# EXECUTIVE SUMMARY

# ON

# FUNCTIONAL PROPERTIES OF ALASKA POLLOCK SURIMI FOR APPLICATIONS IN THE FOOD INDUSTRY

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## SUMMARY

While gel strength has been utilized by the seafood industry as a method for evaluating surimi quality as a raw material for analogs, the processed meats industry is more reliant upon protein content, protein extractability, aroma, flavor, texture attributes and color as measures of ingredient quality. Meat products are also heavily regulated and, in many cases, compositionally defined. With today's production volumes in the meat industry, minimal raw material handling is also desirable.

The application of surimi to emulsified meat products, such as franks and bologna, may require a different perspective and different set of handling procedures quite unlike those used in seafood analog processing. Ideally, the meat industry would like raw materials which can be utilized directly in present systems especially when limited quantities are utilized or allowed. Therefore, the preparation of surimi gels prior to incorporation into test procedures was not a part of this project.

The results of this investigation of functional properties as related to processed meat applications indicated that frozen pollock surimi has considerable potential for incorporation into emulsified meat products. The fat emulsifying capacity is comparable to many presently utilized ingredients and, in conjunction with cooked emulsion fat-binding results, indicates considerable usefulness as a functional protein ingredient.

The results of water holding capacity evaluations (both of surimi alone and in emulsion matrices) may be useful in defining process and formulation parameters, as well as in interpreting cooked emulsion liquid release data (yields). The results indicated that surimi did not bind water to the extent anticipated. It is postulated that further research on process parameters for emulsion systems would result in improvement in the ability of surimi to bind water.

Foaming capacity and stability, while not directly related to present day meat processing systems, has application to innovative foods manufacturing. Fine, white foams were produced not unlike egg-white foams, which could be utilized as binders or matrices for protein-based "lite" foods as this functional property is further investigated and developed.

Results of this investigation indicated that low gel strength surimi was as adequate in most functional properties as high gel strength surimi for application in processed meat products. This would allow the utilization of high gel strength surimi in seafood applications while providing sufficient quantities of surimi for the meat industry. Thus, continued applications research may reveal that the efficient utilization of surimi in emulsified meat products at the anticipated use levels of up to 15% may not require the use of high-gel surimi.

Graphical presentation of pertinent data selected from Tables 1 - 4 are shown in the Appendix in order to illustrate the major findings of the study.

A window of opportunity has opened for utilization of frozen pollock surimi in processed meat products awaiting the light from continued research and process development studies to brighten the field of applications.

# INTRODUCTION

The overall objective of this project was to identify the functional properties of Alaska pollock surimi which are applicable to the food industry, especially the meat industry. This objective was designed to provide a sound basis for expanding the domestic marketing opportunities for surimi.

The Alaska Fisheries Development Foundation, in an endeavor to increase the marketing opportunities for surimi to the food industry, determined that a study of the basic functional properties of surimi was essential for acceptance and utilization of surimi in processed meat products.

The potential for incorporating surimi into processed meat products is dependent, in part, upon the meat industry's acceptance of a product which can provide functional advantages as well as be easily utilized. The meat industry uses a variety of raw materials to formulate processed meat products to provide both economical benefits and a wide array of functional characteristics. The selection of ingredients is based upon a combination of functionality, cost savings, consumer acceptance, regulatory constraints, and availability.

In order to quantify the functional properties most appropriate for processed meat product applications, the following specific factors were evaluated for surimi:

1) The fat emulsifying capacity of surimi using procedures typically utilized to evaluate meat ingredients;

2) The cooked stability of meat-type emulsions prepared with surimi under various meat process conditions;

3) The water-holding capacity of surimi under various process conditions;

4) The foaming capacity and stability of surimi at different concentrations, salt levels and whipping times.

The functional properties of surimi was also compared to other protein ingredients, and to freeze-dried and spray- dried surimi.

