Sauces for Herring

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ABSTRACT

Lauer, B.H. and M.C. Murray. 1978. Sauces for Herring. Fish. Mar. Serv. Indus. Rep. 100 : 19 p.

Heat stable sauces suitable for canning with herring have been developed. These sauces are similar to the types prepared in some European countries, but spiced to suit the European and Canadian preferences. This report describes the cooking of the herring, prior to canning, the role of thickening agents and emulsifiers. It details the processing of canned herring in sauces and the preparation of various sauces. Sauces described compared favorably in taste, texture, stability with commercially available domestic and imported products.

Key Words: Herring, canning, sauces emulsifiers

RÉSUMÉ

Il existe maintenant des sauces stables à la chaleur, destinées aux conserves de hareng. Ces sauces ressemblent à celles qui sont préparées dans certains pays européens, mais elles sont épicées selon les gôuts européens et canadiens. Le présent rapport décrit la cuisson du hareng, préalable à la mise en conserve, et le rôle des agents épaississants et émulsifiants. Il décrit en détails la mise en conserve du hareng en sauces et la préparation des diverses sauces. Ces sauces se comparent avantageusement, par le gôut, la texture et la stabilité, aux marques accessibles sur le marché ici-même et à l'étranger.

INTRODUCTION

Herring in sauces have been available in the European and especially the German markets for many years. With the increasing emphasis on the food use of herring from the Canadian fishery the herring in sauce type of product has become of more interest to the Canadian industry.

To evaluate raw material variations, effects of handling and processes, it is necessary to be able to put together a completed product. Since the composition of the sauces used commercially are proprietary information, it was necessary to formulate some that could be used for process evaluation studies.

This report describes the development and testing of several recipes for sauces to be used in canned herring fillet evaluations. This work was done in 1972 in the Technical Services Section in Halifax and is published to make it available to the industry and others who may have an interest in canned herring products.

NOTE ON RESPONSIBILITY

Manufacturers' names are provided in this report to identify materials that were used during the course of this investigation. In most cases, the products were identified to manufacturers who advertised in the journal Food Product Development. The authors and the Government of Canada wish to emphasize that because certain manufacturers' names and products are mentioned, this does not imply unofficial or official endorsement of these manufacturers or products. The authors are fully aware that most products mentioned are available through several competing manufacturers, and needless to say, time nor facilities were available to test the many substitutes that were available. Due to the wide variations in the physical and chemical properties in various manufacturers' products, it is also important to note that the formulae and recipes elucidated in this report will have to be modified in order to be able to substitute other manufacturers' ingredients and obtain a similar product.

MATERIALS AND METHODS

PRE-COOKING HERRING FILLETS

The following pages describe two experiments which were conducted to determine the optimum pre-cooking conditions for herring fillets. The reasons for pre-cooking herring are as follows: (a) the process causes reduction of moisture in the fillets and a lower volume of extruded liquid in the retorted can, (b) the process causes the fillets to become more firm, and (c) the process heats the fish and hence enables the cans to be sealed without vacuum-sealing equipment prior to retorting.

It should be stated that these experiments were conducted using herring having a fat content of 6%. Different experimental figures would be obtained for herring having higher or lower fat contents. In order to obtain a firm textured product from fat herring, the fillets should be dipped in vinegar-brine solution consisting of the following ingredients:

Salt	10 lbs
Vinegar	1.2 gal (12 lbs)
Water to make	100 lbs

The fillets are placed in this dip for 20-30 min with occasional agitation, prior to pre-cooking.

The following experiments were conducted in a conventional steam box. In the first experiment, the herring fillets were pre-cooked in the same oval cans that would be used for canning. In the second experiment, the herring fillets were pre-cooked on open-mesh screens. The results indicated that (for herring fillets of 6% fat) pre-cooking the fillets for 20 min on open-mesh screens in a steam box caused the greatest liquid loss.

Experiment 1: Pre-cook losses and retort losses of thawed herring fillets pre-cooked in 13-oz oval cans

Thawed herring fillets (15 oz fill-in) were placed in 13 oz oval cans. The cans containing the fillets were pre-cooked in a steam cooker (212°F) for 0, 20, 40, and 60 minutes, respectively. Lots of 4 cans were subjected to each of these treatments. After the required pre-cooking time, the cans were removed from the cooker and they were placed upside-down on a screen to drain for 5 minutes. The weight losses incurred during the pre-cooking procedure were recorded and the losses were expressed as percentages of the fill-in weight. One lot of 4 cans was pre-cooked upside-down on a screen placed in the steam cooker. The results are tabulated in Table 1.

An average of 11% liquid (based on the fill-in weight) was lost in a 20-minute pre-cook. Pre-cooking the fillets upside-down for the same period of time resulted in a further 1% loss. A further 6% was lost by extending the pre-cooking period to 40 minutes, but a further 20-minute pre-cooking period only eliminated about 3% additional liquid. Curve A in Figure 1 shows the relationship between % moisture loss and time of pre-cook (mins).

The cans were sealed after addition of a 75 grain salt tablet. They were then placed in a retort and retorted for 115 min at 230°F. These conditions led to an F_0 value of 5.13. The cans were cooled and stored at room temperature for 5 days, after which they were all opened. The weight of extruded liquid was recorded after draining each individual can for 1 minute. These "Losses" were expressed as percentages of the pre-cook weight and were plotted versus pre-cook time. The results indicated a linear decrease in percentage of liquid "lost" (Curve B; Figure 1) as the pre-cooking time increased.

Curve C in Figure 1 shows the total percentage loss in moisture (based on the fill-in weight) expressed as a function of the pre-cooking time. This curve represents the sum of Curves A and B, using the Y-axis ordinates.

Experiment 2: Pre-cook losses and retort losses of thawed herring fillets pre-cooked on open-mesh screens

Thawed herring fillets (16-lb frozen fillet block thawed overnight in the coldroom) were

placed on an open-mesh screen (26½" x 33½"). The first block of fillets was pre-cooked (steam cooker) for 0, 10, 20, 40, and 60 minutes. Four lots (15 oz, each) were subjected to each pre-cook treatment. After the required pre-cooking time, the fillets on the screens were removed from the cooker, cooled for 5 min exposed to air, and were placed in a 13 oz oval can. The weight losses incurred during the pre-cooking procedure were recorded and the losses were expressed as percentages of the fill-in weight. The results are tabulated in Table 2. The second block of fillets was treated in exactly the same manner, except that the pre-cook times were 0, 5, 10, 15 and 20 minutes. Although conflicting results were obtained for the 10 and 20-minute pre-cook periods for the fillets from the first and second frozen blocks, the results indicated that maximum extrusion (20-25%) occurred after a 20-minute pre-cook on open-mesh screens. Reference to Table 1 in Experiment 1 will indicate that it took a pre-cooking period of 60 minutes in the can to achieve the same degree of fluid loss. Curve A in Figure 2 shows the relationship between % liquid loss and time of pre-cook (min).

The cans were sealed after addition of a 75-grain salt tablet. They were then placed in a retort and retorted for 115 min at 230°F. These conditions led to an F_0 value of 5.13. The cans were cooled and stored at room temperature for 5 days, after which they were all opened. The weight of extruded liquid was recorded after draining each individual can for 1 minute. These "losses" were expressed as percentages of the pre-cook weight (Table 2) and were plotted, versus pre-cook time (Curve B, Figure 2). The fluid "losses" were also expressed as percentages of the fill-in weight (15 oz) (Table 2).

The liquid drained from each of the 4 lots of canned fillets was combined and fat determinations (Babcock method; duplicate determinations) and moisture determinations (oven method; 18 h, 80°C; single determinations; 10-g samples) were performed on the composite sample for each pre-cook time. It was assumed that the difference between the sum of % fat and % moisture, and 100% represented the % protein. These values, in addition to the ratio % moisture : % fat, are tabulated in Table 3.

RECIPES FOR BASIC WHITE SAUCES

The recipes used during the course of this investigation are elucidated in this section. Early work on sauces made use of the National Starch Recipe. The major drawback of this recipe is that the formulation has a high concentration of milk. This is undesirable in a retortable white sauce, since the whey proteins α-lactalbumin and β-lactoglobulin are extremely heat-sensitive and are likely to coagulate (see section on Milk Powder). A satisfactory sauce was obtained when all the ingredients (except butter) were placed in a Ronson Heated Stirrer-Blender along with cold water. The mixture was then heated for 5 min at 190°F to allow gelation, after which the butter was added. The reader will find various considerations in the choice of starches discussed in the section on Milk Powder.

The second recipe was supplied by the A.E. Staley Mfg. Company. This recipe was not tried experimentally. The authors feel, however, that the low milk solids content make this an ideal recipe. An interesting aspect of this formulation is the homogenization step which in conjunction with emulsifiers, should aid in the dispersion of the oil in water. There, this recipe is provided for the reader's perusal and information.

