戻しグリンピース缶詰の肉質軟化に関する研究

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Studies on Softening of "Soaked Dried Peas" for Canning.

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Summary

In order to obtain suitable conditions for softening of soaked dried peas, various tests were investigated.

As results of experiments of packing conditions etc., it was concluded that if peas are washed with running water for 2-3 hr. after blanching and immediately packed with addition of about 0.1% (as Ca) Ca salt in the brine and processed at 121°C for 60 min. for JCS No. 1 can or 30 min. for other smaller cans, we may obtain canned products satisfying general consumers' requirements.

Introduction

In the last decade, the production of "greeen peas" with fresh materials has rapidly decreased in Japan. Instead, the manufacturing of the canned products using soaked dried peas imported from U. S. A. and other countries has been increasing. At present their annual production counts above one million cases.

Soaked dried peas were already canned in Japan even before the World War II, using Alaska produced in Hokkaido, which had been harvested in a pre-matured state (so-called Furuishita). In this case the canned products of a comparatively good quality could be obtained due to the suitable degree of the maturity of the materials. However, the production was limited because of low yields of the material.

On the other hand, soaked dried peas have been largely canned in U. S. A. and European countries. But nature of the products in the above countries is different from that in Japan, since the interest of canners in other countries is simply in softening of peas and not in making unbroken peas as often eagerly discussed in Japan. They can also use even overmatured peas as mixtures in high rates.

On the contrary, in Japan the canned "green peas" have always their first significance as accentuating material for food. They have to be "green" and broken peas are exclusively unfavored. Consequently to maintain their natural figure, canned peas are apt to be too hard for food. In fact, it is a problem that many canned products with soaked dried peas commercially obtained in Japan are found too hard. Under such circumstances it was a request claimed to us, to find a methed of manufacturing soft but still unbroken products of soaked dried peas.

The problem to find the conditions for obtaining unbroken and still soft processed peas is not at all easy to solve, because it contanins two antagonistic factors in nature. Moreover, since dried peas materials used at present for canned products are of various kinds in maturity, the production of soaked dried peas with uniformal softness is difficult. Hence for making good products the investigation of the material should be the first work of this kind of studies. Nevertheless, the investigation of the materials is apt to be hindered by the complexity concerned with the producing districts and dealers, and it seems not to be promoted in a limited time.

The present studies were therefore directed to that better products would be obtained by improving the processing method. At the same time, the measurement of hardness of the products was also studied and this will be together reported.

In addition, copper sulfate as dying material was not used, and instead of it a mixture of blue dye (Brilliant Blue FCF) and yellow dye (Tartrazine) were employed throughout the investigations.

Methods and Results

I. Investigation on hardness measurement method.

It was tested which is the most suitable hardness meter for soaked dried peas among those commercially available for fruits and vegetables. Two types of hardness measurement may be considered for "green peas".

A) the hardness is measured by crushing a given amount of peas at one time.

B) the hardness of each pea is measured.

As type A, Tenderometer of FMC, etc. may be considered, but at present these are scarcely employed in Japan and actually we could not test the instruments. However, we think this type of instrument would give the most reliable hardness.

As for type B, there are, for example, the fruits hardness meter of the Canners Association of Japan (CA), Sato's universal hardness meter, etc. as simple apparatus and General Foods' Texturometer, etc. would be considered as more precise apparatus. However, since we should use a simple apparatus to apply to "green peas" with which a lot of samples should be treated quickly, we mostly tested CA hardness meter and Sato's hardness meter. As results, with CA hardness meter, the hardness of skin seemed to affect the results largely due to its mechanical construction, whereas with Sato's hardness meter the measurement was most satisfactory to express the hardness of peas, when the small plunger (5 mm in diameter and 10 mm in length) was used to crush peas. In Table I the hardness of canned "green peas"

Table I The hardness of canned "green peas" measured with Sato's universal hardness meter

Samples	Materials	Hardness range (15 peas)	Average hardness (15 peas)
A	Fresh	100—280 g	196 g
B	Dried	330—560	416
C	〃	420—990	684

Maximum scale 1 kg
Minimum scale 20 g
Small plunger used (10 mm length and 5 mm in diameter)

measured with Sato's universal hardness meter is presented.

