STUDIES ON THE CAUSE OF THE SPRINGER OF CANNED SALMON

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"Springers" in the canned salmon or the canned mackerel are often found. This springer is recognized as one of the kinds of abnormal cans, and it is of less commercial value just as is the swollen can. The springer is a can with end bulging. Under thumb pressure the bulge flattens with simultaneous bulging of the opposite end. Cans with both ends bulged may also be considered springers, provided one of the ends can be readily flattened. According to BIGELOW[4], the springers are due to the following causes: (1) Pressure from hydrogen generated as a result of chemical action of the acid contents on the metal of the container. (2) Imperfect closing of the can, in which the paper gasket is imprevious to bacteria but admits air. (3) Overfilling of the can, in which products of heavy consistency are especially involved. (4) Sealing at too low a temperature. (5) Dented cans. (6) Incipient spoilage.

From practical experiences in the canneries, the following facts are observed as to the springer of canned salmon. (1) The meat in the springer is as good as in the normal can in respect to taste, color, softness and appearance of the juice. (2) The bulging appearance is observed after and during the cooling of sterilized can. (3) There are a few springers in flat (low) cans, but many in tall cans. (4) Comparatively few springers occur during the filling machine (the filler) is clean, e. g., during 1~2 hours after the beginning of putting the machines in motion in the morning or after the midday meal. (5) There occur few springers when there is little necessity rehandling the meat owing to the normal motion of the filler or employing of normally fresh raw material. (6) In opening the springer of canned salmon, it is supposed that some spaces are usually formed between the meat cuts especially owing to the addition of tail meat. (7) There are few springer when the exhausting is sufficient by means of raising the temperature of the exhaust box, by increasing the exhausting time or by using the exhausting box and vacuum seamer together. (8) There is a difference of occurrence of springers owing to the difference of the weight of the can. The greater the

differences in weight of cans of the same shape, the more often the springers are found.

The senior author, TANIKAWA, has repeatedly tried to detect the cause of the springer of canned salmon by the analysis of gas in the cans, but he has had no favorable result. Now the present authors have proved that one of the causes of springer is unsufficient exhausting owing to the cross packing of the meat in the container.

1. Gas components in the springer of canned salmon.

FUKUOKA[5] has studied the gas components in the swollen can and the springer of various kinds of canned foods : boiled mackerel, tomato sardine, oil-mackerel, boiled clam, and seasoned skipper. He said that these cans always contain CO_2, sometimes with H_2, and the decomposed can which has smell contains N_2 besides CO_2 and H_2.

MATSUIKE and MITSUHASHI[8] have studied the gas components in the springer of canned salmon, one year after the studies of the senior author and MIYAIRI[1] on the same problem.

TANIKAWA and MIYAIRI[1] have obtained the following results on the gas components in the springer of canned sample.

As shown in Tables 1—6, the amount of the gas content in the springer is greater than in the normal cans. This is due to the bulging of the top of the cans. The amounts of the gas of volatile base, CO_2 and N_2 in the springer are greater than in the normal cans, but the amount of O_2 in the former is less than in the latter. H_2 gas could not be found in the normal cans. The amount of gas in the cans which were incubated at 37°C was somewhat greater than the cans which were not incubated. This is probably due to the evaporation of the volatile base dissolved in the meat in the can.

Judging from the gas content in the springer, the authors could not consider the cause of the springer of canned salmon to be the hydrogen-springer resulting from chemical reaction between the material of the containers and the meat.

In respect to sealing of the springer, the authors could not find any imperfect sealing points. The conclusion is that the cause of the springer of canned salmon cannot be the gas components in the can.

Generally speaking, the springer is of lighter weight than the normal cans as shown in Tables 1—6.

2. The weight of the springer compared wirh the normal can.

The springer is found usually among the light weight (less 562 g.) or normal

Table 1. The amount of gas-content in the springer of the canned salmon collected 5 months after the processing.
(Gas estimated at temperature of 7°C)