The third recipe was a formulation developed by the authors, and which was adopted for the line of sauces proposed in the section on Method for Canning Herring with Sauces. Because of the low amount of vinegar and sugar, it was felt that this basic recipe would appeal to Canadian or North American tastes. The fourth recipe which was also adopted for use and higher levels of vinegar and sugar, and had a "tartness" characteristic of German and other European sauces. The third recipe had 6% starch, distributed equally between wheat flour and Clearjel (modified starch). Wheat flour serves to whiten a sauce to a greater degree than a modified starch. Wheat flour does not impart a translucency or sheen to the sauce which sometimes is observed when modified starches are exclusively used. On the other hand, modified starches are more resistant to breakdown during retort operations. Thus, it was desirable to compromise and use equal amounts of the two starches. It will be noted that the amount of milk used in this recipe is considerably lower than that used in the National Starch Company Recipe.

The fourth recipe is typical of a German or European sauce and is provided as an alternative to the third recipe.

All of the formulations can be flavoured with spices and natural or synthetic flavours. Detailed recipes are elucidated in the section on Method for Canning Herring with Sauces. The factors involved in emulsifier selection are discussed in the section on Emulsifiers.

Recipe No. 1

National Starch and Chemical Co. (Canada) Ltd.*

Medium White Sauce

Butter or shortening	7.0%
Clearjel	5.0%
Milk	61.2%
Salt	0.2%
Pepper (to taste)	
Dry milk solids (non-fat)	2.6%
Water	24.0%

Preparation

Heat the milk and milk solids to 190°F. Slurry water and starch, heat to 190°F for five minutes stirring constantly. Add seasoning and then butter.

Above can be varied in the following manner:

1. Whole milk powder and water for milk.
2. Fat-free skim milk powder and water plus additional shortening for milk.
3. Seasonings such as: (a) MSG, (b) celery salt, (c) onion salt, etc., may be used to suit individual taste preferences.

* Address: 2125 Remembrance Road, Lachine,

Quebec. The following statement appears on National Starch's original Technical Service Bulletin: "Our Service engineers are available to help purchasers obtain best results from our products, and recommendations are based on tests and information believed to be reliable. However, since we have no control over the conditions under which our products are transported to, stored, handled, or used by, purchasers, all recommendations and sales are made on condition that we will not be held liable for any damages resulting from their use. No representative of ours has any authority to waive or change this provision."

Recipe No. 2

A.E. Staley Mfg. Company*

Retorted White Sauce

(A)	Water	83.30%
	Milk solids non-fat	3.10%
	Salt	1.00%
	Asmus white pepper	0.20%
	Asmus nutmeg	0.15%
(B)	Butter	7.00%
	Emulsifier	0.10%
	Staley STA-SOL lecithin conc. -BF	0.05%
(C)	Staley THIN-N-THIK^{TM} 65 starch	3.80%
	Soft wheat flour	1.30%

Procedure

1. Blend ingredients (A) and heat to 125°F.
2. Melt (B) and add to (A) with good agitation.
3. Homogenize at 2500 psi.
4. Add thickeners (C).
5. Fill cans, seal, and retort at 260°F to $F_o = 6$.

TM - Trademark A.E. Staley Mfg. Co.

Special notes

1. Process must be confirmed by a canning industry laboratory.
2. Recommend Tween 60 or 80 as emulsifier.

* Address: Decatur, Illinois 62525, U.S.A. The following statement appears on Staley's original Technical Service Bulletin (B78 571): "The foregoing example illustrates a formula or process which is believed to be satisfactory for general use. We make no warranty or representation of any kind, expressed or implied, in regard to this formula. The formula is offered for your consideration, investigation and verification.

Our furnishing this example should not be construed as a recommendation or authorization to infringe any patent. Also, no chemical or material should be used as or in a food or in a product or process in which it may contact a food until you have determined the safety and legality of its use."

Recipe No. 3

Experimental Formulation

White Sauce

Soya oil	7.0%
Vinegar	1.5%
Wheat flour	3.0%
Modified starch (Clearjel)	3.0%
*Milk (whole)	16.0%
Butter	1.0%
Sugar	1.0%
Water	67.5%
Salt	1.0%
** Spices and emulsifiers	(variable)

* Whole milk powder and additional water for milk. See section on Milk Powder for detailed discussion.

** Emulsifiers are discussed in a later section. The spices used to attain the correct flavour are elucidated in the section on Method for Canning Herring with Sauces.

Recipe No. 4

Experimental Formulation

White Sauce Formulation
(German-Type Recipe)*

Soya oil	15%
Vinegar	10%
Wheat flour	2%
Modified starch (Clearjel)	2%
Skim milk solids	2%
Sugar	5%
Water	60%
Salt	2%
Emulsifier	2%

* This recipe was based on recipes suggested by Atkinson (1) in a previous report. However, the present authors have modified it somewhat, mainly with the introduction of modified starch. The used of appropriate modified starches greatly improves the retorting characteristics of the sauce.

STARCHES

Preliminary experiments utilized the Medium White Sauce formulation suggested by the National Starch and Chemical Company (See section on Recipes). The requirement for "Milk" (61.2%) was satisfied by substitution of spray-dried whole milk powder (7.65%) and water (53.55%).

It was found that the sauces prepared as per National's Technical Service Bulletin were too thick. Therefore, after experimentation the level of Clearjel was reduced from 5% to 4% with a corresponding increase of water from 24%-25%. The authors discovered that it was extremely important to add the starch to cold water prior to heating the sauce to 190°F. In this way, the

starch was dispersed resulting in a smooth slurry prior to gelation. Addition of starch to hot water resulted in severe lumping as soon as the starch made contact with the liquid surface.

The manufacturer claims that Clearjel S has superior retorting properties to Clearjel. Notwithstanding this aspect, it was found that a level of 2.5% Clearjel S was sufficient to attain roughly the same viscosity as 4% Clearjel, using the same formulation. The amount of water was adjusted accordingly.

Another starch, Textaid, was tried in place of Clearjel. This starch imparts a characteristic "pulpy" or "grainy" appearance to a product in which it is used. The sauce made with 3.5% Textaid had these characteristics, but upon cooling and reheating, liquid separation was noticed -- a phenomenon known as "syneresis". The manufacturer has suggested that a ratio of 3 parts Textaid to one part Clearjel might produce a more stable product. Staley's Thin-N-Thik 65 Starch probably could be used in formulating sauces; however, this starch was not employed as a substitute in this formulation, nor was the recipe suggested by Staley employed.

The main requirements of a starch for use in this application are: (a) that it be able to tolerate the high temperatures of the retort process; (b) that it maintain its viscosity, sheen, and colour both during the retort process and during prolonged storage; (c) and that it not exhibit any tendency to set to a gel or curdle upon cooling after the retort process. Starches that do set to a gel or curdle invariably exhibit liquid separation on storage.

Specifications for Clearjel*

A modified waxy maize food starch with application in canned foods, bakery products and specialty items.

Grades

Clearjel, Powdered
Clearjel, Pearl
Clearjel, Sterilized - meets National Canners Association standards for thermophilic bacteria.

Physical properties

Colour - white
Form - powder or pearl
Moisture - approximately 11%
pH - approximately 6

Cooked starch properties

Aqueous preparations are smooth, short-textured, heavy-boiled, stable, and will not set to a gel. The viscosity characteristics of this starch are little influenced by variations in pH; Clearjel provides good tolerances when used under high temperature - low pH conditions. This starch is bland with essentially no cereal or starchy taste.

Retorted properties

Clearjel is resistant to breakdown at high temperatures. In retorted products, it provides high viscosity, good sheen, good colour, excellent stability - has little or no tendency to set to a gel but remains smooth even after standing for long periods of time.

Shelf-life stability

Excellent shelf-life of canned foods. Two years or more shelf-life is possible. Canned products retain smooth texture. No liquid separation. No evidence of curdling. No evidence of set-back or stacking in cans.

Use in acid foods

Clearjel has a smooth, short texture when used in highly acid (low pH) foods. It is highly resistant to breakdown when cooked in a low pH medium and has no tendency to become cohesive. It provides good clarity, colour and sheen. Clearjel has no tendency to set to a gel.

Application

Bakery Products: Clearjel is used universally in bakery fruit pie fillings.

