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HERRING - DELICATESSEN AND MARINATED PRODUCTS

(Semi-sterile herring preserves)

by

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You are presumably well acquainted with the fact, that a substantial part of the Swedish canned food production consists of semi-sterile products, chiefly made out of herrings. Similar products are made in the other Scandinavian countries. Slightly other types of herring-delicatessen chiefly more acidified are produced by the German, Dutch, British fish canning industries. They are generally called marinated. This explains why this particular type of product is the subject of a special session at this conference.

These semi-sterile herring products are not cooked, the fish is preserved in the raw condition. They are not processed in heat but are cured in a salt-sugar brine. This exercises certain preserving effect. In addition a minor amount of a preservative is added. In some cases special acids as citric or lactic acid are used. These products are put into cans of the general type or in some cases into specific packages (kegs etc.) which was the original method being adopted for this type of product.

In fact they have been produced in Scandinavia previous to the development of sterilized canned foods through the Appert method. Already in the middle part of the seventeenth century fish, especially sprats, have been spiced and preserved with salt and acids and put into wooden kegs. This is in fact the same product as the Swedish anchovy, which is now being hermetically sealed in tinned cans, although not processed afterwards. The production of semi-sterile herring preserves presumably originated in Scandinavia. Already in the 17th century it was practiced privately and the first industries started 1841, and to-day a large number of canning factories manufacture these products.

There also is a German production of this type of "anchovy", based on raw-material fetched from Belgium and Russia. Already at the start of this century Russia produced what was called "killo" - preserves of sprats - similar to the Scandinavian anchovy.

In our days most of these products are hermetically sealed and in that way protected from the oxidizing influence of air. This means that the development of rancidity is impeded. As I want to tell you, most of these herring delicatessen are made out of various sprats and herrings, and you are all acquainted with the fact, that these fishes have a high fat content. Very few are put into glass packages as it is generally preferable to keep them in the dark in order not to stimulate the decomposition of the fish meat through enzymes and bacterial processes. These changes generally develop more rapidly in light.

Due to the fact that the bacteria not are killed but several survive in the semisterile media and also due to the fact, that the enzymes have not been destroyed but still continue their

activities, changes all the time take place in these products - more or less rapidly. In order to get a typical herring delicatess some of these processes have to start going in order to get the right taste and an appropriate texture of the flesh. The predominant biochemical process is the breakdown of protein into amino acids chiefly through enzymes. These processes are not too well studied from a scientific point of view and are only known in this general trend. The fish flesh is partly transformed through a ripening process in order to develop a specific aroma which furthermore is enhanced by the addition of various spices.

This also means from commercial point of view that they have a restricted shelf-life and cannot be stored for a long time. This of course is a big draw-back when discussing the possibility of using this type of preserves for the feeding of underdeveloped regions or for world-wide export. Generally they only have a keeping time of about six to twelve months in cold storage which is appreciably shortened under warm conditions, in ordinary commercial practice in our own climates at the most two months.

These products depend for preservation on the curing to which they are subjected previous to packing and on subsequent storage at low temperatures. The tin or glass container simply serves as a method of packaging superior to containers previously used and have very little or no preservative effect. It is even not possible to process spiced and cured herring. They get tough and fibrous in texture, unpleasant in flavour and discoloured through the heat treatment.

Preservatives are generally added. Earlier boric acid was used and this is still the case in Germany. Most commonly benzoates are applied - chiefly sodium benzoates or benzoic acid. More effective is the dual effect attained when the benzoate is combined with

hexamethyltetramin. The paraoxy-benzoic acid may be a good substitute for sodium benzoate. 2 g per kg is the quantity of preservative mostly used.

The salt exercises an additional preserving influence. The salt percentage generally is 8-12 % depending on the type of delicatess. The pH is almost on the neutral point.