The approach taken in this project was to evaluate frozen block surimi on the basis of its potential application in existing emulsified-type processed meat systems such as for the manufacture of frankfurters and bologna. These products are produced in substantial quantities (about two billion pounds annually in the United States alone), and provide, (at a 15% use level), a potential utilization of up to 300 million pounds of surimi. Poultry-derived raw materials are commonly utilized at this level in meat-type sausage products at the present time.

Application of frozen block surimi in meat products would be most readily accepted if the surimi were utilized in a manner similar to presently available ingredients and processes. Therefore, the evaluation of functional properties for this project included consideration of the handling conditions (storage, tempering, size reduction) as well as usage conditions (incorporation time and sequence, heat processing, level of usage, etc.), with processed meat applications and methods being given priority over seafood analog applications.

## EXPERIMENTAL METHODS

The experimental evaluation of the functional properties of surimi included the following methods:

1) Cooked Emulsion Stability - A modified, cooked emulsion stability test (Haq et. al., 1972) was performed using a model meat emulsion system to evaluate the ability of surimi to bind, or hold, fat and moisture under simulated emulsion preparation conditions and subsequent heat processing. The treatment variables for this test included:

a) High and low gel strength frozen surimi,
b) Early and late addition to the model emulsion preparation,
c) High (15%) and low (5%) usage levels,
d) Standard and stressed emulsion systems,
e) Standard and accelerated heat processing.

2) Fat Emulsifying Capacity - The modified, fat emulsifying capacity test of Saffle and Galbreath (1964) was conducted to determine the ability of surimi proteins to emulsify fats.

3) Water Holding Capacity - The water holding test of Sadowski (1982) was used to determine the ability of high and low gel surimi to hold water at varying saline concentration, solids to liquid ratios, and under heated and unheated conditions.

4) Foaming Capacity and Stability - A foam capacity and stability evaluation test was conducted with both high and low gel surimi to determine foaming properties at different surimi concentrations, whipping times and saline strengths.

## RESULTS

Fat Emulsifying Capacity - Table 1 presents the results of the fat emulsifying studies of surimi and other ingredients.

The frozen Alaskan high gel-strength surimi showed an average fat emulsifying capacity (EC) of 138 mls/100 mg salt soluble protein as compared to 85.5 mls for the low gel-strength surimi. The high gel-strength Alaska surimi EC values compared favorably with the Japanese surimi which showed a range from 148-160 mls oil emulsified, whereas the lean beef emulsifying capacity was substantially higher (260 mls/100 mg S.S.P.). EC values for spray-dried and freeze-dried surimi were comparable to other surimi forms, with sodium caseinate and isolated soy protein being substantially lower than high gel-strength surimi.

TABLE 1. FAT EMULSIFYING CAPACITY OF SURIMI AND OTHER SELECTED PROCESSED MEAT INGREDIENTS

| Ingredient | Emulsifying Capacity mls oil/100 mg salt soluble protein |
|---|---|
| Surimi: | |
| Alaskan, Frozen, 466 Gel-Value | 138.0 |
| Alaskan, Frozen, 250 Gel-Value | 85.5 |
| Japanese Factory Ship | 160.0 |
| Japanese Shore Plant | 148.0 |
| Spray-Dried, P.F.P. | 151.0 |
| Freeze-Dried, Probine | 111.0 |
| Other Ingredients: | |
| Lean Beef | 260.0 |
| Sodium Caseinate | 105.0 |
| Isolated Soy Protein, Purina 620 | 85.9 |

Water Holding Capacity - The results of the water holding capacity tests for surimi are shown in Table 2 at various saline concentrations. Several surimi quality levels as well as surimi:saline ratios were evaluated. Additional data are presented in the full text report.

The results indicated that aqueous blends of high gel strength surimi, as well as some 3% saline blends, showed the most liquid retention in uncooked blends at all surimi: saline ratios. In the cooked blends, the aqueous solution showed the greatest liquid retention.