Canned Foods: This starch provides excellent shelf-life and high quality when used in -

cream style corn
pork and beans
canned soups
canned sauces and gravies
canned dinner products
baby foods

* "Clearjel" is the registered trademark of a product produced by National Starch and Chemical Corporation, 750 Third Avenue, New York, N.Y. 10017, U.S.A. The information reprinted here originally appeared in Bulletin No. 244 of the above company. The following statement appears in National's original Technical Bulletin: "The information given and the recommendations made herein are based on our research and are believed to be accurate but no guarantee of their accuracy is made. In every case we urge and recommend that purchasers before using any product in full scale production make their own tests to determine to their own satisfaction whether the product is of acceptable quality and is suitable for their particular purposes under their own operating conditions. The products discussed herein are sold without any warranty as to merchantability or fitness for a particular purpose or any other warranty, express or implied. No representative of ours has any authority to waive or change the foregoing provisions but, subject to such provisions, our engineers are available to assist purchasers in adapting our products to their needs and to the circumstances prevailing in their business. Nothing contained herein shall be construed to imply the non-existence of any relevant patents or to constitute a permission, inducement or recommendation to practice any invention covered by any patent, without authority from the owner of the patent."

Specifications for Clearjel* S

Clearjel S is a modified starch derived from waxy maize with application in canned foods and specialty items.

Physical and chemical properties

Colour - white to off-white
Form - powder
pH - 6.0 approximately
Moisture - 11% approximately

Cooked starch properties

Clearjel S water "cooks" are smooth, short-textured, heavy-bodied, stable, and are resistant to "setback". Clearjel S maintains high viscosity, excellent texture, and hydrating power when used under high temperature conditions.

Retorted properties

Because of the above mentioned tolerances, Clearjel S is used to advantage in retorted products. It provides high viscosity, good sheen, good colour, excellent stability; has little or no tendency to set to a gel; and remains smooth even after standing for long periods of time.

Shelf-life stability

Excellent shelf-life of canned foods. Properly processed foods retain a smooth texture with no liquid separation and no evidence of curdling.

Applications

Cream style corn: helps produce smooth textured, noncurdled product with excellent colour and brightness.

Canned sauces and gravies: provides creamy textured products without "setback" or syneresis.

Canned dinner products: maintains viscosity and texture of product even after extended storage.

Marshmallows: permits firm but tender texture with increased shelf-life.

Grades

Clearjel S - Powdered
Clearjel S - T.F., - Powdered - meets the National Canners Association standards for thermophilic organisms.

* See footnote, p. 4. The information reprinted here originally appeared in Bulletin No. 255.

Specifications for Textaid*

A "Food Starch-Modified", refined from corn with a unique textural character.

Physical properties

Colour - white to off-white
Form - coarse powder (mostly 12 to 100 mesh)
Moisture - approximately 8%
pH - approximately 6

* See footnote, p. 4. The information reprinted here originally appeared in Bulletin No. 255.

Cooked-starch properties

Aqueous preparations are heavy-bodied with a unique "pulpy" texture. This desirable "pulpy" or "grainy" character is retained even on extended retorting in both high and low acid foods. Textaid swells in cold water but requires moderate heating (approximately 150°F.) for full development of texture.

Shelf-life stability

Textaid preparations retain their "fresh packed" natural appearance over extended periods on the shelf. Some liquid separation may be observed on storage but in some applications this is considered desirable because it is typical of homemade preparations.

If greater stability is desired including complete elimination of syneresis, it is suggested that a specialty, modified waxy maize starch be added, such as Col-Flo 67, Hi-Flo, or Clearjel. Many manufacturers have found that a ratio of 3 parts of Textaid and one part of Hi-Flo, for instance, produced a very stable product.

Applications

Tomato products: Textaid helps retain "true tomato" character and a rich, "pulpy" appearance in tomato, spaghetti, pizza, sauces, etc. This affords a marked increase in both eye appeal and mouthfeel.

Fruit products: when cooked in fruit juices, Textaid produces sauces which simulate the natural texture of crushed fruit. Because of its stability, under low pH and high temperature conditions, Textaid can be used with fruit juices to make excellent donut and turnover fillings without the problems inherent in using fresh or frozen fruit.

Drinks: when used at low levels, Textaid enhances the natural "real fruit" texture of fruit drinks such as orange and pineapple.

Cereals: when used in "instant", hot cereals, Textaid helps provide a desirable mouthfeel. The Textaid particles remain discreet even after adding hot water or hot milk and the undesirable pasty character associated with some hot, instant cereals can be avoided.

Baby foods: Normally, the processing of such products destroys the natural texture of fruit and vegetable components. The use of Textaid helps maintain texture for both appearance and mouthfeel. Unlike the fibrous, cellulosic material present in vegetables and fruits which must be strained for baby foods, the pulpy Textaid can be digested by salivary enzymes.

Suggested processing and handling

Because Textaid is so unique and presents such an entirely different concept in the use of starches, it generally must be handled differently. We have found that Textaid works best when the following addition methods and handling procedures are observed:

Add dry Textaid to the cold portion of the product before cooking or slurry Textaid

with an excess of water so that the slurry is low enough in viscosity to permit pumping.

In addition, Textaid could be added to an oil phase (if present) or to any nonaqueous system prior to adding to the total formula.

We do not recommend adding Textaid with a conventional cook-up starch slurry. Textaid should not be subjected to a milling or grinding operation as this will reduce its textural effect. We do not advise adding dry Textaid to a hot mix as some lumping may occur.

Formulas

There are many other applications for this unique product not mentioned here. Formulations for many of the above applications and other types of products are available on request.

Specifications for Thin-N-Thik* 65 Starch

Staley's Thin-N-Thik 65 is a new modified tapioca starch created specifically for use in canned foods formulated at near neutral pH, 4.0-6.5.

This starch is characterized by a controlled, thin-to-thick viscosity change which occurs during retorting. Relatively thin through pre-cooking and filling, it reaches a desired thick viscosity by the end of the retort cycle. This thin-to-thick phenomenon allows rapid heat penetration into the can during retorting. In most applications, Thin-N-Thik 65 requires less time to achieve a given sterilization value (F_0) than other commercial starches, producing a finished product with excellent color, flavor, texture, and stability, all at a lower processing cost.

Typical Analysis	Thin-N-Thik 65
Form	Powder
Moisture, %	11.5
pH (10% soln.)	6.0
pH Use Range	4.0-6.5
Viscosity (Brookfield RVT @ 20 rpm, 5% dsb.)	
Primary Cook (to 190°F), cps	100-300
Secondary Cook (post retort), cps.	4000-6000

Applications

In developing formulas for new canned products, Thin-N-Thik 65 should be incorporated as any conventional starch. When used to replace an established starch, simply substitute Thin-N-Thik 65 on a pound-for-pound basis. For full realization of its thin-to-thick behavior, Thin-N-Thik 65 must be the only thickener used and the products themselves must allow thermal convection within the can.

Staley Thin-N-Thik 65 is recommended for use in continuous retort systems where the pH range of the product is compatible with that of the starch. Thin-N-Thik 65 performs well in near neutral pH systems, such as cream sauces, gravies, soups, and puddings.

* "Thin-N-Thik" is the registered trademark of a product produced by A.E. Staley Mfg. Co., 2200 East Eldorado St., Decatur, Illinois. 62525. The information reprinted here originally appeared in Bulletin TDS No. 233-177050 of the above company.

To adapt Thin-N-Thik 65 to your formulation, retort times and/or temperatures must be adjusted to compensate for a more rapid heat penetration. The internal can temperature necessary to reach full viscosity development of Thin-N-Thik 65 will vary from 215°-235°F depending on the pH of the food system and the physical characteristics of the product being processed.

Due to a very rapid rise in internal can temperature during retorting, products containing Thin-N-Thik 65 can be overprocessed (maintained too long at a high temperature). Under all pH conditions, overprocessing causes some deterioration of finished product color, flavor, and texture prior to a breakdown in viscosity. When overprocessing occurs under near neutral conditions, viscosity breakdown is less severe.

MILK POWDER

Whole milk powder was used in the present sauce work in place of fluid whole milk. There is no reason why skim milk solids cannot be used as a replacement for whole milk, provided that when reconstituted, additional butter is used to adjust the butterfat content from 0.5% (or less) to 3.5%. Skim milk powder has the advantage of being more easily dispersed than whole milk powder. However, since these sauces are heated to cooking temperatures, whole milk powder is acceptable, provided that there is adequate agitation. Listed below are the fat contents of milk and its products, available in Nova Scotia:

	Butterfat (%)
Cream (whipping)	32-35
Blend (coffee)	11-13
Homogenized (Fluid Whole Milk)	3.5
"Two-percent"	2
Skim	<0.5%

In the preparation of sauces, several factors related to the milk component must be taken into consideration:

a) homogenized (pasteurized) milk is more viscous than pasteurized milk due to a larger proportion of milk proteins absorbed because of the much larger surface area of the fat globule membrane (4);

b) there is a much greater chance of rancidity developing in homogenized milk due to the larger exposed surface area of the fat globules (4);

c) homogenized milk curdles more readily than unhomogenized milk when used in cooked products (5) due to destabilization of milk proteins by the homogenization process. High temperature and low pH also lead to destabilization;

d) sauces made with homogenized milk show more fat separation than those made from unhomogenized milk (9);

e) the isoelectric point of casein, the major protein of milk, is 4.6. The isoelectric point of lactalbumin is roughly pH 4.5. The acidity of sauces should therefore be carefully controlled. At pH 4.6, casein will be precipitated (or

f) milk proteins, like other proteins, are subject to heat denaturation. Casein is relatively stable to heat (co-agulation times: 12 h at 100 C, 1 h at 135 C, and 3 min at 150 C (7) (8). The sauces described in the present report are heated to 85 C. At this temperature, gelation of the starch occurs. It is unlikely that clotting due to casein denaturation would cause problems associated with lump formation in the sauce. Alpha-lactalbumin and beta-lactoglobulin, the major whey proteins, are easily co-agulated by heat. For instance, Lowe (7) has stated that 83.4% of the albumins and globulins are co-agulated after heating at 80 C for 30 min. Thus, it is likely that co-agulation would be due to heat-denaturation of the whey proteins rather than due to heat-denaturation of casein.