The highly seasonal nature of the herring fisheries makes it extremely desirable for the industry to be able to handle large quantities over short periods. Therefore, high capacity cleaning and boning machines are of advantage. Such machines have been developed by the Swedish Arenco Co and by Nordischer Maschinenbau, Lübeck, Germany. The German machine is operated by one person and has a capacity of 2.800 herrings per hour. A somewhat experienced worker is required to reach this capacity, as every four seconds three herrings have to be put in a certain position in the rotating feeding table.

The herring is automatically headed at the feeding table and at the same time measured for length and thickness. All the tools of the machine are then set according to this measurement, so that there is a minimum amount of waste. After that, the herring is seized by the tail and pulled through the machine which first removes a narrow strip along the belly and the ventral fins. Then a rotating knife opens the belly and a rotating device removes the entrails, including roe and milt. The two latter parts, which in Germany are often used for marinating, are undamaged by this process. A special device not only removes the backbones but also side ribs. The herring then goes through a cleaning and washing device which removes the black skin on the inside of the belly cavity.

The machine also has a device which can cut the herring into pieces for use as tidbits. It can also be set for nobbing, a process by which the heads are removed and the entrails, excluding roe or milt, are pulled out. The Swedish Arenco-machines have this particular function and have successfully been used in many countries. They have a capacity of about 200 herrings pro minute.

Most of the following packing work is done by hand and is only to a very slight extent mechanized although a new development in this particular field is starting. Special efforts have been made to construct cutting machinery for this purpose.

#### A. Scandinavian anchovy

When a semisterile herring delicatess is to be made, both fresh fish and salted fish is used as raw material. In some cases the raw product also has been smoked or treated with acids. First of all I would like to discuss a product, which we call anchovy, the Swedish anchovy. As I already told you this was made in Sweden already in the 17<sup>th</sup> century in families of the upper layers of society. It became an industry only in the latter part of the 19<sup>th</sup> century. As far as I know, the first Scandinavian factory of this type started its activity in 1841 in Norway. Already 1872 Sweden participated with this product at an exhibition in Philadelphia in U.S. A sizable export of this product is registered, especially from Sweden and Norway at the start of this century.

The anchovy is made on the basis of sprats, and the best product is the one, which is obtained when the product is spiced directly into the cans. The fresh sprat is put directly into the consumers' can and to that is added a mixture of dry sugar, salt and spices together with powdered sandel wood or some similar spice. This particular product is used in order to give the fish an appetizing

reddish colour. There are about fifteen various ingredients in the Swedish anchovy, so the flavour is very pleasant. They are all put there in the dry stage, and in various layers in the can. The can is closed in the same way as a completely sterilized one and a few days later the sugar and the salt has been dissolved in the fluid which is drawn osmotically out of the fish. The use of a prepared brine is sometimes practical. Besides this direct method, when the fish product is put directly in the can, we also sometimes repack the anchovy. This means that the anchovy already is prepared and later on is put into the consumers' cans. The first treatment of this product takes place in barrels, where the raw material is treated with sugar and salt and the ripening starts. Later on the can is filled with this half-ready-made product, a specific mixture of spices or some type of sauce is added, and the definite ripening takes place in the can.

There is also a special type of anchovy where the columella, the back bone is taken away and also the skin. It is called the skinned and boneless anchovy, which really consists of sprat fillets or sometimes small herrings.

## 2. Tidbits

Another type of product is "gaffelbitar" generally named tidbits, which is a common denomination for a lot of different herring delicatessen, where the herring is cut in convenient large pieces. This type of product exists in the market under various names. The raw material generally consists of herring caught at Iceland, but you also find products made of other herrings as the Fladen herring and the fat coastal autumn herring. The factories which make these products generally consider the Iceland herring as

qualitatively superior as raw material for this type of delicatess, due to the fact that the fat is more uniformly distributed in the flesh. If this is a correct opinion cannot so far be scientifically verified.

For the production of tid-bits we generally use spiced herring, which is made in the following way. The caught herring, after the head is taken away - decapitated - ~~and the herring~~ is drawn. It is packed together with spices, sugar and salt in a barrel in which it is stored in order to pass through the ripening process. This curing takes place in a salt-concentration of 10-12 % and in cool places.

