oil-water emulsions described above, two other mixtures for batches two and four were prepared in a identical manner but without oil. Four 100 g batches of fish slurry were combined with one of the four mixtures described above.

Each batch was digested with 1/2 g bromelain at 50 C for 15 min and then heated to 80 C for 2 min to inactivate the enzyme. Soybean oil (1 g) was added to batch two and batch four to produce the same fat content in all four final products. The digest fish slurries were freeze-dried. The

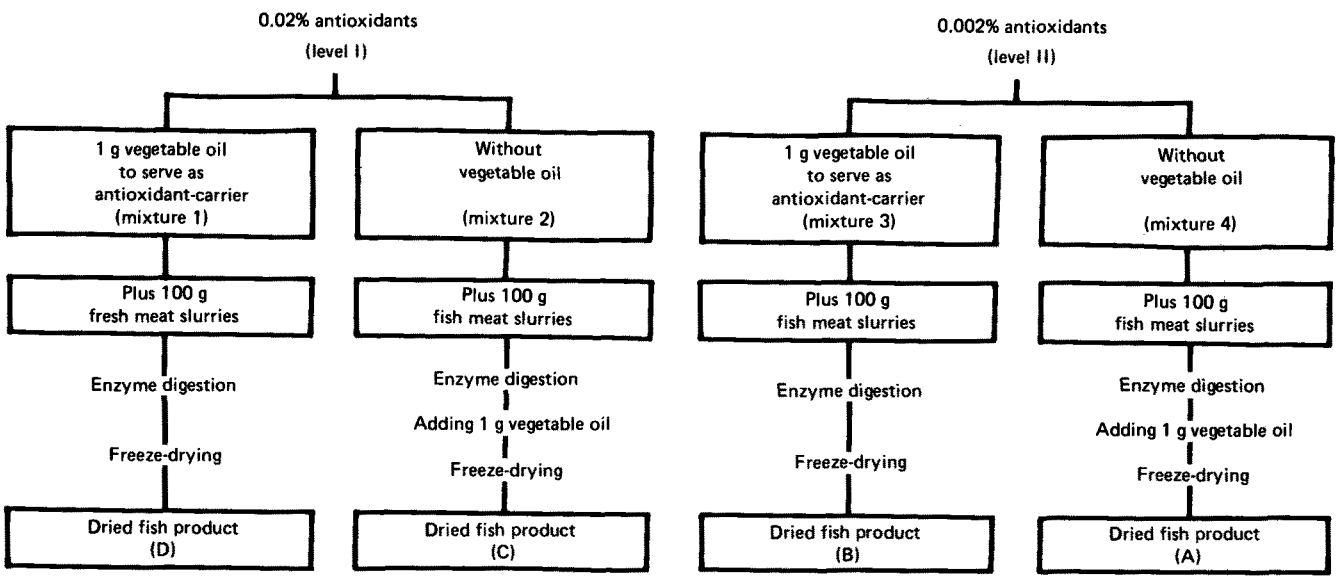

FIG. 1 Processing procedures of four batches (A,B,C,D) of dried fish product.

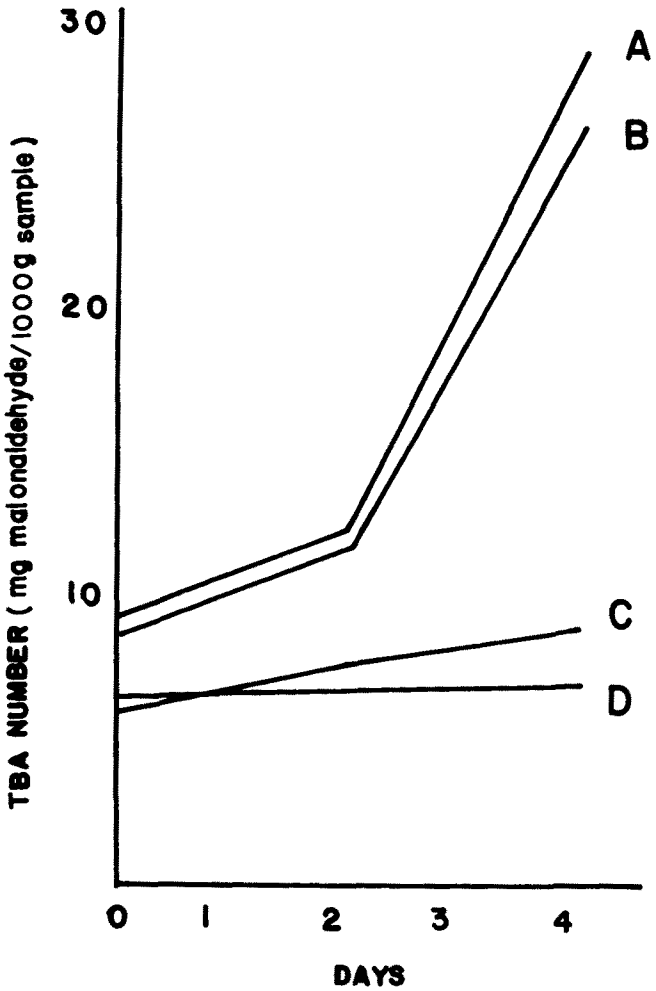

FIG. 2. Changes in thiobarbituric acid (TBA) number of the four batches of dried fish product as storage time is increased. The four batches are: A = 0.002% antioxidants, with vegetable oil carrier; B = 0.002% antioxidants, without vegetable oil carrier; C = 0.02% antioxidants, with vegetable oil carrier; and D = 0.02% antioxidants, without vegetable oil carrier.

processing procedures for the four batches are shown in Figure 1.