EMULSIFIERS

As stated in the section on Pre-cook losses in herring fillets, herring are notorious for their high fat content. Extrusion of fat from the fish into the sauce can be expected during the retort process. This can lead to a product in which large globules of oil will be noticed floating on top of the sauce. It has been suggested by Atkinson (1) and others that homogenization of the sauce prior to canning would result in a smoother sauce with a minimum of separation. However, homogenization of the sauce will not prevent extrusion of oil from the fillets to the sauce during the retort phase; in fact, there is no physical method to ensure dispersion. The only two solutions are to use herring of a low fat content to start with, or to use an appropriate emulsifier. The emulsifier should be used in any case.

There are thousands of emulsifying agents from which to choose. Fortunately, the choice can be narrowed down considerably by making use of the "Hydrophilic-Lipophilic Balance System". The principle of this system is that a number is experimentally determined and assigned to the ingredient or combination of ingredients to be emulsified, and then an emulsifier or blend of emulsifiers is chosen having this same number.

The Hydrophilic-Lipophilic Balance (HLB) of an emulsifier refers to the balance of the size and strength of the hydrophilic (water-seeking, or polar) groups and the lipophilic (oil-seeking, or non-polar) groups of the emulsifier. A series of HLB numbers has been proposed extending from 1 to approximately 20. Lipophilic emulsifiers have an HLB number <9.0 and hydrophilic emulsifiers have an HLB number >11.0. Emulsifiers which are both lipophilic and hydrophilic are assigned numbers from 9-11. In general, it is probably safe to assume that having determined the "Required HLB" of the ingredients, an emulsifier having that same number and similar in chemical composition to the oil to be emulsified, would be the best choice. A booklet published by Atlas Chemical Industries (3) adequately describes the HLB System.

The required HLB of the final (Canadian) sauce recipe formulation was determined as per the instructions (2) furnished with the "Atlas HLB Kit". This kit consists of a series of emulsifiers of known HLB numbers. One merely adds each of these emulsifiers to a series of test emulsions (at a level of 2%). After agitation and a subsequent time period, the test emulsions are examined. The emulsion with the least separation is obviously the most stable, and the HLB number of the emulsifier used to effect this emulsion is noted. This figure corresponds to the required HLB. The chemical choice of emulsifiers is made when one is familiar with the fatty acid composition of the oil being emulsified. When the chemical choice is made, one then ascertains the correct level of emulsifier by experimentation.

The white sauce developed by this laboratory was used as the basis for the required HLB determination. The determination requires that oil and water solubles be separated. The quantities in the basic recipe were multiplied by 6 so that sufficient total formulation would be available for 9-50 cc test emulsions. The following formulations were made:

I. Oily materials

Soya oil	42.0 g	The oily materials represent 8.0% of the entire formulation.
Butter	6.0 g	
*Additional Butter	3.0 g	
Total Wt (I)	51.0 g	

II. Water-solubles

Vinegar	9.0 g	
Wheat flour	18.0 g	
Modified starch	18.0 g	The water-solubles represent 92.0% of the entire formulation.
*Skim milk solids	8.6 g	
Sugar	6.0 g	
Water	399.0 g	
*Additional water	84.0 g	
**Additional water	36.0 g	
Salt	6.0 g	
Total Wt (II)	584.6 g	

* Whole milk is ordinarily used in this recipe. For manufacturing purposes, and for most of the experimental trials in this laboratory, whole milk powder and additional water for reconstitution was used. In this experiment, since oily materials must be separated from water solubles, the milk requirement was divided up into the components of that requirement; namely, skim milk solids, butter and water.

** Since wheat starch and modified starch are not considered water-solubles, they were replaced by an equal weight of water.

Nine test tubes (50 cc) were placed in a test tube rack and to each tube was added the amount of oil phase (I) required to make 50 cc of the emulsion (4.0 cc). To each of the nine test tubes was then added 1.0 cc of each of the emulsifiers of known HLB numbers (2,4,6....18). The oil phase and emulsifier in each tube was then blended thoroughly by means of a Vortex laboratory mixer. The required amount of water phase (II) (with water-solubles dissolved) was then added in order to make a 50 cc emulsion (46.0 cc). Each test tube was then stoppered and shaken uniformly. The tubes were allowed to stand overnight and were observed and photographed the next morning (Figure III).

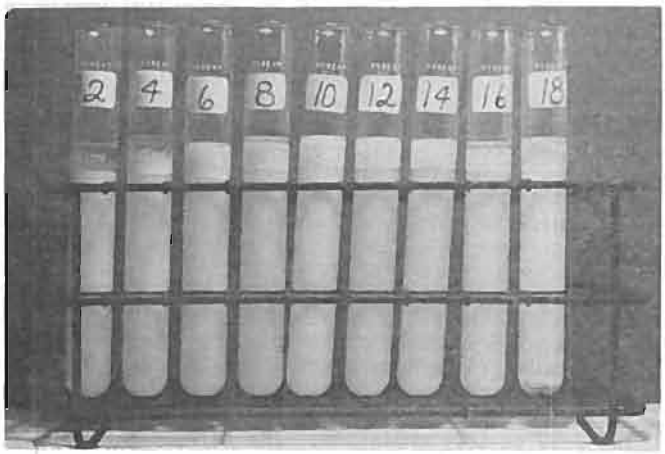

Figure III. Results of the emulsifier experiment. Note that the tube containing the test emulsifier having an HLB of 10 exhibited the best emulsification (i.e. the least oil separation).

The result was that the tube containing the emulsifier with a known HLB of 10 exhibited the best emulsification. Hence, for the sauce, the required HLB was 10.

Normally in canning, 4 oz (112 cc) of sauce are added to 9 oz of pre-cooked herring fillets prior to retorting. It has been observed that approximately 0.85 oz (23.8 cc) of liquid (composition of this liquid: 8.5% fat, 91.5% water + water-solubles) is extruded from the fillets into the sauce. Since in the above experiment, 50 cc test emulsions were used, then it can be assumed that approximately 0.425 oz (11.9 cc) of herring liquid would represent the amount of liquid normally extruded if 2 oz of sauce were added to a can.

Therefore, the above HLB experiment was repeated exactly as above, except that 12 cc of "extruded herring liquid" (obtained from a previous herring canning) was added to each tube in addition to the quantities of I and II mentioned above. The tubes were shaken and were observed and photographed after standing overnight (Figure IV).

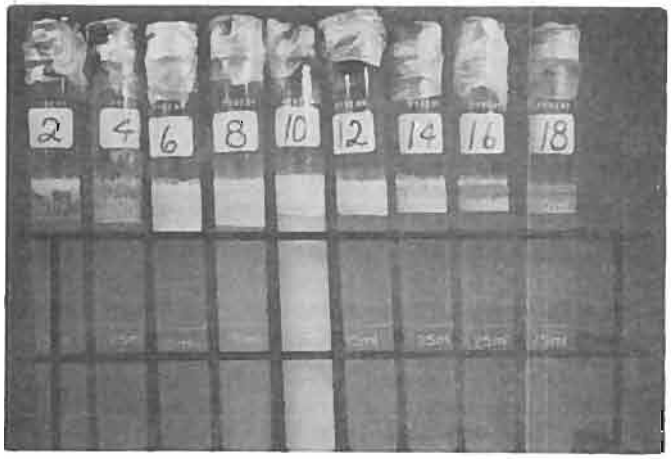

Figure IV. This experiment was a repeat of the experiment depicted in Figure III, except the same amount of herring oil that would be normally extruded was also added to each tube. Despite this, the tube containing the emulsifier with a known HLB of 10 still exhibited superior emulsification.

The result was that the tube containing the emulsifier with a known HLB of 10 still exhibited the best emulsification. Thus, the large range of emulsifiers was narrowed down to those with an HLB of 10.

