**Danish Research Service for Plant and Soil Science**
*Research Centre for Horticulture*
*Institute of Pomology*
*DK-5792 Årslev*

**Report no. 1965**

# Processing of large cucumber (*Cucumis sativus*)

*Forarbejdning af asier*

**K. KAACK**

## Summary

Large cucumber slices canned with brine containing acetic acid and sucrose is used as a spice on some open sandwiches and to some hot meals.

The effect of the most important processing parameters on the product quality has been evaluated.

Firmness decreases during the blanching, pasteurizing and storage of the product. Because of air removal during the blanching a decrease of lightness (CIE-L) was found. Lightness decreases during storage because of formation of brown degradation products by the Maillard process.

The optimum blanching time to obtain a maximum of firmness was 1.3 minutes. A result of further blanching is an increase of drained weight but a decrease of firmness. By decreasing storage temperature (3–19°C) the quality is kept at higher levels.

**Key words:** *Cucumis sativus*, processing, quality, storage.

## Resumé

Der er udført forarbejdningsforsøg med asier. Formålet var at fremskaffe resultater til vurdering af, hvordan de vigtigste forarbejdningsparametre virker på færdigvarekvaliteten.

Under blanchering og pasteurisering bliver asierne mindre sprøde, og plantevævets indhold af luft uddrives. Denne luftuddrivning fremmer lageoptagelsen og medfører, at produktet får en mere ensartet farve.

Den optimale blancheringstid vil være omkring 1 minut. Yderligere blanchering medfører unødvendigt tab af fasthed. Under lagring fortsætter faldet i fasthed, og produktet bliver mere mørkfarvet, fordi der dannes brunfarvningsprodukter ved Maillard processen. Ved lav lagringstemperatur bevares produktets kvalitet bedst.

**Nøgleord:** Asier, *Cucumis sativus*, forarbejdning, kvalitet.

## Introduction

Fruits of cucumber *(Cucumis sativus)* with a raw weight per fruit of about one kg is processed by peeling, bisection in the length direction, slicing to strips, packing and pasteurizing in glasses.

**Table 1.** Experimental designs.
*Forsøgsplaner.*

| Experiment<br>*Forsøg* | Unit operation<br>*Enhedsoperation* | °C<br>*°C* | Minutes<br>*Minutter* | Storage °C<br>*Lagring °C* |
|---|---|---|---|---|
| 1. | Blanching | 75–95[1] | 0, 1, 2, 4, 8, 16 | 15[3] |
| | Pasteurizing | 95 | 20 | 15[3] |
| 2. | Blanching | 85–95[2] | 4 | |
| | Pasteurizing | 75–95[2] | 16, 32, 48, 80, 96 | |
| 3. | Blanching | 98 | 0, 1, 3 | 3, 8, 13, 19[4] |

1) Intervals 5°C
2) Intervals 10°C
3) Analyses after 5 months of storage
4) Analyses after storage in 69, 133, 225, 281, 369, 439, 533 and 587 days

The product is used as a spice on certain kinds of open sandwiches and some hot meals.

The aim of the experiments were to determine the effects of processing parameters and storage temperature on product quality.

## Materials and methods

### Processing

Peeled and cleaned cucumber halves of the variety 'Langelandsk Kæmpe' were obtained from an industrial plant and cut to slices with an average thickness of 0.8 cm and an average length of 6 cm.

Water blanching was carried out in a steam jacketed kettle with a large amount of water at temperatures specified in the experimental designs. No enzyme test was carried out because enzymatic caused off flavour never occur.

Immediately after the expire of the blanching time, the slices were cooled in a large amount of tap water (13°C).

Three hundred gram of slices were packed in 580 $cm^3$ glasses and 305 g of brine at 65°C were added just before pasteurizing. The brine contained 40 p.c. sucrose, 2 p.c. acetic acid, 1 p.c. NaCl, o.1 p.c. potassium sorbate, and 0.1 p.c. sodium benzoate.

Pasteurizing was carried out in water baths at the temperatures specified in the experimental designs. With water bath temperatures at 75, 85 and 95°C a brine temperature of 72°C in the centre of the glasses were obtained after 40, 21, and 10 minutes respectively.

After expired pasteurizing time the glasses were cooled (13°C) in water baths.

The products were stored in a cold storage room at the temperatures and period of time specified in the experimental designs (Table 1).

### Analysis

Surface colour was measured by use of a Hunter Colorimeter and expressed by CIE values (L, a, b). The surface colour was measured after close packing of cucumber slices in a 2 cm high petri dish.

The firmness of the slices was determined with an Instron apparatus (Food Tester Model) equipped with a Kramer-Shear cell.

The maximum force at a shear velocity of 30 cm/min was registered with 100 g of cucumber slices in the cell. The results were expressed as kg (maximum force).

Response surface methodology combined with backward stepwise variable selection were used to evaluate the results from experiment 3.