From the above results, we conveniently defined the hardness of "green peas" as follows.

Too hard : average hardness above 500 g
Allowablly soft : average hardness 300-500 g
Soft : average hardness below 300 g

In Table II are presented the results of hardness measured with Texturometer. Although this method may give a sufficient result for measurement, it seems impractical to apply the method to "green peas", for the reason of complication of procedure and economy.

Table II Hardness measured with Texturomter

No.	Diameter of pea	Hardness	No.	Diameter of pea	Hardness
	mm	per Volt		mm	per Volt
1	6	1.33	6	7	2.03
2	〃	1.40	7	〃	1.90
3	〃	1.45	8	〃	2.08
4	〃	0.96	9	〃	2.20
5	〃	1.80	10	〃	2.01
Average		1.39	Average		2.04

Test conditions Plunger : Lucit 17 mm
Clearance : 2 mm
Voltage : 2 V
Chart speed : 1500mm/M

Considering the above results of measurements with hardness meters, we decided that the tests presented below would be carried out under the following conditions.

Hardness meter : Sato's universal hardness meter
maximum scale 1 kg
minimum scale 20 g

Table III Hardness of commercial products of "green peas"

		Labeled	Date	pH	Hardness range	Average hardness
A	Bottled	Fresh	9015	5.7	190— 340 g	282 g
B	〃	〃	0108	5.9	280— 560	377
C	〃	〃	9826	6.0	200— 380	292
D	〃	〃	8326	6.4	260—above 1,000	394
E	〃	—	0112	6.5	510— 〃	612
F	〃	—	9Y21	5.8	100— 290	204
G	Pouched	—	—	5.8	490—above 1,000	764
H	Canned	Dried	9Y12	6.1	290— 620	470
I	〃	Fresh	8612	5.9	360— 770	401
J	〃	Dried	9329	6.0	290— 520	397
K	〃	〃	9809	5.5	470—above 1,000	670
L	〃	Fresh	9602	5.6	290— 790	418
M	〃	〃	9Y17	5.8	190— 570	378
N	〃	〃	8Y30	5.7	290— 410	351
O	〃	〃	9326	5.8	250— 440	334
P	〃	Dried	9927	5.6	420—above 1,000	593
Q	〃	〃	9Z02	6.1	110— 450	276

O……Made in the Republic of China. Q……Yellow peas ("Golden peas").

small plunger 5 mm in diameter
10 mm in length

Number of peas tested :

15 peas per can for JCS * No. 6 can (301×205).

30 peas per can for JCS No. 1 can (603×700).

(Only well-shaped and not broken peas are chosen for measurement).

II. Hardness measurement of commercially available "green peas."

In order to investigate the hardness of "green peas" commercially available, 17 samples were chosen and tested. These results are shown in Table III.

As seen in Table III, in the case of products with fresh peas, all the average hardnesses were below 400 g and their deviation was comparatively small. On the other hand, in the case of soaked dried peas almost all the products except H and J showed the average hardness above 600 g and the hardness range was found very large. This may be said a reasonable result, considering the nature of the materials, but it should be also noted that these soaked dried peas were too hard for canned products.

Although H and J were labeled as soaked dried peas, they were comparatively soft. However, these products apparently differed from other products in the shape of peas and considered to have been manufactured with the peas produced in Hokkaido. Sample Q was "golden peas" and they were soft but almost all the peas were broken.

From the above, it was concluded that we should produce canned soaked dried peas of the hardness at least below 500 g as average value.

III. Investigation on manufacturing conditions.

Until last year copper sulfate would be used as dying material for "green peas" manufacturing. However, recently the control of food additives has become stricter and copper sulfate as dying material seems to be prohibited in near future. In this situation our tests of "green peas" were also intended to proceed without using copper sulfate. The biggest problem in this case was to decide the condition of processing without copper sulfate.

