The Functionality of Soy Protein Concentrate in Canned Luncheon Meat

G. R. SCHMIDT[1], W. J. MEANS[1], D. F. HERRIOT[2] and B. F. MILLER[1]

[1]Department of Animal Sciences, Colorado State University, Fort Collins, Colorado 80523, U.S.A.

[2]A. E. Staley Manufacturing Company, P.O. Box 151, Decatur, Illinois 62525, U.S.A.

INTRODUCTION

Non-meat proteins have been utilized for many years in processed meat production. These proteins are predominently derived from the soybean and cow's milk (Roberts, 1974; Endres, 1981). The non-meat protein is utilized to enhance water and fat binding properties in one of two main ways. It may be mixed or chopped directly with all of the ingredients of a sausage batter or it may be chopped with water and fat to form a "rind/fat emulsion" system which is then mixed with the lean meat tissue.

Previous reports (Sofos et al., 1977a, 1977b) tested emulsion stability in weiners when textured soy protein and soy protein isolate were substituted for lean meat. These authors found that greater than 25 percent hydrated textured soy protein substituted for lean skeletal beef appeared to cause problems with emulsion stability. Textured soy protein and soy protein isolate substitution for lean meat did not affect cooking losses, peeling and skin formation. Other reports in the literature deal with the use of soy protein of various types in wiener-type products (Cassens et al., 1975; Lin et al., 1975; Terrell and Staniec, 1975; Randall et al., 1976).

Literature on the functionality of soy proteins in "rind/fat emulsion" products is scarce. The objectives of this paper were to measure the effectiveness of added soy protein concentrate STA PRO 3200 (A. E. Staley Manufacuturing Company, Decatur, Illinois, U.S.A.) to retain fat and water in canned luncheon meat that was processed to pasteurization and sterilization temperatures. Additionally, light micrographs were prepared of the products in order to give some indication as to the mechanism of the water and fat binding functionality of soy protein concentrate in a blend of a "rind/fat emulsion" and a meat mince.

MATERIALS AND METHODS

The study compares the ability of 0, 2 and 4 percent of soy protein concentrate to retain fat and moisture in canned luncheon meat that contained either 1 or 2 percent NaCl.

The luncheon meat was heat processed to pasteurizing and sterilizing standards to determine the extent of deterioration caused by the more severe sterilizing heat treatment in this type of product and whether there would be any interactions between the severity of heat treatment and salt and soy treatments. The sterilizing process used in this study is a processing extreme, as nitrite containing products are usually processed to a shelf stable condition, (F_o=2.0-2.8) rather than to commercial sterility, (F_o=6.0) (Lechowich et al., 1978).

Chilled boneless pork legs and backfat were obtained from a local meat plant (Loveland Foods, Loveland CO, U.S.A.) and utilized within seven days post-mortem. The legs were trimmed of fat and separated into 90% lean (lean pork) and 50% lean (fat pork) portions. The luncheon meat was processed according to the specification as shown on table 1.

Table 1. COMPOSITION OF TREATMENTS (%)

Treatment	1	2	3	4	5	6
Emulsion:						
Soy Protein Concentrate	0	0	2	2	4	4
Water	20.5	20.3	20.1	19.9	19.7	19.5
Pork Backfat	31.8	31.5	31.1	30.9	30.6	30.3
Mince Mix:						
Salt	1.0	2.0	1.0	2.0	1.0	2.0
Sodiumtripoly phosphate	0.5	0.5	0.5	0.5	0.5	0.5
Lean pork	30.8	30.4	30.2	29.9	29.6	29.2
Fat pork	15.4	15.2	15.1	14.9	14.8	14.6
Total	100	100	100	100	100	100

Appropriate "rind/fat emulsions" were prepared by chopping one of three levels of soy protein concentrate and water with pork backfat in a 35 liter Meissner silent cutter (RMF Steel, Kansas City, MO) that had provision for knife speed control, bowl speed control, bowl revolution count, continuous temperature monitoring and vacuum chopping. Advantage was taken of these features to process under vacuum to a constant degree of mechanical working end point: knife speed 4,000 rpm (6 blades, 32 cm diameter), bowl revolutions at 8.33 rpm, vacuum 0.78 bar until a temperature of 12°C was reached.