Storage Treatment

A portion of the dried fish was measured for its oxidative stability immediately after drying. Portions of the remaining sample were placed in glass tubes, closed, and stored in a 63 C oven for 48 or 94 hr (9).

Oxidation Measurements

Thiobarbituric acid (TBA) numbers were determined for the four batches stored at three time periods each. The modified TBA method of Yu and Sinnhuber (T.C. Yu and R.D. Sinnhuber, personal communication) was used.

A laboratory oxygen analyzer, Beckman model 777, was used to measure the oxygen consumption rates. Distilled water (20 ml) and 2 g sample were placed in 25 ml flasks and stirred with a magnetic stirrer to keep the mixture suspended. The oxygen analyzer sensor was exposed to air and set at 160 mm Hg. The sensor was inserted into the suspension, and an attached recorder was operated for 30 min. The decrease in oxygen tension/min at the most steady slope was taken as a comparative measure of the rate of oxygen consumption.

An analysis of variance was performed on the data using a replicated measure design. The entire procedure was replicated three times.

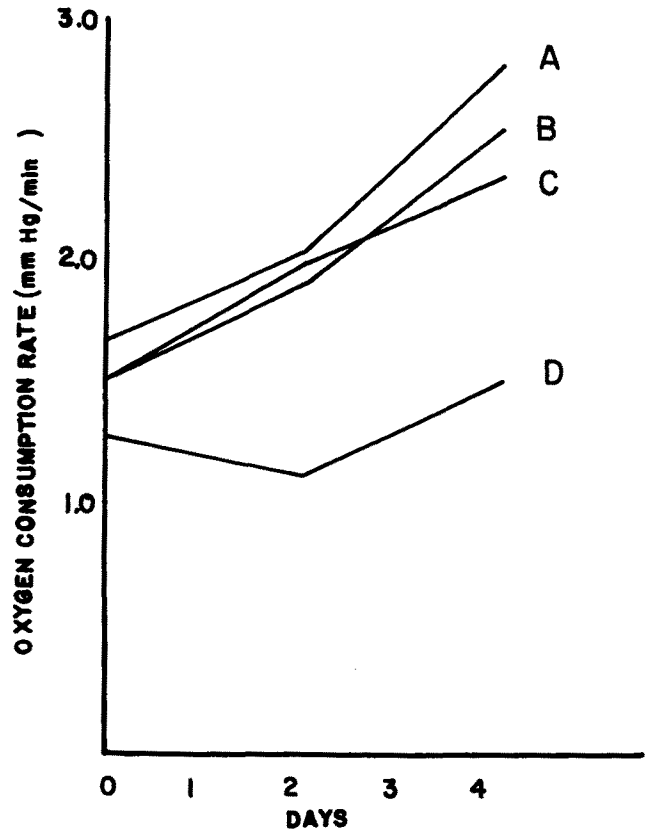

FIG. 3. Changes in oxygen consumption rates of the 4 batches of the dried fish product as the storage time is increased. The four batches are: A = 0.002% antioxidants, with vegetable oil carrier; B = 0.002% antioxidants, without vegetable oil carrier; C = 0.02% antioxidants, with vegetable oil carrier; and D = 0.02% antioxidants, without vegetable oil carrier.

RESULTS AND DISCUSSION

The fat content of the dried product ranged from 25-30% with a mean value of 27.2%, as determined by Association of Official Analytical Chemists' methods. The vegetable oil, added to all samples, comprised 4-5% of the total fat content.

TBA numbers were determined to measure oxidative changes in the four treatments held for varying storage times. Values were significantly lower in both of the treatments which used a vegetable oil carrier for the antioxidant. The higher level of antioxidant, when carried by vegetable oil, was particularly effective, as that treatment showed no increase in TBA numbers (Fig. 2).

The TBA values in this study were not correlated with flavor but were used to measure relative rates of oxidation. Flavor tests would be more meaningful if done with the people who ultimately will consume the product. Ideally, these tests would be made on the products which result from combining the dried fish product with a cereal rather than on the fish product alone.

The decrease in oxygen tension measured by the oxygen analyzer is an indication of oxygen consumption rate by the highly unsaturated samples. Oxygen uptake measurements were relative rather than absolute, since the dissolving rate of oxygen into the suspension from the air is not known. The analysis of variance on the oxygen uptake data revealed that storage, antioxidant level, and vegetable oil carrier were all significant in influencing oxygen uptake. In batch three, the lower level of antioxidant was effective in inhibiting the oxygen consumption rate when incorporated into a vegetable oil carrier (Fig. 3).

A higher level of antioxidant was less effective when not combined with vegetable oil carrier as seen in batch two at

the end of 48 hrs of storage.

The accelerated storage conditions used in this study cannot be used to predict the actual storage life of this product. Results might vary somewhat if the product were stored at ambient temperatures in a tropical country with a high humidity. The accelerated storage in this study was used to speed up oxidative changes so antioxidant effectiveness could be compared.

King (10) added tocopherol to milk for control of oxidized flavor and found that emulsified tocopherol was more effective than the nonemulsified preparation. His results and the results of the present study indicate that a carrier which brings the antioxidant into more intimate contact with the fat can enhance the effectiveness of the antioxidant.

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