As is known, copper sulfate had been utilized not only for its dying effect but for its sterilizing capacity in canned "green peas" manufacturing. Consequently in previous manufacturing of canned "green peas" the processing at 100°C for 60 min. would be applied to manufacturing of JCS No. 4 can (301×407) of "green peas". It would be necessary to process at above 108° or to control pH to lower values by adding citric acid, etc. and to process at 100°, when canned without copper sulfate. Considering these factors, the following tests were undertaken.

1) *The results of the first run.*

In order to examine the possibility to process at 100° by the aid of addition of citric acid to the products, the following tests were carried out.

The standard method used was the one which was approved at the technical meeting of Canned Soaked Dried Peas Manufacturing Commitee on November 4, 1968 and later refined at Institute of The Canners Association of Japan.

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* (JCS···Japanese Can Size)

Manufacturing Method of Test Cans.

A. Standard method

1. Soaking in 3 volumes of water for one night.
2. Blanching in 2 volumes of water for 40 min.
   (for 20 min. at inside temperature 95°—98°)
3. Aging for 30 min.
4. Washing for one night with running water.
5. Filling 130 g in JCS No. 6 can (301×205).
6. Brine 20 g NaCl+90 mg yellow dye+20 mg blue dye per 1 kg water.
7. Seaming an "O" type seamer with chamber vacuum 55 cmHg.
8. Processing at 108° for 40 min. (pH 6.2).

B. Citric acid treatment

(a) 0.5% citric acid was added to brine (pH 4.8).

(b) Dried peas were soaked in 0.5% citric acid solution overnight and 0.5% citric acid was also added to the brine (pH 4.1).

Processing was carried out at 100°C for 60 min. both in the above two cases.

The results of the quality tests for the products prepared by the above experiments are shown in Table IV.

The materials used were new dried peas obtained at the end of November, 1968 and older dried peas.

New : within half a year after harvesting.

Older : more than one year passed after harvesting.

Table IV The results of quality test for the first run

Peas	Citric acid	Processing conditions	pH	Splits	Hardness range	Average hardness
new	added*	100 °C for 60 min.	4.1	13	500—740 g	612 g
〃	without	108 °C for 40 min.	6.2	11	330—560	416
〃	added**	100 °C for 60 min.	4.8	6	370—950	493
〃	without	108 °C for 40 min.	6.2	22	320—620	481
older	added**	100 °C for 60 min.	4.8	14	470—790	531
〃	without	108 °C for 40 min.	6.2	10	390—650	500

* Soaked in 0.5% citric acid overnight. 0.5% citric acid was also added to brine.
** 0.5% citric acid was added to brine only.

As seen in Table IV, it was likely that pH control would be facilitated by the aid of 0.5% citric acid treatment and the processing at 100°C might be possible. However, the peas were found always softer with samples processed at 108°C. Moreover, samples treated with citric acid seemed to have some disadvantage in taste.

2) *Results of quality tests for the second run.*

The second run was carried out under the same conditions as for the first, except the followings. In the previous run, the sample which had been soaked in 0.5% citric acid overnight and to which the brine containing 0.5% citric acid was added, showed a rather too low pH, i. e. pH 4.1, so that this time citric acid concentration was reduced to

0.3% for soaking overnight and also 0.3% was used as the concentration in the brine, only for the corresponding sample.

The results are presented in Table V.

Table V Results of quality tests for the second run

Quality grading by 20% salt solution	Peas	Citric acid	Processing	pH	Splits	Hardness range	Average hardness
Floated	New	Added	100° for 60 min.	4.5	8	330—720 g	504 g
〃	Older	Added	〃	〃	4	350—640	573
〃	New	Without	108° for 40 min.	6.2	5	180—440	305
〃	Older	Without	〃	6.3	8	500—820	623

As seen in Table V, when citric acid concentration was reduced to 0.3%, pH 4.5 was resulted which could be considered favorable for processing.