In selecting the chemical type of emulsifier, one must consider the fatty acid composition of the oils being emulsified. Although this laboratory is not presently equipped to perform such analyses, the approximate composition of oils is documented in the literature. The major fatty acids of soybean oil are oleic acid (28%) and linoleic (54%). The major fatty acids of herring oil are oleic acid (21%), arachidonic acid (28%), and clupanodonic acid (23%). The major fatty acids of butterfat are palmitic acid (20%), stearic acid (20%), and oleic acid (24%) (6). From this discussion, it is apparent that the C_{18} fatty acids form a relatively large proportion of all three oils, and that an emulsifier with a large proportion of these fatty acids would theoretically provide optimum results in emulsification.

"Span" and "Tween" are tradenames for two emulsifiers manufactured by Atlas Chemical Industries. The former is a sorbitan fatty acid ester and the latter is a polyoxyethylene sorbitan fatty acid ester. Span 20 and Tween 20 comprise laurates (C_{12}), Span 40 and Tween 40 comprise the palmitates, Span 60 and Tween 60 comprise the stearates, and Span 80 and Tween 80 comprise the oleates. Thus a mixture of Span 80 and Tween 80, Span 60 and Tween 80, or Span 80 and Tween 60 would probably be appropriate. The Atlas HLB computing graph may be used to determine the percentage of each to be used in the Span-Tween mixture. The emulsifier mixtures are as follows (See graphs):

	% Span	% Tween
Span 60-Tween 80	48	52
Span 80-Tween 80	47	53
Span 80-Tween 60	45	55

The next step is to determine the minimum level of the Span-Tween mixture to be used to achieve satisfactory emulsification. When the previously described "Required HLB" experiment was repeated using 0, 0.25, 0.5, 0.75, 1.0, 2.0, and 3.0% levels of the Span 80-Tween 80 mixture, the results indicated that the 3.0% level led to the most satisfactory emulsification.

METHOD FOR CANNING HERRING WITH SAUCES

Sauce

(1) Weigh out sufficient ingredients according to the recipes which follow to make 4 oz of sauce per each 13-oz can of herring (100 g of each recipe yields roughly 3.56 oz of sauce).

(2) Add vinegar, milk powder, wheat flour, modified starch, salt sugar and cold water. Stir in a

Ronson Heated Stirrer-Blendor without heat to ensure dispersion (about 3 min). This and the following operations may be carried out in a steam-jacketed cooker for large quantities. Care should be taken to ensure adequate stirring.

(3) Heat the mixture to 190 F and maintain at this temperature with agitation for 5 min to allow gelation.

(4) After the sauce has thickened, add butter, soya oil, and emulsifier. Then homogenize sauce at 2500 psi if a homogenizer is available. Maintain sauce at 190 F.

(5) Add spices while stirring and maintain at 190 F.

Herring

(1) Obtain herring fillets from herring-in-the-round or from frozen fillet blocks. Trim and wash fillets.

(2) If fillets have a fat content greater than 6%, it is advisable to dip them in an acetic acid-brine dip (See section on Pre-Cooking Herring Fillets) for 20 minutes. This leads to firmer and whiter fillets and minimizes oil extrusion into the sauce.

(3) Lay fillets skin-down on an open-mesh screen or packed in can upside down on screen and pre-cook in a steam box for 20 minutes.

(4) Remove screen from steam box, allow fillets to cool, and weigh 9 oz of fillets into each 13 oz can.or adjust weight of packed cans. If fillets were steamed in cans, allow them to drain and turn them right side up. The fillets may be removed from the screen by means of a kitchen spatula.

(5) Add 4 oz of the appropriate sauce such that the fill-in weight is 13 oz. It is important that the fillets are warm and the sauce is hot in order that an adequate vacuum will be formed upon sealing.

(6) Seal the cans.

(7) Place the cans in a retort and heat-process to ensure a minimum process of $F_o 4$.

SPECIFIC SAUCE RECIPES

Recipes for various sauce formulations follow in the ensuing pages. The method to be used in formulating these sauces is described in the section on Method for Canning Herring with Sauces. As mentioned in the section on Responsibility, several substitutes can be used in place of many of the ingredients specified in these recipes. The ingredients mentioned in the recipes which follow simply represent the ingredients which were at the disposal of the authors.

The first six recipes represent those which might appeal to Canadian tastes. The basic sauce is essentially bland in nature. The second six recipes represent those which are peculiar to German or European tastes. Most Canadians will probably appreciate these recipes also.

Sour Cream Sauce

Basic Sauce Formulation

Soya oil	7.0%
Vinegar	1.5%
Wheat flour	3.0%
[1]Modified starch (Clearjel)	3.0%
[1]Milk (whole)	16.0%
Butter	1.0%
Sugar	1.0%
Water	66.5%
Salt	1.0%

Spices and emulsifier to be added to 100 g of above

[2]Sour cream flavour	0.05 ml
[3]White pepper	0.85 g
[4]Tabasco	1 drop
[5]Chicken mix	0.8 g
[5]Minced onion	0.6 g
[6]Lemon juice (fresh)	0.5 g
[6]Tween 80 (53%) - Span 80 (47%)	1.0 g

[1]Whole milk powder (2%) and water (14%) for milk

[2]Firmenich Liquid flavour, Cat. No. 59.431/A; Firmenich of Canada Ltd., 30 Finley Road, Bramalea, Ontario

[3]McIlhenny Co. liquid tabasco

[4]See attached data sheet for Chicken Broth Dry Mix (Pfizer Data Sheet #638, Pfizer Chemicals Division, 235 East 42nd St., New York, N.Y. 10017)

[5]W.H. Schwartz & Sons Ltd., Lakeside Industrial Park, Halifax, Nova Scotia

[6]See section on emulsifiers

Onion Sauce

Basic Sauce Formulation

Soya oil	7.0%
Vinegar	1.5%
Wheat flour	3.0%
[1]Modified starch (Clearjel)	3.0%
[1]Milk (whole)	16.0%
Butter	1.0%
Sugar	1.0%
Water	66.5%
Salt	1.0%

Spices, ingredients and emulsifier to be added to 100 g of above

[2]White pepper	0.2 g
[3]Minced onion	2.0 g
[4]Onion salt	1.2 g
[5]Onion powder	0.8 g
[6]Mustard powder	0.5 g
[6]Worcester sauce	0.5 g
[7]Chopped onion (fresh)	10.5 g
[7]Tween 80 (53%)-Span 80 (47%)	1.0 g

[1]See Footnote No. 1, Sour Cream Sauce

[2,3,4]See Footnote No. 5, Sour Cream Sauce

[5]Colman's mustard, J. & J. Colman Ltd., Norwich England

[6]Dry Worcester Sauce #092702, Item No. LSN 2-136; R.T. French Co., Inc., Industrial Products Div., 1 Mustard St., Rochester, N.Y., U.S.A.

[7]See Footnote No. 6, Sour Cream Sauce

Paprika (and bacon) Sauce

Basic Sauce Formulation

Soya oil	7.0%
Vinegar	1.5%
Wheat flour	3.0%
[1]Modified starch (Clearjel)	3.0%
[1]Milk (whole)	16.0%
Butter	1.0%
Sugar	1.0%
Water	66.5%
Salt	1.0%

Spices and emulsifier to be added to 100 g of above

[2]Chicken broth	2.0 g
[3]Sauteed onion	0.25 g
[3]Mushroom powder	0.25 g
[4]Tabasco	3 drops
[5]Paprika	2.5 g
[6]Tomato flavour	0.013 ml
[7]Lemon juice (fresh)	0.15 ml
[7]Bacon bits	1.0 g
[8]Tween 80 (53%)-Span 80 (47%)	1.0 g

[1]See Footnote No. 1, Sour Cream Sauce

[2]See Footnote No. 4, Sour Cream Sauce

[3]See Footnote No. 5, Sour Cream Sauce

[4]See Footnote No. 3, Sour Cream Sauce

[5]Don Paprika; Chili Products, Universal Foods, 14221 Magnolia Street, Westminster, California

[6]Imitation Tomato Flavour (oil soluble), Cat. No. F-5558, 3470 St. Antoine St., Montreal 30, Canada

[7]Blue Ribbon Imitation Bacon Bits, Brooke Bond Canada Ltd., Montreal, Canada

[8]See Footnote No. 6, Sour Cream Sauce

Curry Sauce

Basic Sauce Formulation

Soya oil	7.0%
Vinegar	1.5%
Wheat flour	3.0%
[1]Modified starch (Clearjel)	3.0%
[1]Milk (whole)	16.0%
Butter	1.0%
Sugar	1.0%
Water	66.5%
Salt	1.0%