**Table 2.** Constants $\log_e(a)$, reaction rates (k) and correlation coefficients (r) for the relation between firmness (H) and blanching time (T) (experiment 1).
*Konstanter $\log_e(a)$, reaktionshastighedskonstanter (k) og korrelationskoefficienter (r) for sammenhængen mellem fasthed (H) og blancheringstid (T), (forsøg 1).*

| °C<br>*°C* | $\log_e(a)$<br>*$\log_e(a)$* | k<br>*k* | r<br>*r* |
|---|---|---|---|
| 75 | 4.16 | –0.004 | 0.848 |
| 80 | 4.33 | –0.016 | 0.975 |
| 85 | 4.25 | –0.038 | 0.997 |
| 90 | 3.86 | –0.046 | 0.975 |
| 95 | 4.31 | –0.109 | 0.999 |

**Table 3.** Constants $\log_e(a)$, reaction rates (k) and correlation coefficients (r) for the relation between firmness (H) and pasteurizing time (T) (experiment 2).
*Konstanter $\log_e(a)$, reaktionshastighedskonstanter (k) og korrelationskoefficienter (r) for sammenhængen mellem fasthed (H) og pasteuriseringstid (T), (forsøg 2).*

| Blanch.-temp.<br>*Blanch.-temp.*<br>°C<br>*°C* | Past.-temp.<br>*Past.-temp.*<br>°C<br>*°C* | $\log_e(a)$<br>*$\log_e(a)$* | k<br>*k*<br>$min^{-1}$<br>*$min^{-1}$* | r<br>*r* |
|---|---|---|---|---|
| 85 | 75&85 | 4.22 | –0.002 | 0.991 |
| 85 | 95 | 4.22 | –0.012 | 0.946 |
| 95 | 95 | 4.40 | –0.012 | 0.996 |

Drained weight (G), firmnes (H), lightness (L) and CIE-a (a), were expressed as a function of blanching time (T), storage time (M), storage temperature (C) and interactions. With a variance coefficient equal to or greater than 4 a variable was included as having significant effect.

## Results

By linear regressions a first order reaction rate of firmness (H) change with blanching time (T) were found:

$$\log_e(H)=\log_e(a)+kT \qquad 1)$$

The values of the constants $\log_e(a)$, reaction rate constants (k) and correlation coefficients (r) for the results of experiment 1 were calculated (Table 2).

By use of the Arrhenius equation the activation energy was calculated to be 39.4 kcal/mole. The firmness decreases by increasing pasteurizing time (Table 3). The average lightness decreases by increasing blanching time, but pasteurization had no effect on the lightness (Table 4).

The effect of processing parameters and storage conditions of experiment 3 were carried out by backward nonlinear stepwise regression with calculation of regression coefficients ($k_i$) and the correlation coefficients (r) (Table 5).

Blanching time to obtain maximum drained (Fig. 1) weight was calculated by differentiation:

$$(dG/dT)_C=k_{2G}+2k_{8G}T=0 \text{ for } T=2.5 \qquad 2)$$

**Table 4.** Average lightness (L), (black=0, white=100). (Experiment 1 and 2). LSD = 1.
*Gennemsnitsværdier for lyshed (L), (sort=0, hvid=100). (Forsøg 1 og 2). LSD = 1.*

| Blanching<br>*Blanchering* | | | | | | |
|---|---|---|---|---|---|---|
| Min | 0 | 1 | 2 | 4 | 8 | 16 |
| Lightness | 63 | 54 | 53 | 52 | 54 | 54 |
| **Pasteurizing**<br>*Pasteurisering* | | | | | | |
| Min | 16 | 32 | 48 | 64 | 80 | 96 |
| Lightness | 52 | 53 | 52 | 51 | 50 | 51 |

**Table 5.** Constant ($k_0$), regression coefficients ($k_i$) and korrelation coefficients (r) from backward stepwise multiple regression. Storage time (M), blanching time (T), temperature °C (C), drained weight (G), firmness (H), lightness (L), CIE-a (a).
*Konstant ($k_0$), regressionskoefficienter ($k_i$) og korrelakorrelationskoefficienter (r) fra trinvis (backward) multiple regression (forsøg 3).*
*Lagringstid (M), blancheringstid (T), temperatur °C (C), drænet vægt (G), fasthed (H), lyshed (L), CIE-a (a).*

| Variable<br>*Variabel* | Coefficient<br>*Koefficient* | Dependent variable<br>*Afhængig variabel* | | | |
|---|---|---|---|---|---|
| | | G | H | L | a |
| – | $k_0$ | 295.8 | 336.8 | 74.3 | –5.4 |
| M | $k_1$ | – | –1.4 | –0.4 | 0.19 |
| T | $k_2$ | 53.8 | 65.6 | –5.7 | – |
| C | $k_3$ | 0.39 | | –0.4 | 0.14 |
| MT | $k_4$ | – | 0.9 | – | 0 |
| MC | $k_5$ | – | – | – | – |
| TC | $k_6$ | – | –0.6 | 0.08 | – |
| $M^2$ | $k_7$ | | | | |
| $T^2$ | $k_8$ | 10.7 | –25.9 | 0.75 | – |
| $C^2$ | $k_9$ | – | – | – | – |
| r | | 0.951 | 0.867 | 0.941 | 0.805 |