Sample No.	The weight of the canned food. (g)	Atmospheric pressures at estimating time. (mm)	Total-gas contents at estimating temp. (c.c.)	Total amount of gas content at standard state. (c.c.)	The amount of volatile base. (c.c.)	The percentage of volatile base to total gas content. (%)	Gas content of CO_2 at standard state. (c.c.)	The percentage of Co_2 to total gas content. (%)	Numbers of tail meat. (pieces)	Remarks
1	570	751.0	34.6	33.4	0.58	1.73	2.41	7.22	1	
2	562	748.3	32.0	30.7	0.77	2.50	5.28	17.20		meat crushed
3	555	752.0	45.5	43.9	0	0	2.51	5.71	2	
4	559	752.0	27.4	26.4	0	0	2.46	9.31	1	
5	562	759.5	31.6	30.8	1.95	6.33	2.14	6.96		
6	566	759.5	21.5	20.9	0.97	4.65	1.85	8.84		
7	555	759.5	32.0	31.1	0.58	1.88	3.48	7.19	1	
8	570	760.8	27.3	26.6	0.39	1.47	1.75	6.59		
9	546	760.8	32.9	32.1	0.39	1.22	1.56	4.86		
10	555	760.8	31.7	30.9	0.49	1.58	1.85	5.99		
11	570	760.5	32.9	32.1	1.66	5.17	3.07	9.57		
12	570	760.5	25.9	25.3	0.64	2.51	1.86	7.34		
13	562	758.3	28.3	27.5	0.88	3.19	1.75	6.37	1	
14	570	758.3	34.7	33.8	1.85	5.48	1.85	5.48		
15	566	757.1	36.8	35.7	0	0	2.39	6.70	2	
16	566	750.1	23.9	23.0	1.06	4.60	1.15	5.00		
17	569	750.1	20.7	19.9	1.40	6.80	0.77	3.86		
18	555	749.8	38.5	37.0	0.34	0.92	2.76	7.47		
19	559	749.8	32.6	31.3	0.58	1.84	2.02	6.44		
20	559	757.9	33.9	32.9	0.44	1.33	2.09	6.35	1	
Average	562	—	—	30.2	0.88	3.13	2.25	7.22		

Table 2. Gas-content in normal commercial canned salmon which was processed at the same time as the springer described in Table 1. (Gas estimated at temp. of 7°C)

Sample No.	The weight of the canned food. (g)	Atmospheric pressures at estimating time. (mm)	Total gas contents at estimating temp. (c.c.)	Total amount of gas content at standard state. (c.c.)	The amount of volatile base. (c.c.)	Th percentage of volatile base to total gas content. (%)	Gas content of CO_2 at standard state. (c.c.)	The percentage of CO_2 to total gas content. (%)	Numbers of tail meat. (pieces)	Remarks
1	574	747.6	8.4	8.1	0.39	4.76	0.53	6.55	1	
2	566	747.6	21.5	20.6	0.38	1.86	0.77	3.72		
3	570	747.6	10.3	9.9	0.53	5.34	0.72	7.28		
4	574	747.6	10.0	9.6	0.43	4.50	1.00	10.00		
5	574	735.6	21.3	20.1	0.42	2.11	0.99	4.93	1	
6	574	735.6	11.0	10.4	0.66	6.36	0.99	9.54	1	
7	570	733.0	19.1	18.0	0.44	2.44	1.27	7.07		
8	570	733.0	9.2	8.7	0.47	5.46	0.61	7.10	2	
9	560	733.0	10.35	9.7	0.47	4.81	0.71	7.25		
Average	570.9	—	—	12.8	0.47	4.18	0.84	7.05	—	

Table 3. Gas-content in the springer which was processed at the same time as the springer described in Table 1 and placed in the thermostat (37°C) for 7 days. (Gas estimated at temperature of 7°C)

Sample No.	The weight of the canned food. (g)	Atmospheric pressures at estimating time. (mm)	Total-gas contents at estimating temp. (c.c.)	Total amount of gas content at standard state. (c.c.)	The amount of volatile base. (c.c.)	The percentage of volatile base to total gas content. (%)	Gas content of CO_2 at standard state. (c.c.)	The percentage of CO_2 to total gas content. (%)	Numbers of tail meat. (pieces)	Remarks
1	559	740.4	27.8	26.4	1.52	5.76	0.86	3.24		
2	578	740.4	17.8	16.9	1.04	6.18	0.81	4.79		
3	589	745.8	7.0	6.7	0.29	4.29	0.29	4.29	1	
4	570	754.2	24.3	23.5	1.17	4.96	0.87	3.70	1	
5	562	754.2	27.8	26.9	1.26	4.68	0.87	3.24		
6	566	758.4	34.5	33.6	1.46	4.35	1.17	3.48		
7	574	758.4	22.8	22.1	0.87	3.95	1.02	4.61	1	
Average	571.1	—	—	22.3	1.09	4.88	0.84	3.91	—	