In low gel-strength, uncooked surimi blends, water holding capacity increased at 3% saline, especially at the 1:2 surimi:saline ratio. The aqueous blends released less added liquid than either 1% or 2% saline, while cooked blends of low gel surimi returned very little liquid (presented in the full text report).

TABLE 2. PERCENT OF ADDED LIQUID RETAINED IN SURIMI BLENDS CONTAINING VARYING AMOUNTS OF SALINE AT DIFFERING CONCENTRATIONS

| | | Surimi:Saline Ratio | | | |
|---|---|---|---|---|---|
| | Saline | 1:2 | | 1:5 | |
| Surimi Type | Conc.,% | Uncooked | Cooked | Uncooked | Cooked |
| Alaskan, Frozen | 0 | 39.5 | 31.3 | 34.7 | 24.9 |
| 466 Gel Value | 3 | 68.6 | 18.4 | 31.1 | 11.1 |
| Alaskan, Frozen | 0 | 22.5 | 36.5 | 45.6 | 21.5 |
| 250 Gel Value | 3 | 100.0 | 36.8 | 37.0 | 7.0 |

Foaming Capacity/Foam Stability - Table 3 shows the results of the foaming capacity and stability for 10% surimi in 5% saline solution when whipped for either 5 or 10 minutes.

Highest foam volumes were produced at higher (5% and 6%) saline concentrations from both low and high gel-strength 10% surimi solution. The low gel-strength surimi produced greater volumes per unit of whipping time. Increased foam stability, as measured by a decrease in liquid released over time after whipping, was also produced at higher saline concentrations, longer whip time, and with the low gel-strength surimi.

TABLE 3. FOAMING CAPACITY AND STABILITY OF 10% SURIMI SOLUTIONS IN 5% SALINE AT 5 AND 10 MINUTE WHIP TIMES

| Surimi Type | Whip Time (min) | Initial Foam Volume | Foam stability at selected time intervals (mls drip @ specified times) 1 min | 5 min | 10 min |
|---|---|---|---|---|---|
| Alaskan, Frozen 466 Gel Value | 5 | 465 | 69 | 95 | 101 |
| | 10 | 1200 | 0 | 0 | 0 |
| Alaskan, Frozen 250 Gel Value | 5 | 570 | 15 | 32 | 50 |
| | 10 | 1250 | 0 | 0 | 0 |

Emulsion Cooked Stability - Table 4 presents selected results of the emulsion cooked stability evaluations for various surimi treatments. Complete data are presented in the full text report. Generally, the use of surimi resulted in improved fat binding and reduced liquid cookout over control emulsions. Higher process temperatures also showed slight improvement in fat binding and water holding capacity at the 15% surimi usage levels. At the 5% surimi usage level, low gel surimi had lower fat cookout values than either the high gel surimi or the control.

TABLE 4. TOTAL FAT AND LIQUID COOKOUT VALUES FOR EMULSIONS PREPARED WITH SURIMI UNDER VARYING PROCESS CONDITIONS

| Emulsion Treatment | Cook Temp (°C) | Total Cook Loss(%) | Fat Cookout mls/100 g Emulsion | Liquid Cookout mls/100 g Emulsion |
|---|---|---|---|---|
| 15% High Gel, Alaskan Late Addition | 70 | 15.5 | 1.0 | 14.0 |
| | 90 | 14.7 | 0.8 | 12.8 |
| 15% Low Gel, Alaskan Late Addition | 70 | 8.2 | 0.4 | 6.8 |
| | 90 | 7.0 | 0.3 | 5.8 |
| Control, No Surimi | 70 | 22.4 | 3.7 | 17.4 |
| | 90 | 23.5 | 4.7 | 17.2 |

## REFERENCES

Haq, A., Webb, N. B., Whitfield, J. K. and Morrison, G. S. 1972. Development of a Prototype Sausage Emulsion Preparation System. J. Food Sci. 37:480.

Sadowska, M., Nacsk, M., Sikorski, E. and Ziminska, M. 1982 Effect of Fish Protein Properties on Rheological Properties of Meat Sausages. J. Texture Studies. 13:371.