From the results in Table IV and V, in comparing new peas with older peas, the former were apparently softer. Hence new materials should be primarily recommended to use.

3) *Results of quality tests for the third run.*

In the third run, copper chlorophyllin treatment was carried out. The concentration of copper chlorophyllin was 0.1g/l for blanching.

The results are presented in Table VI.

Table VI Results of quality tests of copper chorophyllin treated "green peas"

Peas	Citric acid*	Processing	pH	Splits	Hardness range	Average hardness
New	Added	100°C for 60 min.	4.7	7	460—830 g	602 g
Older	〃	〃	4.7	0	600—940	795
New	Without	108°C for 40 min.	6.4	6	380—660	499
Older	〃	〃	6.2	2	480—810	622

* Citric acid was added in 0.5% only to the brine.

As seen in Table VI, copper chlorophyllin treated peas showed a tendency to increase the hardness though not intensively. Considering undesirable addition of copper reagent, the use of copper chlorophyllin should be avoided.

4) *Effect of washing with running water after blanching.*

It is generally seen that the packing of "green peas" immediately after blanching often causes splitting of peas, so that washing with running water after blanching is carried out usually for one day or even for two days before solid packing. Hence we investigated the effect of the washing on the hardness.

In Table VII, change of hardness before the solid packing is presented.

As can be seen in this Table, with increasing time for washing with water, the hardness of "green peas" increases. Washing overnight after blanching causes an appreciable increase in hardness.

The hardnesses measured with these "green peas" are shown in Table VIII. No citric acid was employed and processing was carried out at 108°C for 40 min. in all the cases.

Table Ⅶ Change of hardness before packing

Peas	Quality grading by 20% salt solution	Immediately after quality grading		After water washing overnight		After water washing one day and a night	
		Range	Average	Range	Average	Range	Average
New	Floated	280— 720 g	505 g	450— 900 g	574 g	470— 760 g	654 g
	Sank	470—above 1,000	691	510—above 1,000	834	550— 990	818
Older	Floated	400— 890	566	560— 840	685	580— 810	719
	Sank	530—above 1,000	650	730—above 1,000	878	710—above 1,000	880

In blanching, 1/10,000 copper chlorophyllin was used.

Although from Table Ⅷ we could recognize slight increase of the hardness with increasing washing time (especially with new peas), the average hardness did not show any appreciable difference. Therefore we may obtain products of good quality, if we pack immediately after washing for reducing the hardness.

IV. Possibility of quality grading by salt soltion.

As already stated, materials of soaked dried "green peas" contain many different kinds in maturity and hence the products of uniformal quality are difficult to be obtained.

In this sense we tried the quality grading by salt solution for the peas after blanching.

Table Ⅷ The results of hardness measured for canned "green peas"

Washing with running water for	Quality grading by 20% salt solution	Peas	pH	Splits	Hardness range	Average hardness
				peas	g	g
One night	Floated	New	6.4	6	380—660	499
	〃	Older	6.2	2	480—810	622
	Sank	New	6.4	13	460—800	568
	〃	Older	6.2	2	480—940	658
Two nights	Floated	New	6.3	4	420—680	521
	〃	Older	6.2	3	500—920	521
	Sank	New	6.3	4	480—910	589
	〃	Older	6.2	2	540—850	625

For the fresh peas usually the salt solution of below 10 % is used, but for soaked dried peas we used 20% NaCl solution because peas involve a lot of those in overmaturity.

The results are presented in Table Ⅸ a and b.

Table Ⅸa. Effect of quality grading by 20% salt solution

Peas	Original	After one night soaking	After quality grading	
New	1,000 g	2,080 g	Floated	1,595 g
			Sank	870
Older	1,000	2,055	Floated	1,860
			Sank	520

New : within half a year after harvesting.
Older : more than one year passed after harvesting.

The results of hardness measured for the products treated in Table Ⅸ are given in Table Ⅹ.