Table 4. The amount of gas-content in the normal commercial canned salmon which was processed at the same time as cans described in Table 2 and was kept in the thermostat (37°C) for 7 days. (Gas estimated at temperature of 7°C)

Sample No.	The weight of the canned food. (g)	Atmospheric pressures at estimating time. (mm)	Total gas contents at estimating temp. (c.c.)	Total amount of gas content at standard state. (c.c.)	The amount of volatile base. (c.c.)	The percentage of volatile base to total gas content. (%)	Gas content of CO_2 at standard state. (c.c.)	The percentage of CO_2 to total gas content. (%)	Numbers of tail meat. (pieces)	Remarks.
1	566	745.8	24.8	23.7	1.34	5.65	0.95	4.02	1	
2	570	745.8	23.1	22.1	0.96	4.33	0.86	3.90		
3	562	744.5	31.9	30.5	1.15	3.76	0.38	1.25		
4	574	744.2	27.4	26.2	1.34	5.11	0.57	2.19		
5	581	744.2	9.0	8.5	1.00	11.73	0.38	4.47	1	
6	574	761.2	32.3	31.5	0.73	2.33	1.19	3.78	2	
7	570	761.2	23.5	22.9	1.66	7.23	0.78	3.40		
8	570	761.2	8.8	8.6	0.88	10.23	0.57	6.82		
Average	570.9	—	—	21.75	1.13	6.30	0.73	3.73		

weight cans (526~578 g) as shown in Table 7.

The average weight of the springer collected in 5 months after the processing in the factory was 556 g, and the average weight of the normal canned salmon was 559 g. Regarding the difference of the weight of can between the springer and the normal can, MATSUIKE and MITSUHASHI[2] said that the average weight of the springer was 563 g, while that of the normal can was 574 g, the difference of their weight being about 11 g. These results agree with the observations of the present authors.

It is a fact that the springer is rarely caused by the overfilling despite the results offered by BIGELOW[4], but in the light weight can or normal weight there is a probability occurrence of the springer. In the light weight can, it is supposed that there are surely clearances in the meat in the container.

The authors have proceeded with these studies, basing their work on the fact above mentioned.

3. The observation of the contents in the springer.

In a modern cannery preparing canned salmon the meat is filled by Machine Filler. Sometimes the meat is filled in a state of crossed packing. The packed can is rehandled in order to clear the surface of the meat in the can. That is to say, gaps between

Table 5. Gas-content in the springer of canned salmon collected in the factory.

Sample No.	The weight of the canned food. (g)	Atmospheric pressures at estimating time. (mm)	Total-gas contents at estimating temp. of 7°C (c.c.)	Total amount of gas content at standard state. (c.c.)	The amount of volatile base. (c.c.)	The percentage of volatile base to total gas content. (%)	Gas content of CO_2 at standard state. (c.c.)	The percentage of CO_2 to total gas content. (%)
1	570	764.4	38.2	37.5	0.19	0.52	2.25	6.02
2	562	764.4	17.0	16.7	0.69	4.12	0.88	5.29
3	562	764.4	23.8	23.3	1.08	4.62	0.98	4.20
4	555	748.7	33.2	31.9	1.00	3.01	1.30	3.91
5	574	761.4	24.2	23.4	1.84	7.83	0.48	2.07
6	570	769.0	26.7	26.3	1.08	4.12	0.59	2.25
7	562	759.1	27.4	26.7	0.97	3.62	1.07	4.01
8	570	759.1	23.1	22.5	0.39	1.73	1.66	7.36
9	570	761.9	26.0	25.4	1.17	4.60	1.79	7.0
10	574	762.6	46.1	45.1	1.17	2.60	1.85	4.1
Average	556.9	—	—	27.9	0.96	3.68	1.29	4.62

(Table 5. Continued)

Sample No.	Gas content of O_2 at standard state. (c.c.)	The percentage of O_2 to total gas content. (%)	Gas content of H_2 at standard state. (c.c.)	The percentage of H_2 to total gas content. (%)	Gas content of N_2 at standard state. (c.c.)	The percentage of N_2 to total gas content. (%)	pH	Vacuum inches
1	0.19	0.52	0	0	34.81	92.94	6.4	0″
2	0.39	2.32	0	0	14.71	88.24	6.6	0
3	0.49	2.10	0	0	20.78	89.08	6.4	0
4	0.70	2.11	0.19	0.6	30.00	90.36	6.8	0
5	0.30	1.65	0.19	0.83	20.52	87.61	6.4	0
6	0	0	0	0	24.65	93.63	6.8	0
7	0	0	0	0	24.64	92.34	6.4	0
8	0.49	2.16	0.49	2.16	19.47	86.59	6.2	0
9	0.38	1.50	0	0	22.09	86.92	6.4	0
10	1.26	2.80	0	0	40.81	90.50	6.2	0
Average	0.53	1.90	0.29	1.19	25.25	89.82	6.5	—

Table 6. Gas-content in the normal canned salmon collected at the same time as the springer.