Saffle, R. L. and Galbreath, J. W. 1964. Quantitative Determination of Salt-Soluble Protein in Various Types of Meat. Food Technol. 18(12):119.

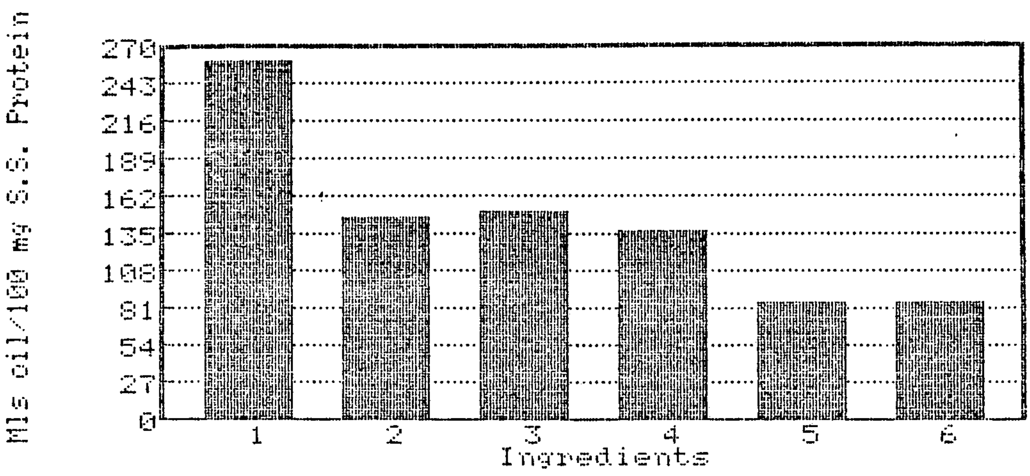



Figure 1. Emulsifying capacity of various protein based ingredients.

| | | |
|---|---|---|
| 1 | 260 | Beef, 90% Lean |
| 2 | 148 | Surimi, Jap. Shore Plant |
| 3 | 151 | Surimi, (PFP) Spray Dried |
| 4 | 138 | Surimi, Alaskan Gel Value 466 |
| 5 | 85.50 | Surimi, Alaskan Gel Value 250 |
| 6 | 85.90 | Isolated Soy Protein |

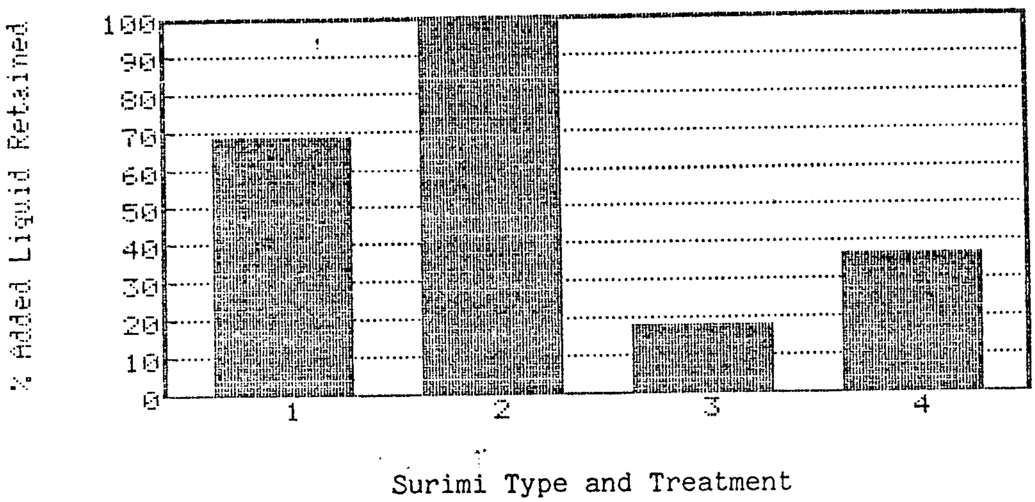
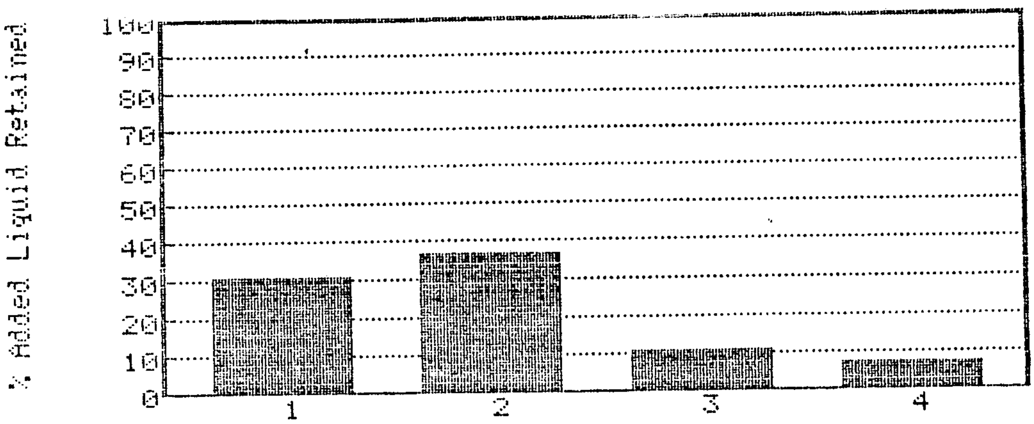