The fat pork and lean pork were minced through a 0.42 cm plate and mixed with appropriate levels of salt, sodium tripolyphosphate and enough water to dissolve the phosphate in a Keebler Model No. 238 mixer (37.5 kg capacity) under vacuum for three minutes.

The minced meat mix was remixed with the emulsion under vacuum for three minutes. Each treatment was replicated three times.

The luncheon meat was stuffed into 301 x 401 cans and closed under vacuum at a closing weight of 556 ± 3 gm. The cans were divided into two batches, one for pasteurizing and the other for sterilizing. Two cans in each batch were fitted with thermocouples monitoring the center temperature. The pasteurized cans were processed in 76.5°C water, stirred by bubbling air through it, to an end point of $F^5_{65.6}$ = 15. The sterilized

cans were processed in steam at 115.6°C to an end point of F_o = 6.0. The amount of processing was determined by the integral calculation method (Geankoplis, 1978) as processing proceeded using an appropriately programmed calculator and processing was terminated and cooling started in time to give the desired end point. The sterlized cans were cooled under pressure. The cans were removed to the 4°C cool room once the center temperature dropped below 50°C and were held there for a minimum of 15 hours before analysis.

Analyses

Three cans from each replicate of each treatment were opened and permitted to drain ot free liquid. The total weight and the weight of the contents minus separated liquid were recorded. Visible fat was scraped from the contents and the weight of the can contents minus separated liquid and fat were recorded.

Micro structure

Cans of product from the 2% salt treatment of the second replicate were selected from each treatment for histological analyses. Cubes of sample 1 cm per side were frozen on the quick freeze stage of a freeze microtome at -20°C. Sections were cut 16μ thick and attached to gelatin dipped slides by touching the cold slide to the section resting on the knife and then air dried at room temperature for 24 hours. They were stained in Mayer's Hematoxylin pH 3.4, Phloxine B and safran to visualize the proteins. Cover slips were attached with Permount.

Statistical Analyses

This experiment was of a randomized complete block design with 3x2x2 factorial (3 soy levels, 2 salt levels, 2 cooking mthods) treatment combinations. Data were submitted to the SPSS program (Nie et al., 1975) and analyzed via one-way analysis of variance. Mean separations were accomplished using Least Signifiant Difference.

RESULTS AND DISCUSSION

The analysis of variance showed no effect due to level of salt. Therefore, all results were pooled for both levels of salt. The effect of three levels of soy protein concentrate on liquid retention in pasteurized and sterilized canned luncheon meat is shown in figure 1. The pasteurized product retained more moisture than the sterilized product at all levels of soy addition. The addition of 4% soy protein concentrate enhanced liquid retention in the pasteurized product. The addition of 2% soy protein concentrate retained more liquid than the addition of no soy protein concentrate and the addition of 4% soy protein concentrate retained more liquid than the addition of 2% in the sterilized product. The effect of the levels of soy protein concentrate

THE EFFECT OF 3 LEVELS OF SOY PROTEIN CONCENTRATE ON LIQUID RETENTION IN PASTEURIZED AND STERILIZED CANNED LUNCHEON MEAT

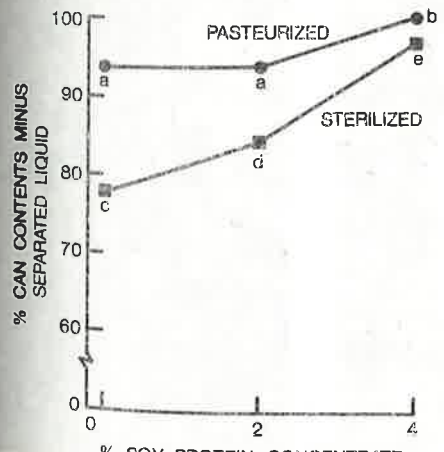

Figure 1

THE EFFECT OF 3 LEVELS OF SOY PROTEIN CONCENTRATE ON LIQUID AND FAT RETENTION IN PASTEURIZED AND STERILIZED CANNED LUNCHEON MEAT