From the results of Table Ⅹ, it was recognized that the "green peas" that floated by

20% salt solution quality grading gave apparently lower hardness and hence this quality grading was effective. However, as presented in Table IX, the percentage of "green peas" that floated by 20% salt solution quality grading was 78% as maximum and 41% as minimum, showing the average 57%. Moreover, the results may largely depend on peas material, blanching conditions, etc. Consequently it may be concluded that salt solution quality grading is practically of little signifcance for the present purpose.

Table IXb. Effect of quality grading by 20% salt solution

Peas	Original	After one night soaking	After quality grading	
New	1,500 g	3,170 g	Floated	1,540 g
			Sank	2,240
Older	1,500	3,095	Floated	1,920
			Sank	1,630

Table X Hardness measured of "green peas" after quality grading by salt solution

Peas	Quality grading by 20% salt solution	Hardness range	Average hardness	Note
		g	g	
New	Floated	180—440	305	The same material as for Table IX a.
〃	Sank	360—940	566	
Older	Floated	500—820	623	
〃	Sank	430—930	635	
New	Floated	380—660	499	The same material as for Table IX b.
〃	Sank	460—800	568	
Older	Floated	480—810	622	
〃	Sank	480—940	658	

(All the "green peas" were prepared without addition of citric acid and processed at 108°C for 40 min.).

V. Investigation of processing conditions.

1) *The possibility of the prosessing at* 121°C.

The processing conditions for canned soaked dried peas according to NCA in U. S. A. are as follows.

Table XI Processing conditions for soaked dried peas (according to NCA Process table)

Cans	Initial temp.	Processing temp.	Processing time
No. 10*	38—60° C	115° C	70 min.
〃	〃	121°	40 min.
No. 2½** and smaller	38—60°	115°	45 min.
〃	〃	121°	20 min.

* Same as JCS No. 1.
** Same as JCS No. 2 and smaller.

We first tested the processings at 115°C for 45 min. and at 121°C for 20 min. with samples of solid filling one day after blanching. These were found to produce satisfactorily few splits and the possibility of processing at the above temperatures could be demonstrated.

Further, as stated in the sections for the investigation of manufacturing conditions and effect of washing with running water, in order to keep the hardness low, it is necessary to pack the solid immediately after blanching. In carrying out the experiments, we added Ca salt in the can, for we thought that knowing the hardening effect of Ca salts on processed peas, we might expect their protecting effect against the splits, though Ca salt might harden the skin of peas.

In Table XII the results of the investigation of the concentration effect of Ca salt are presented.

As seen in Table XII, the addition of 0.3% $CaCl_2$ in brine resulted favorable products

which had almost no splits and were still satisfactorily soft, when packed immediately after blanching.

In this position we decided the following method for manufacturing the canned products of soaked dried "green peas" and tested with different lots of the material.

The manufacturing method of canned soaked dried peas.

1) Soaking in 3 volumes of water for 16 hr.
2) Blanching elevating the temperature in steam cooker up to 95° in 20 min., thereafter at 95° for 20 min.
3) Aging for 30 min.
4) Quality grading after cooling with running water, in 20% NaCl solution (broken peas or splits that may float are thrown).
5) Washing with running water for 2 to 3 hr.
6) Filling (Immediately after washing)
130g JCS No. 6 enameled can.
7) Brine 20g NaCl, 20mg blue dye, 90mg yellow dye and 5 g calcium lactate in 1 liter water (98°C).
8) Seaming an "O" type seamer with chamber vacuum 55-60 cmHg.
9) Processing at 121° for 30 min.
10) Cooling

In Table XIII are presented the results obtained with different lots of materials. These materials were given in February and in May, by Tokai Canning Co., and by Tengu Canning Co., respectively.