After the herring is ripened it is filleted and later skinned and the side bones are removed. This procedure generally takes place at room temperature. The entire product is allowed to warm up before handling, as experience claims, the amount of oil extracted from the flesh becomes less in this way. The fillets are cut appropriate in cross-way pieces or obliquely in thin slices. Various types of spiced sauces are added as dill or tomato or imitations of oyster, roe, wine etc. These products are preferably stored at +2°C until shipment.

### 3. Herring fillets

We also have different types of herring fillets; sugar-salted or spiced herring often called Matjessill - Matjes herring - which really consists of the young herring not yet sexually fertile. Now it is generally used in many places to indicate lightly salted fat herring without gonades. You can find this in the form of whole fillets in packages of various sizes. Very common is the long can, hermetically closed, which contains two pieces of big fillets.

Matjes herring is generally prepared in the Scottish way. The fish is first drawn after which it is treated with very fine salt. The amount of salt is only 12 percent or slightly higher. It is also more sensitive to the attack of bacteria and it has to be stored more carefully, preferably at temperatures just above zero.

#### Scientific problems of delicatessen

The predominant trouble of semisterile preserves of herring is their restricted shelf-life. Preservation is only possible for limited periods. In spite of the use of preservatives fermentation proceeds at a minor degree but becomes evident only after some months and then generally after storage under warm conditions. The proteolysis is accelerated and the fish flesh successively becomes soluble. The entire content becomes fluid. This is however a long-range effect. But the keeping time may be sharply reduced by unfavorable conditions of storage and handling.

This successive formation of amino acids, which dissolve, constitutes a big trouble to establishing a true net weight. Even the normal ripening process means a loss of weight. The season for catching the raw material and the age of the fish to a certain degree fixes the rapidity of these biochemical transformations.

In many cases a whitish coating precipitates on the surface of the fish. It also appears in the bottom of the can but not between the fillets, which lie close together. It occurs wherever the brine is in free connection with the fish surface. This white coating consists of crystallized tyrosin - formed when the protein decomposes. A similar precipitate sometimes appears on bacon or marinades. Under which conditions tyrosin is found is not scientifically established. It seems to occur very much by chance.

Previous to this may in some cases develop a sliminess of the brine. Studies on the causes of this transformation of the sauce are in progress at the Gothenburg-institute. It is chiefly caused by certain non-sporulating bacteria, e.g. some species of Streptococcus and Alkaligenes. Leuconostoc-organisms are rare. More important are however some spore-forming aerobic bacilli of the subtilis and mesentericus group. The cause of the slime-production apparently is a polymerization of various carbohydrates. Most remarkable is the fact that some of these slime-producing bacteria develop even in very strong brine (20 %) obviously they have a strong halophilic character. Contamination presumably takes place during processing.

In connection with the brine it should be emphasized what detrimental influence some ingredients might have in certain cases. If contaminated, through spices, which sometimes might be the case, they might introduce undesirable bacteria: Onions often carry aerogenes-bacteria, which develop in an acid media. This makes it necessary to cook the onion previous to being used in preparing a delicatess.

The chief difficulty of delicatessen-preserves is to establish the amount and type of bacteria, which should be permissible with regard to public health and product quality. Fact-finding research on a broad scale is needed. So far, however, no poisoning cases have been reported and it is most likely that this factor plays a large rôle to the quality of the products. In this respect the situation is quite similar to what is valid for frozen products.

#### B. Marinated products (German: Marinaden)

In earlier times marinades were often manufactured on salted herring. Now this is not practised to the same extent as earlier.

There is a marked tendency to marinades on fresh fillets. The raw herring is primarily bleached through treatment with hydrogen peroxide and later preserved in acetic acid brine (5-6 % acetic acid or vinegar, 6-8 % salt). In order to avoid fermentation sugar is not used as a sweetening agent but saccharin (0.01 %) or similar chemicals.