Figure 2. Percent of added liquid retained by cooked and uncooked blends containing surimi and 3% saline (1:2).

| | | |
|---|---|---|
| 1 | 68.60 | Alaska Gel Value 466, Uncooked |
| 2 | 100 | Alaska Gel Value 250, Uncooked |
| 3 | 18.40 | Alaska Gel Value 466, Cooked |
| 4 | 36.80 | Alaska Gel Value 250, Cooked |




Surimi Type and Treatment

Figure 3. Percent of added liquid retained by cooked and uncooked blends containing surimi and 3% saline (1:5).

| | | |
|---|---|---|
| 1 | 31.10 | Alaska Gel Value 466, Uncooked |
| 2 | 37 | Alaska Gel Value 250, Uncooked |
| 3 | 11.10 | Alaska Gel Value 466, Cooked |
| 4 | 7.0 | Alaska Gel Value 250, Cooked |

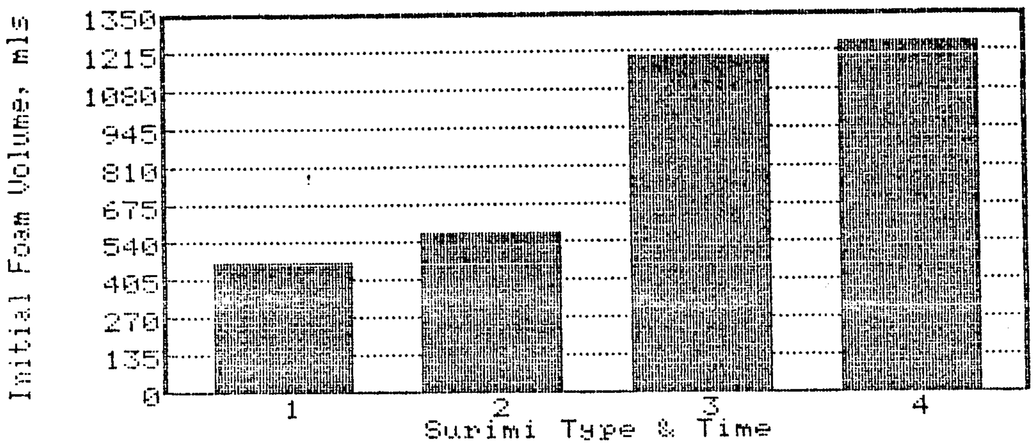



Figure 4. Foaming capacity (mls) of 10% Alaska Surimi in 5% saline at five and ten minute whipping times.