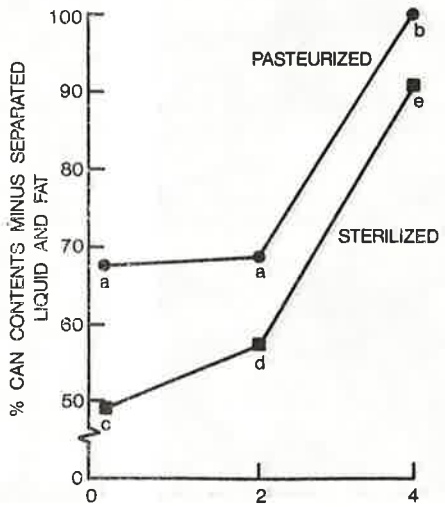

Figure 2

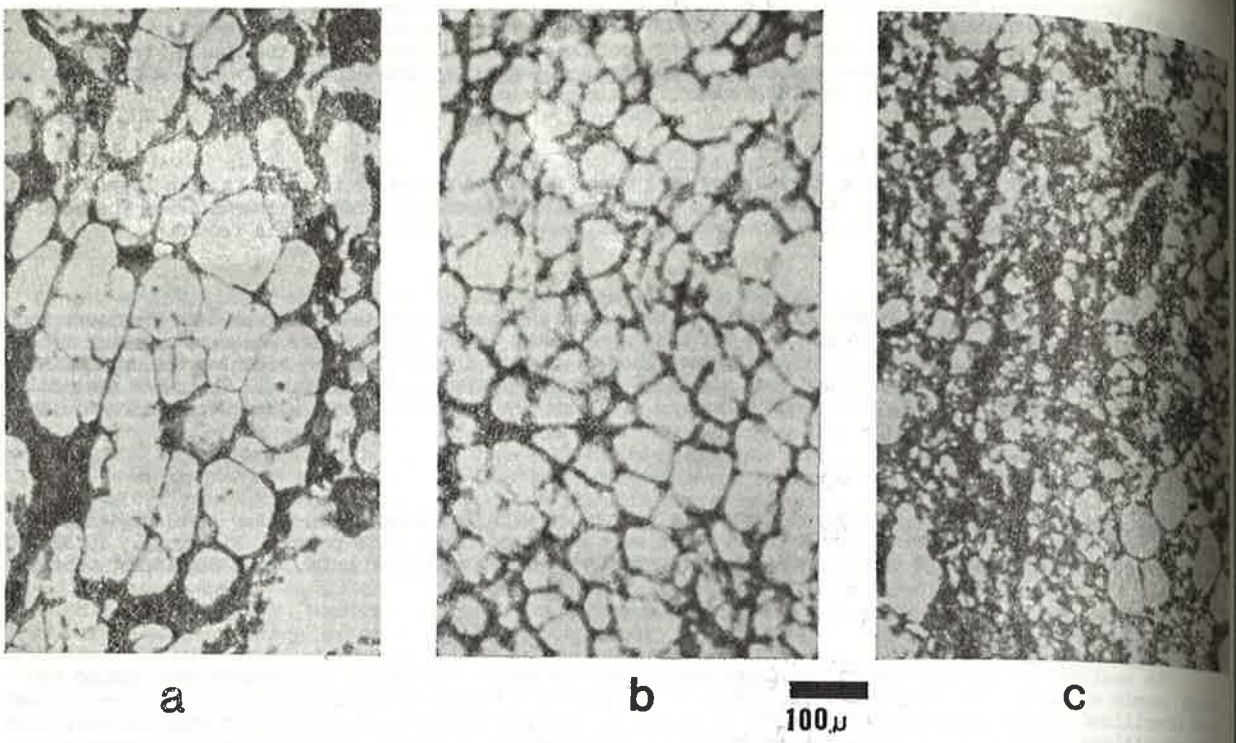

Figure 3

LIGHT MICROGRAPHS OF PASTEURIZED CANNED LUNCHEON MEAT THAT CONTAIN EITHER 0, 2 OR 4% SOY PROTEIN CONCENTRATE.
A=0% B=2% C=4%