Marinades are spiced by onion, cucumber, laurel leaves or specific spices. A special sauce is made from herring milts.

In order to attain a reasonable shelf-life of marinades salt and acids may be added in excess. Before using the products they are water-treated. Cold-storage is practiced to an increasing degree. Preservatives are sometimes used - especially hexamethylenetetramine at a concentration of 0.1 %. As the final concentration of salt in the fish is not high (about 2 %) this product will not keep more than 4 to 6 weeks at ordinary temperatures, so they are in addition kept at temperatures below +10°C. There are large German factories annually producing more than 5.000 tons of marinades.

From the technological point of view four different types of marinades are distinguished:

1. Cold marinades - e.g. Bismarck-herring, Rollmops, "Kron" sardines, marinated herring etc.
2. Cooked marinades (German: Kochmarinaden) e.g. Jelly-herring (German: Gelee-heringe). Aspic-herrings etc.
3. Fried marinades (German: Bratmarinaden) - e.g. fried herring, fried rollmops.
4. Special marinades (German: Fein-marinaden), e.g. herring filets, Bismarck-herring and rollmops, mayonnaise dressing.

### 3. Fried marinades

The fresh fish are washed, beheaded, cleaned and rolled in dry seasoned flour. After frying in oil at 180°C for 4-8 minutes (small) or 12-20 minutes (large) - which is done in a special machine, the herring are packed in tins, generally 8 liters, and covered with vinegar. Sometimes they are packed in vegetable oils, such as soy- and cottonseed.

### 4. Rollmops.

A special type of marinated product is the so-called "Rollmops" which is very little produced in Sweden. It is preserved through an acidified salt solution and is chiefly manufactured in Germany, Norway and Denmark. At the preparation the fish, generally consisting of herring - is drawn and washed thoroughly with a salt solution after which it is treated with acid for some days, generally an eight per cent citric acid. The fillets, when sufficiently ripened, are rolled around a small piece of dill pickle or bit of onion or cucumbers and fastened with wooden tooth picks.

### 5. Herring salad

A by-product of the marinade production is herring salad. Fish after treatment the requisite time in the pickling vats are finally sorted: Broken fish and trimmings are packed in tins, jars or wooden kits with vegetable and sauce. Chopped onion, cabbage and cucumbers are mixed with 20 % of fish and a sauce made from salted herring milts and vinegar is poured over it.

Scientific problems of marinades.

Scientific studies in Germany have revealed that during the curing in the pickle the salt enters the herring flesh through diffusion and consequently is directly proportional to the concentration and time of treatment. When equilibrium is attained about 40 % of the original salt in the brine has entered the fish. The acetic acid on the other hand seems to get linked to some protein compound and become bound in the flesh. The source of acetic acid is indifferent and the concentration exerts less influence on the final amount of acetic acid being absorbed. The amount of acetic acid absorbed, is also linked to the salt concentration and influenced by it. When 2 % acetic acid is used, insignificant amounts are absorbed at all salt concentration; at 4 % acetic acid the salt concentration is decisive. Absorption only takes place at salt concentrations between 6-10 %. When 6-8 % acetic acid is used the pickling proceeds completely independent of the salt concentration.

Consequently when difficulties arise there is no use treating the raw products for a prolonged period. No curing or pickling is then possible to accomplish if the right concentrations have not been observed.

A special problem is the softening of the cold marinades in the warm season. This is quite a natural process and generally not due to deficiencies in the manufacture. At a temperature of + 30°C a similar proteolysis takes place as in the delicatessen. Amino acids are formed indirectly through the proteolytic enzymes produced by bacteria.

Transport should only take place at temperatures below + 20°C and storage should preferably be as near zero as possible.

Freezing spoils the product.

During the curing proteolysis takes place and an average weight loss of 2 % is due to breakdown of protein into amino acids which is dissolved in the brine. In addition 13-14 % of water is lost in the diffusion process. Some fat and other components are also lost to the brines so the total average loss according to Biegler's calculations amounts to 22-25 %.