Table XII Effect of calcium salt on quality of canned "green peas"

No.	$CaCl_2$ %	Packed immediately after blanching			Packed one night after blanching		
		Splits	Hardness range	Average hardness	Splits	Hardness range	Average hardness
1	0	almost all peas	240—510 g	388 g	14 peas	360—760 g	530 g
2	0.1	58 peas	240—430	327	6	330—830	606
3	0.2	48	340—560	458	10	430—760	580
4	0.3	5	380—680	494	7	470—940	707

(All products were processed at 121°C for 30 min.).

Table XIII Results obtained with different lots of materials

Lot No.	Ca-Lactate	Packed immediately after blanching			Packed one night after blanching		
		Splits	Hardness range	Average hardness	Splits	Hardness range	Average hardness
1	0.5%	16 peas	490—760 g	512 g	12 peas	430—820 g	588 g
1	0	almost all peas	—	—	135	380—590	511
2	0.5	17	380—700	497	—	—	—
3	〃	19	310—570	465	—	—	—
4	〃	8	390—680	519	—	—	—

(About 400 peas were contained in JCS No. 6 can (301 × 205)).

As seen in Table XIII, in all the cases of 4 lots used in this test, very few splits were found and the average hardnesses were about 500g which may express sufficient softness of canned products. Here again the effects of addition of Ca salt and of washing time are seen.

In addition a part of these products was inspected by Mr. Ikeno, Director of Kobe Office of the Japan Canned Food Inspection Association. The results were grade 3 for hardness and grade 4 for shape (especially for split). *

* JAS inspection qualification above 3 : Pass

5 : Fancy grade

From these results we concluded that we may obtain sufficiently soft canned soaked dried peas, when processing is carried out at 121°C for 60 min. for JCS No. 1 can (at 115° for 90—100 min.), or at 121° for 30 min. for JCS No. 2 can or smaller cans (at 115° for 60—70min.).

Of JCS No.1 can, although we can not say that we did sufficient investigation, one test of processing at 121° for 60 min. gave a favorable result : percentage of split 3.3%/200g, hardness range 360—720g, average hardness 534g.

2) *Calculation of processing value.*

As stated above we set up the processsing conditions for soaked dried peas as at 121°C for 30 min. or at 115° for 60 min. for JCS No.4 can.

However, considering the posibility that canned dried peas can be infected with *C. botulinum*, we tried to estimate the sterilization value, though the above conditions are considered normally sufficent, for these are considerably stricter than those defined by NCA.

From the temperature measurement in processing, fh values were obtained to be 2.8 both for 121° and 115°C processings.

In order to obtain processing value F_0, we used Ball's equation : in this treatment g value was taken to be 0.1.

$$t=fh\ \log\frac{jI}{0.1}+U-fhC_{0.1}$$

In the case of processing at 121°C for 30 min.

T_1 =121°C=250°F

t =30 min.

fh =2.8

come-up time=2 min.

jI =68

Z =18

$C_{0.1}$ =1.754

Hence

$$U=t+2\times 0.42-fh\log\frac{jI}{0.1}+fhC_{0.1}$$

$$U=27.11$$

from $\log\frac{U}{F_0}=\frac{250-T_1}{Z}$, $F_0=U$ in the case of 121°

hence $F_0=27.11$

In the case of processing at 115°C for 60 min.

$T = 115°C = 245°F$

$t = 60$ min.

$fh = 2.8$

come-up time=3 min.

$jI = 63.5$

$Z = 18$

$C_{0.1} = 1.754$

Hence $U = t + 3 \times 0.42 - fh \log \frac{jI}{0.1} + fhC_{0.1}$

$U = 57.15$

$\log \frac{U}{F_0} = \frac{250 - T_1}{Z}$

$F_0 = 14.12$

According to Mr. Fujiwara of the Canners' Association of Japan, in the case of *C. Botulinum* $F_0=4.03$, $Z=18$ are taken. In comparison of these values with those obtained by us for the present case, our conditions are sufficient for processing and may be said even excessive.

However, canned soaked dried peas manufactured under our conditions have no problem of flavor nor other points and we could not find any disadvantage due to processing. Hence the manufacturing of canned soaked dried peas was decided to be carried out under the conditions as stated above.