Sample No.	The weight of the canned food. (g)	Atmospheric pressures at estimating time. (mm)	Total-gas contents at estimating temp. of 7°C (c.c.)	Total amount of gas content at standard state. (c.c.)	The amount of volatile base. (c.c.)	The percentage of volatile base to total gas content. (%)	Gas content of CO_2 at standard state. (c.c.)	The percentage of CO_2 to total gas content. (%)
1	578	760.5	11.8	11.5	0.49	4.24	0.49	4.24
2	570	760.9	19.7	19.2	1.17	6.09	0.88	4.57
3	559	766.7	14.6	14.4	1.18	8.22	0.79	5.48
4	578	766.7	14.6	14.4	0.20	1.38	0.49	3.44
5	581	762.4	18.7	18.3	0.29	1.60	0.59	3.20
6	562	761.0	23.7	23.1	0.69	3.00	0.49	2.10
7	592	765.0	10.2	10.0	0.10	1.00	0.39	3.90
8	566	759.5	26.2	25.5	0.10	0.40	0.15	5.70
9	559	761.8	30.6	29.9	0.87	2.90	1.76	5.90
Average	571.7	—	—	17.4	0.57	3.20	0.67	4.27

(Table 6. Continued)

Sample No.	Gas content of O_2 at standard state. (c.c.)	The percentage of O_2 to total gas content. (%)	Gas content of H_2 at standard state. (c.c.)	The percentage of H_2 to total gas content. (%)	Gas content of N_2 at standard state. (c.c.)	The percentage of N_2 to total gas content. (%)	pH	Vacuum inches
1	0.29	2.54	0	0	10.24	88.98	6.2	6″
2	0.98	5.08	0	0	16.20	84.26	6.2	3
3	0.20	1.37	0	0	12.20	84.93	6.6	3
4	1.09	7.59	0.20	1.38	12.38	86.21	6.4	4
5	1.17	6.40	0	0	16.24	88.80	6.3	
6	1.27	5.50	0	0	20.68	89.4	6.2	
7	0.49	4.90	0	0	9.02	90.2	6.3	
8	0.48	1.90	0	0	23.48	92.0	6.2	
9	0.48	1.60	0	0	26.80	89.6	6.3	
Average	0.72	4.10	—	—	16.36	88.26	6.3	—

Table 7. The percentage of weights of can.

Classification by weights	%
Light weight can (less than 562 g.)	37
Normal weight can (562 – 578 g.)	56
Heavy weight can (more than 578 g.)	4

Fig. 1. The condition of meat packing in the springer.

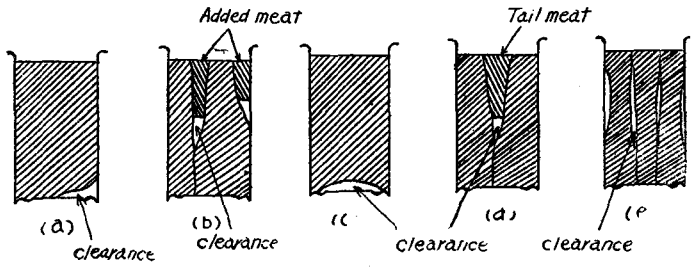
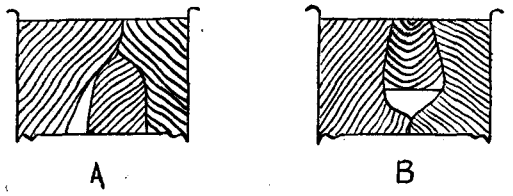


Fig. 2. The condition of meat packing in the springer of canned salmon.



the meat are filled with pieces of meat and crushed by the flat in appearance.

However, if there are vacant spots (clearances) deep in the meat, those vacant parts contain air.

MATSUIKE and MITSUHASHI[3] explained the matter, supposing the forms of vacant parts in the meat of the crossly packed salmon as in Fig. 1. The authors have also believed that there will be vacant parts in the springer of canned salmon.