| | | |
|---|---|---|
| 1 | 465 | Gel Value 466, 5 minutes |
| 2 | 570 | Gel Value 250, 5 minutes |
| 3 | 1200 | Gel Value 466, 10 minutes |
| 4 | 1250 | Gel Value 250, 10 minutes |

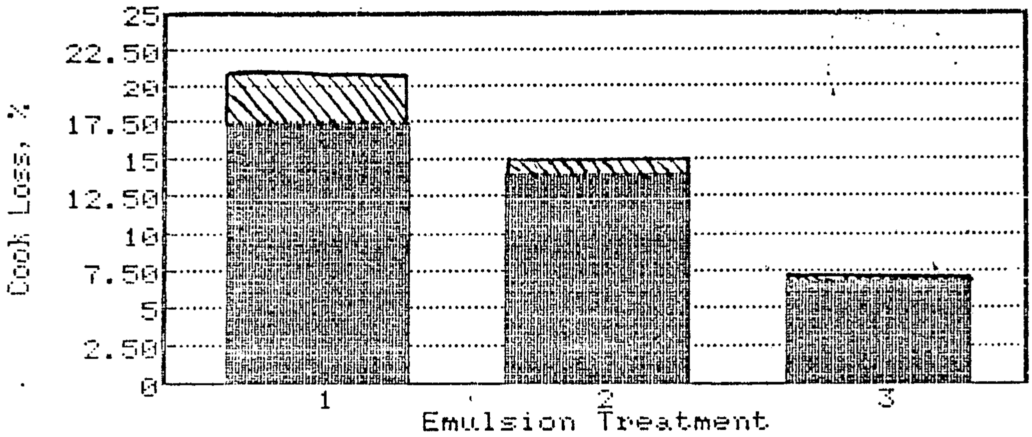



Figure 5 Fat and aqueous cooking losses for meat-type emulsions containing high and low gel surimi. (70°C)

1 Control
2 15% High Gel, Late Addition
3 15% Low Gel, Late Addition

Aqueous Phase
Fat Phase

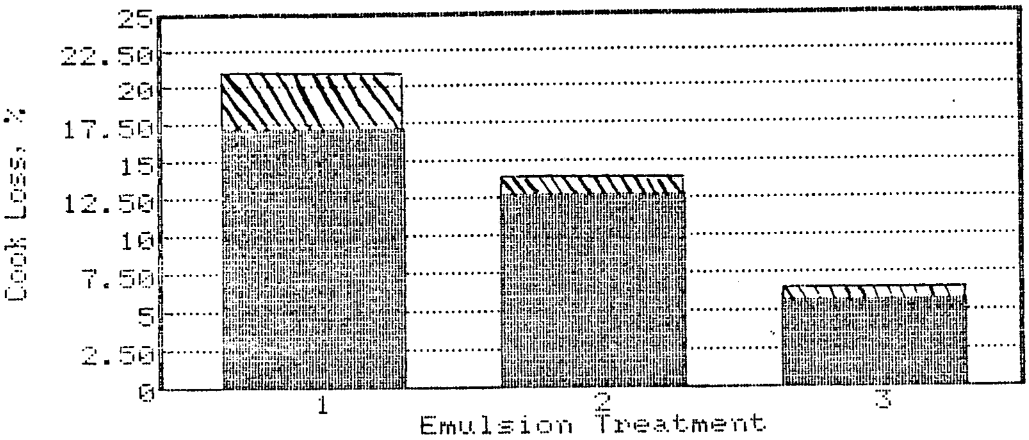



Figure 6 Fat and aqueous cooking losses for meat-type emulsions containing high and low gel surimi. (90°C)

1 Control
2 15% High Gel, Late Addition
3 15% Low Gel, Late Addition

Aqueous Phase
Fat Phase