Spices and emulsifier to be added to 100 g of above

[2]Salt	1.5 g
[2]Celery salt	0.3 g
[2]Garlic pepper	0.4 g
[2]Curry powder	2.0 g
[2]Ginger	0.2 g
[2]Red pepper	0.2 g
[2]Cumen seed	0.2 g
[2]Garlic salt	0.4 g
[2]Sauteed onion	0.3 g
[3]Tween 80 (53%)-Span 80 (47%)	1.0 g

[1]See Footnote No. 1, Sour Cream Sauce

[2]See Footnote No. 5, Sour Cream Sauce

[3]See Footnote No. 6, Sour Cream Sauce

Mushroom Sauce

Basic Sauce Formulation

Soya oil	7.0%
Vinegar	1.5%
Wheat flour	3.0%
[1]Modified starch (Clearjel)	3.0%
[1]Milk (whole)	16.0%
Butter	1.0%
Sugar	1.0%
Water	66.5%
Salt	1.0%

Spices and emulsifier to be added to 100 g of above

[2]White pepper	2.5 g
[2]Sauterne wine flavour	1.0 ml
[3]Mushroom flavour	0.015 ml
[4]Canned sliced mushroom	8.5 g
[5]Tween 80 (53%)-Span 80 (47%)	1.0 g

[1]See Footnote No. 1, Sour Cream Sauce

[2]Natural Sauterne Flavour (8-fold alcohol-free concentrate); Vie-Del Co., Fresno, California

[3]Firmenich liquid flavour, Cat. No. 50-685/A; Firmenich of Canada Ltd., 30 Finley Road, Bramalea, Ontario

[4]Slack Bros. Ltd., Waterloo, Quebec, Canada. Distributed by J.W. Windsor Co. Ltd., Montreal

[5]See Footnote No. 6, Sour Cream Sauce

Mustard-Horseradish Sauce

Basic Sauce Formulation

Soya Oil	7.0%
Vinegar	1.5%
Wheat flour	3.0%
[1]Modified starch (Clearjel)	3.0%
[1]Milk (whole)	16.0%
Butter	1.0%
Sugar	1.0%
Water	66.5%
Salt	1.0%

Spices and emulsifier to be added to 100 g of above

[2]Yellow food colour	1 drop
[3]Mustard powder	1.5 g
[2]Horseradish powder	1.5 g
[2]Salt	.25 g
[2]Red pepper	.05 g
[4]Tween 80 (53%)-Span 80 (47%)	1.0 g

[1]See Footnote No. 1, Sour Cream Sauce

[2]See Footnote No. 5, Sour Cream Sauce

[3]See Footnote No. 5, Onion Sauce

[4]See Footnote No. 6, Sour Cream Sauce

Tomato Sauce (German-Type)

Basic Sauce Formulation (including spices)

Soya oil	15%
Vinegar	5%
Modified Starch (Clearjel)	2%
Sugar	5%
Water	50%
[1]Salt	2%
[1][2]Emulsifier	1%
[3]Tomato paste	20%
[3][4]Worcester sauce (powder)	0.5%
[4]Lemon flavour (powder)	0.1%

[1]Several emulsifiers may be used in this formulation: glyceryl monostearate (GMS), Tween 80, or Emulsifier #76 alone or in combination with Emulsifier #63 (Germantown Manufacturing (Canada) Ltd., 920 Alness St., Downview (Toronto) Ontario

[2]Concentrated tomato paste (The Pastene Co., Ltd.; Montreal, Canada

[3]Powdered Worcestershire Sauce No. 1129; The Illes Co., 5527 Redfield St., P.O. Box 35412, Dallas, Texas 75235

[4]Lemon powdered flavour No. 200 S; The Nestle Company, Inc., White Plains, N.Y. U.S.A.

Wine Sauce (German-Type)

Basic Sauce Formulation (including spices)

Soya oil	15%
Vinegar	10%
Wheat flour	2%
Modified starch (Clearjel)	2%
Skim milk solids	3%
Sugar	5%
Water	25%
[1]Salt	2%
[1][2]Emulsifier	1%
[3]Tomato paste	5%
[3][4]White wine	30%
[4]Cinnamon	0.05%
[4]Cayenne pepper	0.02%
[4]Sweet basil	0.01%

[1]See Footnote No. 1, Tomato sauce (German-type).

[2]See Footnote No. 2, Tomato sauce (German-type).

[3]The authors have tried 3 locally available Canadian wines of varying sweetness:-

(1) Very dry: Abbey Premium White Table Wine, N.S.L.C. No. 7887
(2) Dry: Chateau Cartier Canadian Riesling, N.S.L.C. No. 7881
(3) Semi-sweet: Bright's Manoir St. Davids, N.S.L.C. No. 418

[4]See Footnote No. 5, Sour Cream Sauce

Cream Sauce (German-Type)

Basic Sauce Formulation (including spices)

Soya oil	15%
Vinegar	9%
Wheat flour	3%
Modified starch (Clearjel)	3
Skim milk solids	4%
Sugar	5%
Water	50%
[1]Salt	2%
[1][2]Emulsifier	1%
[2]Cream ("Blend")	7%
Onion juice	0.3%
Soya sauce	0.5%

[1]See Footnote No. 1, Tomato Sauce (German-type)

[2]See section on Milk Powder

Mustard Sauce (German-Type)

Basic Sauce Formulation (including spices)

Soya oil	15%
Vinegar	10%
Wheat flour	2%
Modified starch (Clearjel)	2%
Sugar	2%
Water	60%
[1]Salt	2%
[1][2]Emulsifier	2%
[2]Mustard powder	4%
[2]Garlic powder	0.1%
[3]Worcester sauce	0.5%

[1]See Footnote No. 1, Tomato Sauce (German-type)

[2]See Footnote No. 5, Sour Cream Sauce

[3]See Footnote No. 3, Tomato Sauce (German-type)

Curry Sauce (German-Type)

Basic Sauce Formulation (Including spices)

Soya oil	15%
Vinegar	12%
Wheat flour	2%
Modified starch (Clearjel)	2%
Skim milk solids	2%
Sugar	5%
Water	55%
[1]Salt	2%
[1][2]Emulsifier	2%
[2]Mustard powder	0.5%
[3]Curry powder	1.5%
[3]Worcester sauce	1.0%

[1]See Footnote No. 1, Tomato Sauce (German-type)

[2]See Footnote No. 5, Sour Cream Sauce

[3]See Footnote No. 3, Tomato Sauce (German-type)

Mushroom with Wine Sauce (German-Type)

[1]Basic Sauce Formulation (including spices)

Soya oil	15%

Vinegar	10%
Wheat flour	2%
Modified starch (Clearjel)	2%
Skim milk solids	3%
Sugar	5%
Water	25%
Salt	2%
Emulsifier	1%
Tomato paste	5%
White wine	30%
Cinnamon	0.05%
Cayenne papper	0.02%
Sweet basil	0.01%

To 100 g of this formulation is added 6 g canned mushroom slices.

[1]Same footnotes apply to this as to the wine sauce on p. 51.

TASTE PANEL EVALUATION

The taste panel formed for the evaluation of sauces consisted of a Laboratory Technician (Panellst A), a Home Economist (Panellst B), a Food Technologist (Panellst C), a Biologist (Panelist D), and a Microbiologist (Panelist E). These individuals were all staff members of the Laboratory in Halifax. Each sauce is discussed separately below. As many commercially-available products of the desired flavour were purchased as possible. These products were compared with those developed in this laboratory. The panel was conducted according to methods outlined in a publication of the Canada Department of Agriculture*. Each member of the panel was given heated samples of each product. The samples were identical in size and were presented in identical white translucent dishes. Each panellst had all the brands of a given flavour in front of him at one time. The panelists were asked to rate each product according to a hedonic scale. A sample score-sheet and calculation follows this discussion.

Cream Sauce

Five samples were tested; one imported German product, two domestic Canadian products from two separate producers, and our own "German" and "Canadian" recipes. Analysis of variance indicated that at P = 0.05, panelists noted a significant difference in the taste of some of the samples presented them. There was no significant difference in the way panelists scored. Application of Duncan's Multiple Range Test indicated that the sauces could be placed in two groups constituted as follows: (1) the imported German product and our own "German" recipe, and (2) our own "Canadian" recipe and the two commercially-available Canadian products. There was no significant difference between individual sauces in each group, but the former group of sauces was significantly better than the latter.

Curry Sauce

Three products were evaluated: our "Canadian" product, our "German" product, and a Canadian domestic product. Analysis of variance indicated that at P = 0.05, there was no significant difference between any one of the sauces tested; neither was there any significant difference in the way panelists scored.

Mushroom Sauce

Four products were tested: an imported German product, a Canadian domestic product, and our own "German" and "Canadian" products. There was no significant difference (P = 0.05) between any of the samples tested, but there was a significant difference in the way people scored. Application of Duncan's Multiple Range Test indicated that at P - 0.05, Panellst B consistently scored significantly lower than Panelists A,C, and D; Panelist E consistently scored significantly higher than the previous three persons. Again it must be pointed out that despite the way in which panelists scored, there was no significant difference between any of the samples.