Another trouble with marinades is the yellow colouring of the onion in Rollmops and Bismarck herring. This is a chemical-catalytic process due to the formation of special color substances with metal impurities dissolved from the tin can - presumably small quantities of ironsulphides. When cans have been kept at a high temperature the oil separates and collects at the top of the brine.

#### Comments.

I do not know the real reason for placing the topic of herring delicatessen and marinated herring on the agenda of this conference. Most of these products through this particular processing become specialities and consequently reach a higher price value. It has also been stressed they have a restricted shelf-life and do not keep for any longer time under warm conditions. As products for the feeding of the human population they are best adapted to the temperate regions. Future development in their processing might of course create means of obtaining sterile or almost sterile herring delicatessen with the raw condition retained that is to say without cooking. The increased use of refrigeration in storage and under transport give these semi-sterile products new chances.

On the other hand in compliance with the desire to get as many diverse products as possible - in order to counteract monotony of the diet - it might be worth while to develop methods for large-scale production of certain herring delicatessen. I do however not want to conceal that the general trend in the Swedish development in this field is the contrary one. Efforts are made to manufacture products more and more specialized and of a superior quality.

Production of herring delicatessen

A. Denmark

Year	Danish anchovies and bone-free herring		Tidbits, herring fillets etc.	
	1000 kg	1000 crowns	1000 kg	1000 crowns
1939	538	955	643	1226
40	471	973	543	1303
41	454	1074	378	1318
42	423	1445	284	1334
43	489	1792	248	1346
44	767	2348	321	1470
45	599	2051	555	2105
46	445	1776	729	3514

B. Norway.

Year	Norwegian anchovy in cans		Norwegian anchovy in barrels		Tidbits in sauce	
	Quality 1000 kg	Value 1000 crowns	Quality 1000 kg	Value 1000 crowns	Quality 1000 kg	Value 1000 cr.
1927	749	797	98	114	388	594
28	610	858	49	71	388	658
29	786	861	75	73	400	679
1930	736	726	93	90	388	628
31	548	580	31	56	331	533
32	610	630	52	52	475	633
33	620	663	36	42	430	591
34	497	572	52	48	534	776
35	663	774	134	64	639	998
36	635	663	104	51	683	1052
37	missing		159	71	899	1472
38	620	733	72	35	1025	1757
39	713	872	225	81	997	1861
1940	457	670	141	69	515	1247
41	missing		72	85	550	1791
42	357	842	313	805	135	179
43	228	502	284	325	595	1787
44	396	883	135	179	595	1787
45	393	929	82	107	527	1715
46	416	1200	116	199	1240	4436
47	1093	2942	294	528	1943	7498

C. Sweden

Year	Swedish anchovies		Tidbits and herring fillets	
	Quantity 1000 kg	Value 1000 Sw. crowns	Quantity 1000 kg	Value 1000 Sw. crowns
1909		1628		
10		1703		
11		1604		
12		1747		
13		1585		
14		1644		
15		1870		
16		2954		
17		2034		
18		3758		
19		3460		
1920		4775		
21		4740		
22		3619		
23		3589		
24		3425		
25		3765		
26		3546		
27	4260	4054		
28	4025	3765		
29	4214	4029		
1930	4236	3900		
31	3394	2963	4741	4690
32	3473	2846	4719	4385
33	3046	2698	4213	4163
34	3516	2906	4766	4821
35	4051	3726	5056	5525
36	4237	3833	5011	5363
37	3939	3461	5463	5935
38	3988	3699	5470	6236
39	4382	4427	6495	7505
1940	3819	4607	4687	6949
41	5345	6720	3876	8405
42	5486	9043	1709	5328
43	6774	13982	843	2816
44	5461	10362	2287	7353
45	6149	12054	3009	9515
46	4645	8576	4480	13527
47	5499	9480	6293	18163
48	5211	9347	6894	20025