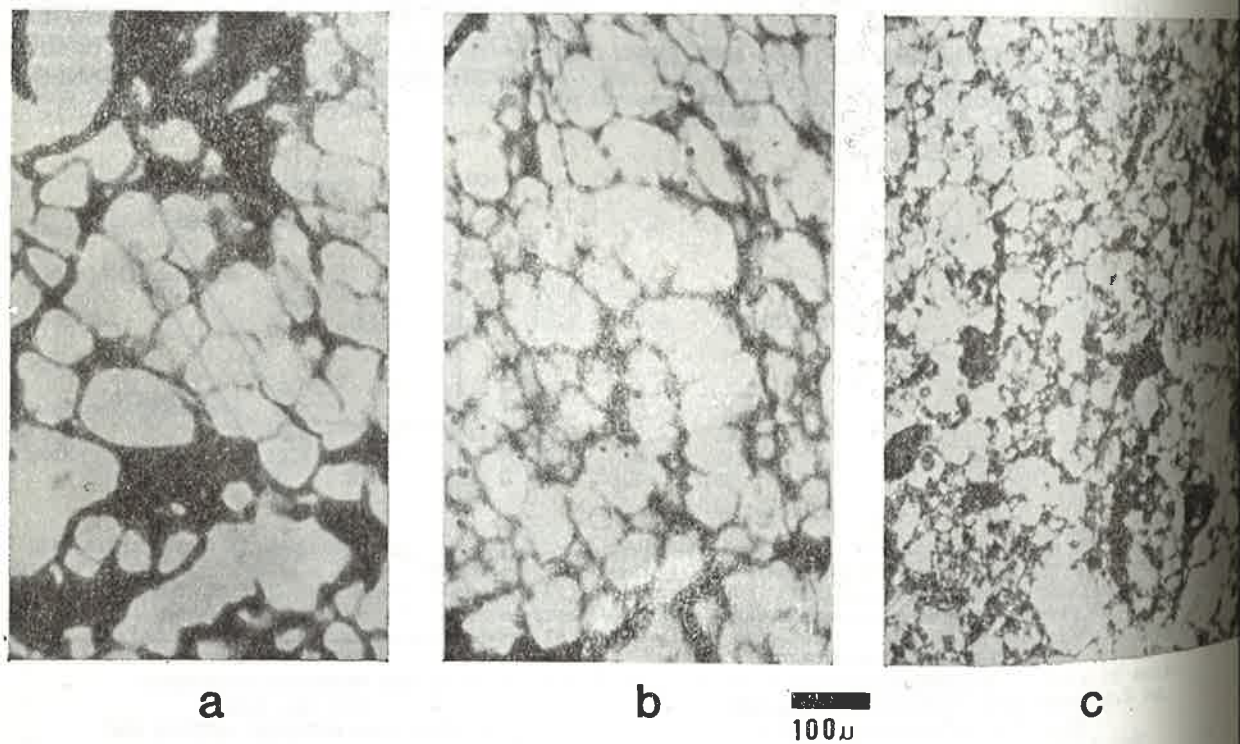

Figure 4

LIGHT MICROGRAPHS OF STERILIZED CANNED LUNCHEON MEAT THAT CONTAIN EITHER 0, 2 OR 4% SOY PROTEIN CONCENTRATE
A=0% B=2% C=4%

addition on liquid and fat retention in pasteurized and sterilized canned luncheon meat is shown in figure 2. The results are similar to those observed for liquid retention only. The pasteurized product retained more fat and moisture than did the sterilized product. The addition of 4% soy protein concentrate greatly enhanced the fat and liquid retention in both pasteurized and sterilized canned luncheon meat. The increase of soy protein concentrate from 2 to 4% resulted in a change in the percent canned contents minus separated liquid and fat from 69 to 100% in the pasteurized product and from 57 to 91% in the sterilized product. This is a clear indication that soy protein concentrate acts effectively at an appropriate level to retain fat and moisture in heat processed luncheon meat.