We could not carry out sufficient tests with JCS No. 1 can, mainly due to the shortage of labor, and the presentation of the data is omitted here. However, no problems would be considered of the processing value, if the processing is carried out at 115° for 90—100 min. or at 121° for 60 min.

VI. Change of quality of canned soaked dried peas during storage.

1) *Change of hardness during storage.*

Since the main component of "green peas" is starch, it is naturally supposed that the starch in α-state resulted during canning process is converted to β-starch during storage and consequently the hardness of the products will increase with time. Storage tests were carried out from the above points, especially to follow the change of hardness of the products during the storage.

The results are presented in Table XIV. In this table size S and L represent peas sieved by a net of 8.7 mm meshes and those remained unsieved, respectively.

As seen in Table XIV, though the hardness seems to increase slightly during one month storage, no large change could be observed. We are considering to continue this type of investigation by storing the products for further 6 months or 12 months and discuss the problem.

As already stated above, starch in "green peas" would change from its α-form to β-form during storage. This may cause the increase of hardness. We investigated whether this

effect could be strengthened by chilling the products during storage.

The results are presented in Table XV.

As seen in Table XV, the change of hardhness could hardly be observed even after 2-month storage in refrigerator.

2) *Color change of "green peas" during storage.*

As already stated in near future copper sulfate as dying material will be prohibited by the Japanese government and instead, use of a mixture of blue dye and yellow dye will replace the copper sulfate. In relation with this, the problem which can should be used, plain can or enameled can as container, had to be considered. In order to solve this problem, the storage test was carried out. JCS No. 4 cans processed at 121° for 30 min. were stored at room temperature. The results are presented in Table XVI.

To measure the color, the brine was filtered with No. 5 C filter paper and the filtrate was applied to a Hunter Color Machine. The transmitted light was measured by using distilled water as blank (L= 100, a=0, b=0).

As seen in Table XVI, L value increased with time and a value apparently de-

Table XIV Change of hardness of "green peas" during storage

Storage period	Size / Ca-salt	S 0.5% Ca-Lactate	S 0.3% $CaCl_2$	L 0.5% Ca-Lactate	L 0.3% $CaCl_2$
After one day	Split %	6.7%	5.7	10.8	7.0
	Hardness range	340—760 g	250—820	450—820	390—780
	Average hardness	497 g	512	580	588
15 days	Split %	4.9%	5.1	9.7	6.7
	Hardness range	310—760 g	390—800	390—760	430—950
	Average hardness	558 g	572	542	634
one month	Split %	4.6%	5.3	10.9	4.6
	Hardness range	310—810 g	390—800	410—720	480—780
	Average hardness	574 g	567	588	641

Table XV Change of hardness during the chill storage

Immediately after packing		After two months storage	
Hardness range	Average Hardness	Hardness range	Average Hardness
430—820 g	599 g	above 400—1,000 g	593 g
490—750 g	587 g	480— 780 g	583 g

(Chilled in a domestic refrigerator at around 7°C).

Table XVI Color change of canned "green peas" during storage

Storage time	Color	Plain can	Enameled can
Before packing	L value	63.50	
	a value	−81.37	
	b value	42.60	
Immediately after processing	L value	79.09	
	a value	−68.00	
	b value	47.20	
15 days	L value	92.39	93.69
	a value	−24.59	−29.41
	b value	35.00	39.60
1 month	L value	93.91	94.11
	a value	−24.52	−26.53
	b value	34.90	38.78
2 months	L value	90.70	93.80
	a value	−22.80	−28.70
	b value	34.89	40.70

creased, i. e. the blue element decreased from green color and yellow element increased. Change of b value was very little during 2-month storage.

The change with time was especially appreciable by 15th day and the brine was considered to become more yellow due to a selective adsorption of blue dye by peas during this storage period.