The authors have opened 2 cans of the springer of canned salmon, Flat 1 Pound type. It was not possible to obtain the springer in Tall 1 Pound. The meat in these samples was gently taken off on dishes and the form of vacant parts in the meat was observed.

By these experiments, the authors have found that there are vacant parts in the meat of the springer as shown in Fig. 2.

At the same time normal cans were opened and the state of packing observed, but no vacant part in the meat were seen.

Generally speaking the springer has been said to occur more often in Tall 1 Pound can than Flat 1 Pound can. This is owing to the fact that the flat can is less likely to be cross packed than the tall can; then the former has less chance to have vacant parts in the meat.

But the flat can also rarely presents the springer as the experiment by the authors.

The can which has vacant parts in the meat almost always becomes a springer.

4. Experiment on the artificial making of the springer.

The authors have supposed that the springer may be caused by expansion of

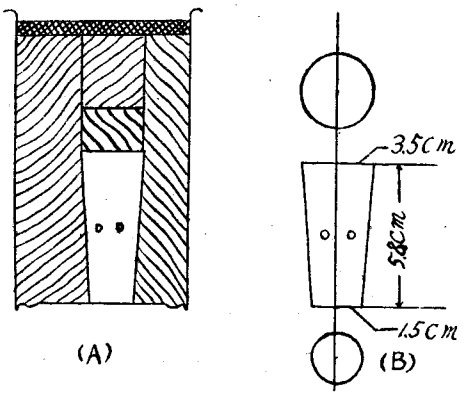
the entertained air in the vacant parts in the meat of the can according to the change of room temperature.

Here, the authors have tried to make the springer artificially by intentionally cross-packing the meat in the can in a way to leave vacant spaces.

The authors have packed mackerel meat in stead of salmon meat, because they were unable at the moment to obtain salmon.

The authors packed 510 g of mackerel meat in Tall 1 Pound can as shown in Fig. 3 (A). In this case they have placed a conical hollow tin made in imitation of fish tail meat as shown in Fig. 3 (B) deep in the meat.

Fig. 3. Meat packing in order artificially to make the springer.



The authors have packed also 510 g of mackerel meat in other Tall 1 Pound can, in which the trace of the conical tin was left by removing it.

To these cans was added crushed meat on the surface of the meat and made to have clean top by pressing. Then exhausting and sterilization were carried out as usual.

As control the authors packed the same content of the mackerel meat in Tall 1 Pound can which was processed as usual.

Those cans were placed in the thermostat of 37°C during 3 days, two of them became springers, the two in which clearances were left, but not the control can. By experimental result, the presumption of the authors was proven to be correct.

From these results it is judged that the springer may be caused by the same mechanism irrespective of the kind of fish.

5. The prevention of the springer.

As the mechanism of the occurrence of the springer has been cleared up, if the cause is removed, it follows that the springer will not occur. This fact became clear from the following experiment. The authors packed mackerel meat in a Tall 1 Pound can without making clean top by the flat of the hand. That is to say the clearance was left between the can wall and the meat. The processing thereafter was as usual. They also packed another can which was exhausted 30 minutes longer than the usual heat exhausting in order completely to remove the air in the meat. Those cans were incubated in the thermostat of 37°C, but they have not become springers. In the latter can, the vacuum inches was

rather 11 inches.

To prevent the occurrence of the springer the clearance must be left between the can wall and the meat, or there must be longer exhausting. Parhaps the extention of exhausting time will be discussed in another place from the chemical or commercial points of view.

6. On the sprinqer of the dented can.

A can sometimes becomes a springer by inner pressure from the denting of the container.

The authors obtained two dented cans which indicated the state of the springer. These dented cans were normal in weight; 563 g and 564 g. They were clearly bulged by the inner pressure.

Conclusion.

The authors have clarified the mechanism of the happening of the springer of canned salmon as follows:

In the machine packing, tail meats or other meat blocks are cross-packed leaving the clearance in meat. To the surface of the meat is added crushed meat then pressed by the flat of the hand in order to make a clean appearing top. The gas in the clearance in the meat is expanded by the change fothe atmospheric temperature, with the result that the end of the can is bulged. This is the springer.

The springer is caused irrespective of the kinds of fish packed, by the same conditions.

As the causes of the happening of the springer, one cause which was demonstrated by the authors should be added to the 6 causes offered by BIGELOW over 25 years ago.

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