The light micrographs, as shown in figure 3, give some indication as to the function of soy protein concentrate in enhancing the fat and moisture binding ability of a pasteurized canned luncheon meat. Photos A, B and C were all made at similar settings and magnification levels. It is clear to see that when no soy protein concentrate is used, the protein matrix is inadequate to entrap small droplets of fat and moisture. As the soy protein concentrate is increased to the 2% level, the fat droplets tend to decrease slightly in size and the protein matrix becomes somewhat thicker. It becomes very clear in micrograph C of figure 3 that the addition of 4% soy protein concentrate greatly contributes to the formation of an optimum matrix to entrap fat and moisture in the canned luncheon meat.

When the product is further heat processed to sterilization, as shown in figure 4, the general appearance does not differ greatly from the pasteurized product. The protein matrix increases in quantity as the level of soy protein added is increased from 0, to 2, to 4 percent. However, it appears that there is some destruction of the protein matrix at all levels due to the severe heat processing. This is shown in figure 4a as a broken and indistinct matrix surrounding the fat and water droplets. Future research may determine whether some proteins are more resistant than others to being broken down by severe heat processing.

CONCLUSIONS

General conclusions to be made from this work are that when soy protein concentrate is added at an appropriate level to canned luncheon meat by being chopped into a fat/rind emulsion, this soy protein concentrate acts effectively to entrap fat and moisture during heat processing. The entrapment of the fat and moisture appear to be implemented by the soy protein concentrate surrounding tiny fat and moisture droplets. When adequately dispersed, this soy protein concentrate is heat set by processing and retains the fat and moisture within the product. Considerable economic efficiencies can be gained by incorporating soy protein concentrate into high fat and water luncheon meats that must be severely heat processed.

REFERENCES

Cassens, R. G., Terrell, R. N. and Couch, C. 1975. The effect of textured soy flour particles on the microscopic morphology of frankfurters. J. Food Sci. 40:1097.

Endres, J. 1981. Overview - Meat extender utilization. Proc. of the Meat Industry Research Conference p. 103. American Meat Institute Foundation, Arlington, VA.

Geankoplis, C. J. 1978. "Transport Processes and Unit Operations," p. 253 Allyn and Bacon Inc., Boston, MA.

Lechowich, R. V., Brown, W. L., Diebel, R. H. and Somer, I. I. 1978. The role of nitrite in the production of canned cured meat products. Food Technol. 32:45.

Lin, M. J. Y., Humbert, E. S., Sosulski, F. W. and Card, J. W. 1975. Quality of wieners supplemented with sunflowers and soy products. Can. Inst. Food Sci. Technol. J. 8:97.

Nie, N. H., Hull, C. H., Jenkins, J. G., Steinbrenner, K., Bent, D. H. 1975. Statistical package for the social sciences. Second Ed. McGraw Hill Book Co., NY.

Randall, C. J., Raymond, D. P. and Voisey, P. W. 1976. Effect of various animal and vegetable protein materials on replacing the beef component in a meat emulsion system. J. Inst. Can. Sci. Technol. Aliment. 9:216.

Roberto, L. H. 1974. Sausage Emulsions and Functionality of non-meat proteins in perspective. Proc. of the Meat Industry Research Conference p. 43. American Meat Institute Foundation, Arlington, VA.

Sofos, J. N. and Allen, C. E. 1977a. Effects of lean meat source and levels of fat and soy protein on the properties of wiener-type products. J. Food Sci. 42:875.

Sofos, J. N., Noda, I. and Allen, C. E. 1977b. Effects of soy proteins and their levels of incorporation on the properties of weiner-type products. J. Food Sci. 42:879.

Terrell, R. N. and Staniec, W. P. 1975. Comparative functionality of soy proteins used in commercial meat food products. J. Am. Oil Chemists' Soc. 52:2204.