The difference of color change between the products in plain can and enameled one was in fact slight, though until two months after processing it seemed rather appreciable as the measured values. We may say there was no visible change followed by ordinary eyes.

The reason for this may be explained as due to the fact that the inside of plain can was changed by sulphur stain as if it were enameled. Considering this apparent black colorization and staining of the plain can, we would like to recommend the use of enameled can for canning of "green peas".

Discussion

As we described about the results of the present tests, there are many factors concerning the softening of "green peas" for canning and they are related to each other in complicated ways. However, the biggest factor may be the quality of the material. Namely, the materials employed these days, so called "Small Sieve Whole Green Peas", involve not only those of a wide range of maturity but the ratio of the matured peas to the whole are vary high.

On the other hand, in manufacturing canned fresh "green peas", not only they are harvested in an adequate maturity, but they are quality graded immediately after harvesting. Consequently the homogeneous materials of quality are employed and these products are satisfactorily soft.

In this sense, for canning of soaked dried peas, if possible, dried materials of "Furuishita" of Hokkaido, i. e. peas harvested in an adequate maturity, shoud be used. Even in the cases where such materials are inavailable, at least quality grading should be carried out by any method and the quality of the materials should be made homogenous. These conditions may be absolutely necessary for solving the fundamental problems for the present purpose. Here we repeatedly like to emphasize the necessity of investigations of materials and their improvement.

Next, for the present tests we used Sato's hardness meter for measuring hardness of "green peas". However, for the measurement of hardness of such materials as peas the hardness meters such as Tenderometer, which treats a given amount of peas at the same time, would be more recommendable and we also believe we should use such equipments in our further investigations.

For the conditions for manufacturing of "green peas", we could only treat 5 kg of material as maximum amount in one run due to the limitation of equipment and shortage of labor. Oonsequently our investigations on the conditions of blanching or aging can not be said to have been carried out sufficiently. These should be also repeatedly studied in future.

For the washing with running water, there were found some correlations between the washing time and the hardness of the products.

We may obtain the better results with the shorter washing time. If possiblet the packing immediately after washing would be recommendable.

Quality grading by salt solution was not very effective even by 20% NaCl solution. This kind of quality grading was therefore concluded to be impractical.

The investigations of processing temperatures were carried out according to the methods described in the process table of NCA, where, for processing soaked dried peas, 115° or 121° are most commonly used.

We also carried out processing at temperatures above 115°C, since for the dried peas the infection by *C. botulinum* is easily considered to occur. The results showed that even the processing at such relatively high temperature did not cause any serious splits and especially when Ca salt was added (about 0.1% as Ca) and packing immediately after blanching was also possible and the products could pass the inspection of JAS.

Although there still remain many points to be improved about softness of "green peas", with the present method we may manufacture products which may not disappoint the consumers.

We also estimated the sterilization values for the processing at 121° for 30 min. or at 115° for 60 min. in the case of canning with JCS No. 4 can. In this case $F_0=28.37$ for 121° and $F_0=14.12$ for 115° were obtained and both values satisfied the conditions set up by Fujiwara of CA of Japan, i. e. $F_0=4.04$ for *C. botulinum*. The present conditions may be regarded even as excessive for the present purpose. However, we could not find any disadvantage in the excessive processing and were convinced to obtain soft "green peas" of a good quality by this method for soaked dried "green peas".

Concerning change of quality during the storage we experienced only the results of 2-month storage and hence we are not ready to reach the conclusion. This may be reported later with further experience.

要　　約

戻しグリンピース缶詰の肉質軟化を目的として試験を行い，製造条件，殺菌条件等の検討を行った結果

1. ボイル後の水晒し1夜を2～3時間に短縮し当日肉詰を行う.
2. 腹切れ防止には注入液に Ca として 0.1 %程度の Ca 塩を添加する.
3. 殺菌は1号缶では121°C 60分，2号缶以下は121°Cで30分行う.

以上の条件で製造することにより，十分満足出来る程度の軟さを持つ製品が得られることを認めた.

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