Mustard Sauce

Five products were evaluated: two imported German products, one Canadian domestic product, and our own "Canadian" and "German" products. The analysis of variance showed that there was a significant difference in the products tested and there was a significant difference in the way panellsts scored. Application of Duncan's Multiple Range Test indicated the German import was in a class by itself which was significantly better than the remaining four products. The products which constituted the remainder of the group did not differ significantly from one another. The panelists can be grouped into three scoring groups which differed significantly from one another: (1) Panellst B (2) Panellsts C and D, and (3) Panelists A and E. Panellst B scored consistently lower than Panellsts C and D, and Panelists A and E scored consistently higher than Panellsts C and D.

Wine Sauce

Five products were tested: three German imported products, one Canadian domestic product, and our own "German" product. Analysis of variance indicated that there was no significant difference (P = 0.05) between any of the samples tested. The results also indicated that there was no significant difference in the way the panelists scored.

Tomato Sauce

Five products were tested: two German imported products, two Canadian domestic products, and our own "German" product. Analysis of variance indicated that there was no significant difference (P - 0.05) between any of the samples tested. The results also indicated that there was no significant difference in the way the panelists scored.

Paprika Sauce

Four products were tested: two German imported products, one Canadian domestic product, and our own "Canadian" product. Analysis of variance indicated that there was a significant

*"Methods for Sensory Evaluation of Food". Publication #1284. Canada Department of Agriculture. Elizabeth Larmond, Editor.

difference in the way in which panelists scored. Application of Duncan's Multiple Range Test indicated that the German imported product was significantly (P = 0.05) better than either of the other three, but that each of these other three did not differ significantly from one another.

Onion Sauce

Two products were tested: A Canadian domestic product and our own "Canadian" product. Analysis of variance indicated that there was no significant difference (P - 0.05) between any of the samples tested, but there was a significant difference between panelists. Application of Duncan's Multiple Range Test indicated that there was a significant difference in scoring between the following two groups: (1) Panelists A,B, and C, and (2) Panellists D and E. Panelists in the latter group scored higher than those in the former.

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Table 1. Weight losses incurred during pre-cooking and retorting of thawed herring fillets

Pre-cook time (min)	Weight loss due to pre-cook** (average %)	Weight loss due to retort *** (average %)	Weight loss due to retort **** (average %)	Total fluid loss in process ***** (average %)
0	-	17.73	17.73	17.73
20	11.00	15.28	13.60	24.60
20*	12.13	13.88	12.20	24.36
40	17.20	11.60	9.60	26.80
60	20.10	8.86	7.06	27.16

* This lot of 4 cans placed upside-down on a screen during pre-cook.

** Weight loss expressed as a percentage of the fill-in weight (15 oz.).

*** Retort conditions: 230°F for 115 min. Weight loss expressed as a percentage of the weight of fillets after pre-cooking. In this case, the "loss" actually represents liquid extruded from the fillets thus forming "natural juices" in the can interior.

**** Values expressed as a percentage of fill-in weight (15 oz.).

***** Total fluid loss = % weight loss due to pre-cook + % weight "loss" due to retort (both expressed as percentages of fill-in).

Table 2. Weight losses incurred during pre-cooking (on open mesh screen) and retorting of thawed herring fillets*

	Pre-cook time (min)	Weight loss due to pre-cook (average %)	Weight loss due to retort (average %)	Weight loss due to retort (average %)	Total fluid loss in process (average %)
20/4/72**	0	-	17.60	17.60	17.60
	10	15.00	13.30	11.33	26.33
	20	25.33	8.39	6.26	31.59
	40	25.66	6.50	4.83	30.49
	60	25.80	6.51	4.83	30.63
21/4/72	0	-	18.00	18.00	18.00
	5	12.66	14.19	12.40	25.06
	10	17.33	11.20	9.26	26.59
	15	16.66	11.12	9.26	25.92
	20	19.33	10.74	8.66	27.99

* Same footnotes apply here as in Table 1.

** In this experiment, two lots of herring were canned; one on April 20th, 1972 and the other on April 21st, 1972. It appeared that maximum liquid extrusion occurred within a 20-min pre-cook; hence, the second lot.

Table 3. Composition of the liquid extruded upon retorting of pre-cooked (on open-mesh screen) thawed herring fille

Date	Pre-cook time (min)	Moisture (%)	Fat (%)	Protein (%)	Ratio, Moisture : Fat
20/4/72*	0	89.70	0.50	9.80	179.5
	10	83.20	3.50	13.30	23.8
	20	79.80	7.00	13.20	11.4
	40	78.10	9.50	12.40	8.2
	60	76.50	12.25	11.25	6.3
21/4/72	0	89.60	0.75	9.65	119.5
	5	85.30	3.75	10.95	22.8
	10	86.00	3.50	10.50	24.6
	15	83.70	5.00	11.30	16.7
	20	79.40	9.25	11.35	8.6

* See second footnote, Table 2.

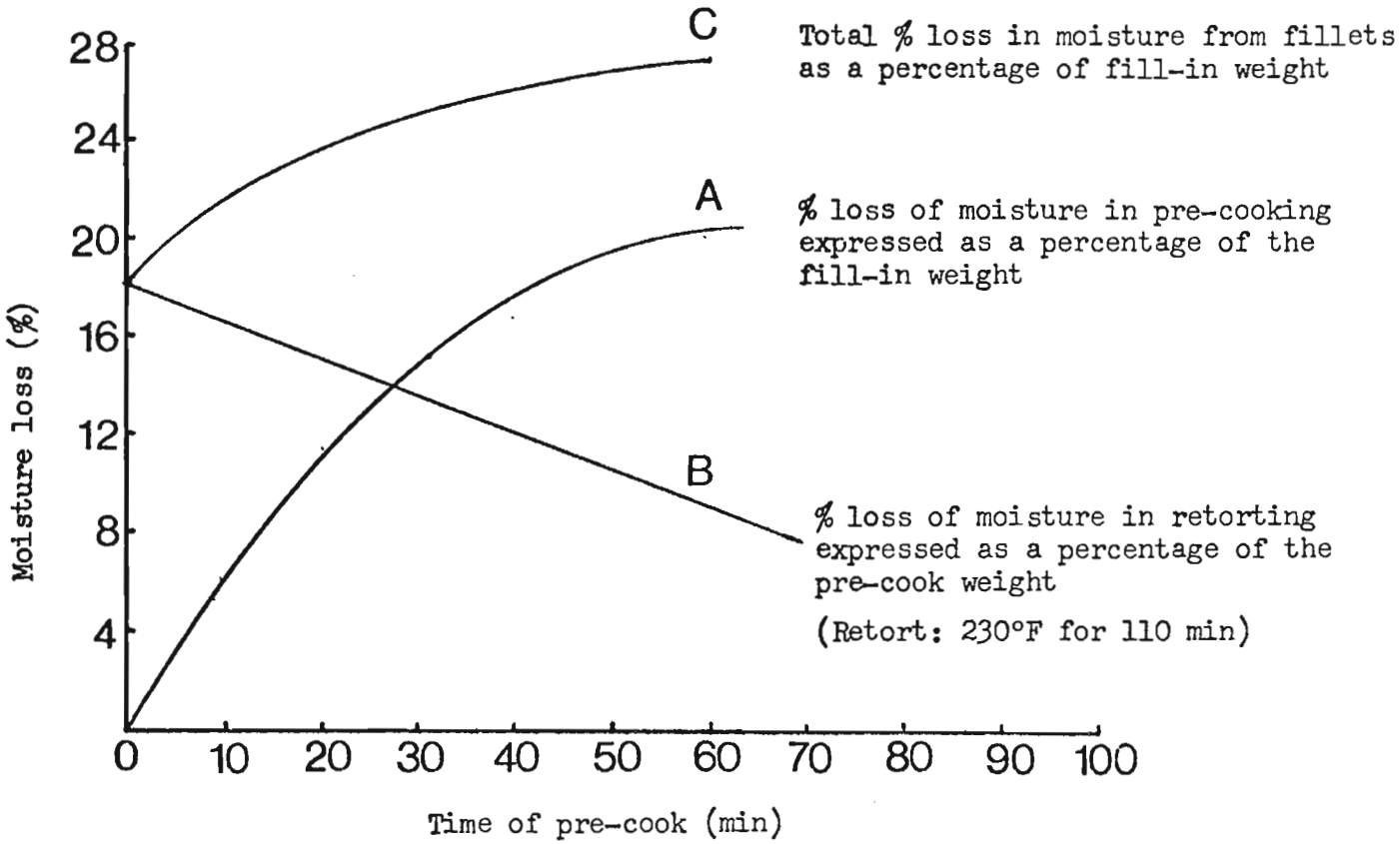

Figure I. Pre-cook losses and retort losses of thawed herring fillets pre-cooked in 1-lb oval cans.

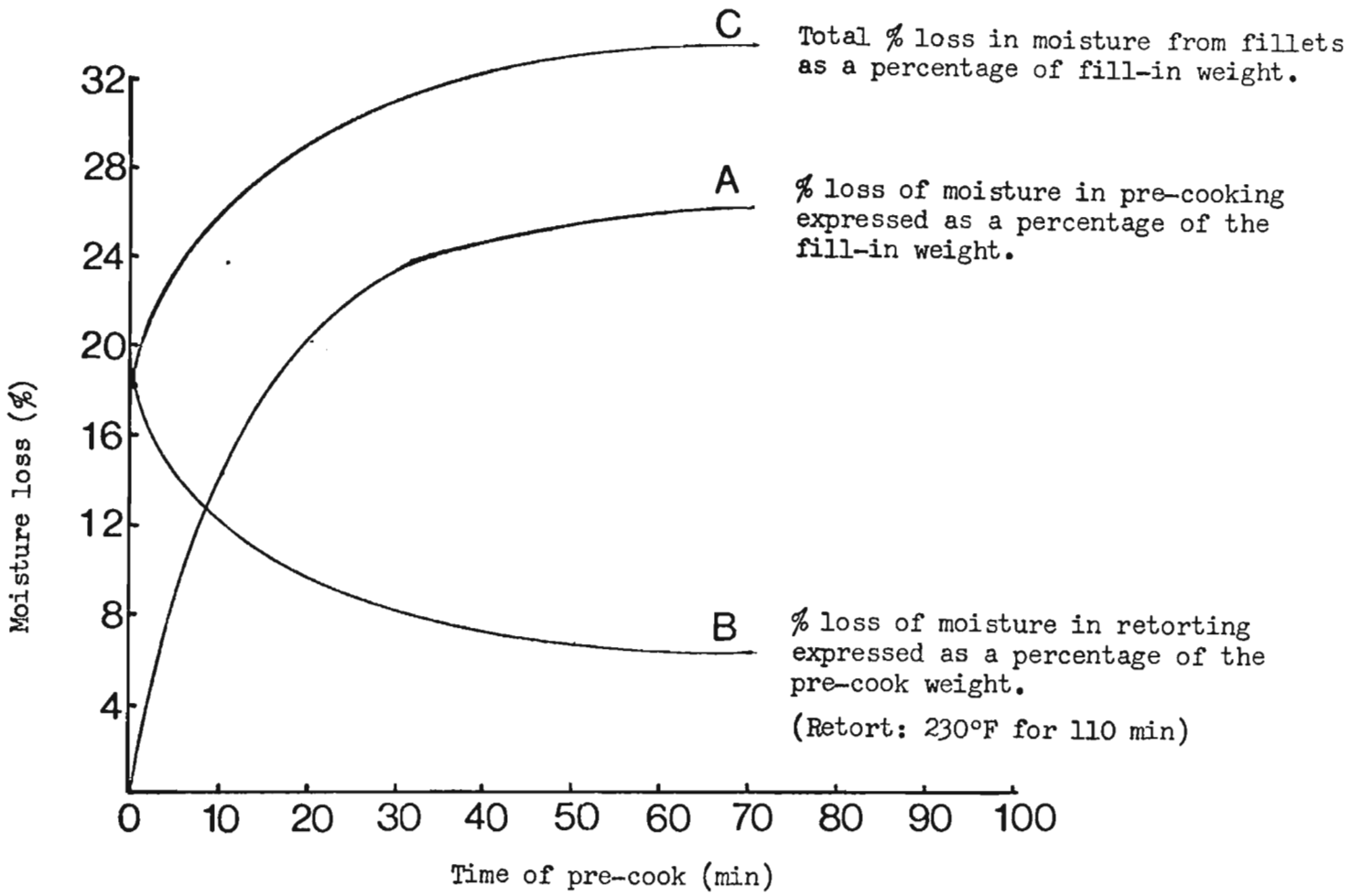

Figure II. Pre-cook losses and retort losses of thawed herring fillets pre-cooked on open-mesh screens.

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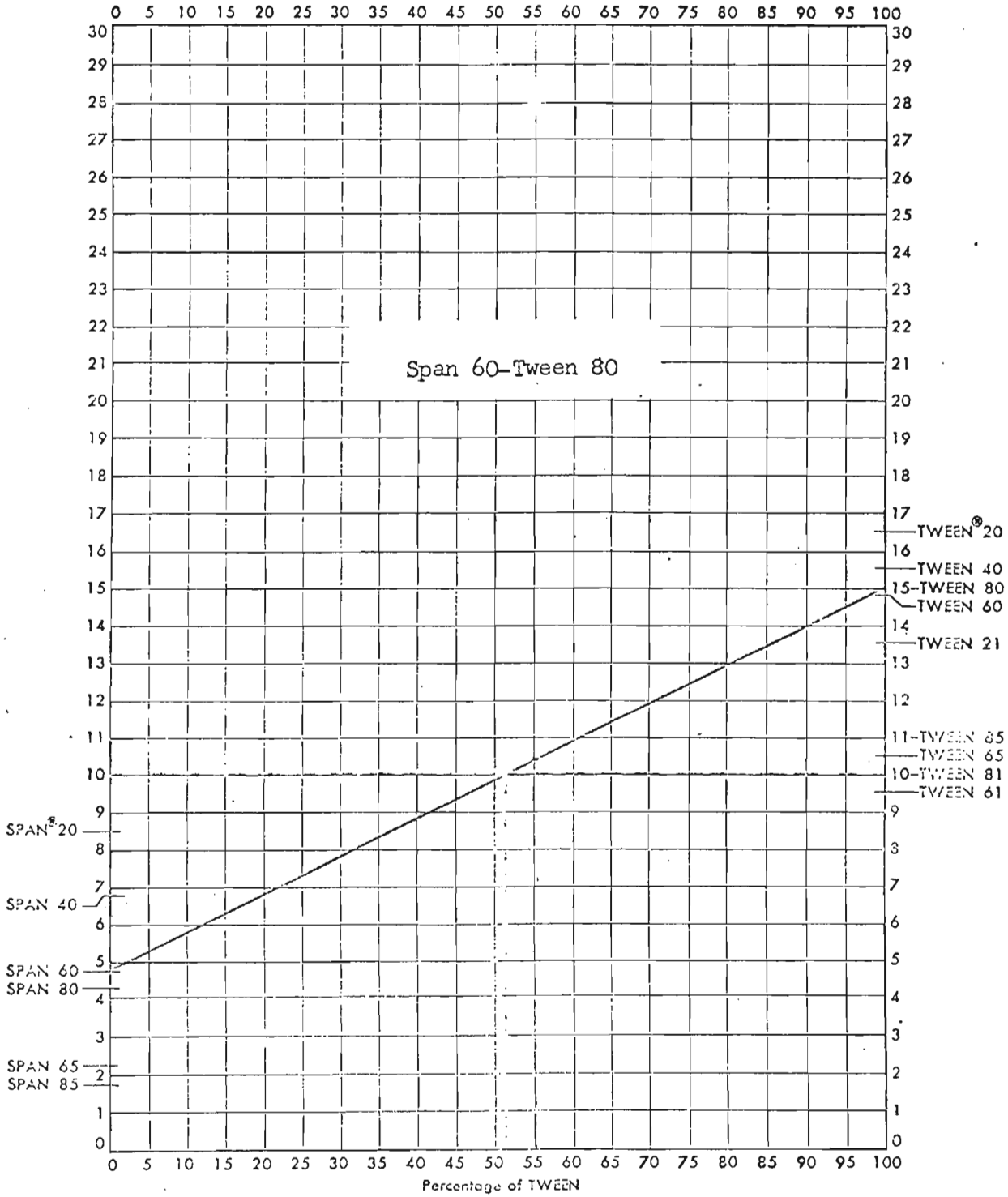

ATLAS HLB COMPUTING GRAPH FOR COMBINATIONS OF SURFACE ACTIVE AGENTS

This chart may be used to calculate conveniently the HLB of various mixtures of Span and Tween emulsifiers. *Example:* What is the HLB of a mixture of 55% Tween 60 and 45% Span 60? Make a line between Span 60 at the left margin and Tween 60 at the right margin. Bring a line up perpendicularly from 55% Tween along the base of the chart. At the point where this intersects the line previously drawn, read 10.3 at either the left or right margin. This is the HLB of the mixture. HLB values of emulsifiers other than the Span or Tween products may be entered on the margins at left or right for use in computing HLB of other mixtures.

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