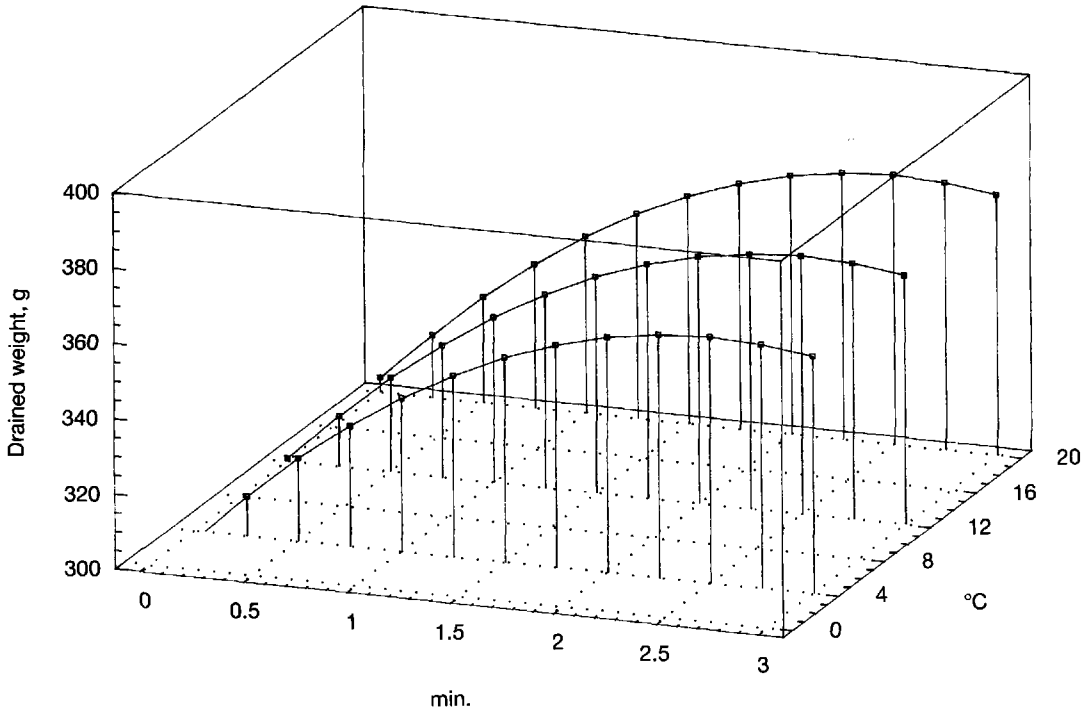


Fig. 1. Drained weight (g) as a function of blanching time (min) and storage temperature (°C) (experiment 3).
*Drænet vægt (g) som funktion af blancheringstid (min.) og lagringstemperatur (°C) (forsøg 3).*

Firmness (H) depended significantly on storage time (M), storage temperature (C) and blanching time (T).
Differentiation leads to:

$$(dH/dT)_{M,C}=k_{2H}+k_{4H}M+k_{6H}C+2k_{8H}T \qquad 3)$$

For M and C equal to 12 months and 15°C respectively, the optimum blanching time (H maximum) was calculated to be 1.3 minutes. Firmness after 12 months of storage was a function of blanching time and storage temperature (Fig. 2). With T = 1.3 minutes differentiation leads to:

$$(dH/dC)_{M,T}= -0.84 \text{ kg/°C} \qquad 4)$$
$$(dH/dM)_{C,T}= -0.20 \text{ kg/month} \qquad 5)$$
$$(dL/dC)_{M,T}= -0.32 \text{ unit/°C} \qquad 6)$$
$$(dL/dM)_{C,T}= -0.44 \text{ unit/month} \qquad 7)$$

From the calculation can be concluded that firmness and lightness of a product blanched at optimum blanching time (H maximum) decreases by increasing storage time and by increasing storage temperature.

Lightness after 12 months of storage was a function of blanching time and storage temperature (Fig. 3). Lightness decreases by increasing blanching time and by increasing storage temperature (Fig. 3).

Immediately after processing the cucumber slices have a green colour shade. This colour shade decreased (increasing CIE-a) during storage and at increasing storage temperature

$$(da/dM)_C= 0.19 \text{ unit/month} \qquad 8)$$
$$(da/dC)_M= 0.14 \text{ unit/°C} \qquad 9)$$

## Discussion

The loss of firmness or softening during blanching and pasteurization is a common effect of heating. Blanching of large cucumber involve removal of air from the air-tissue, which constitute 20–30 p.c. of the inner part of the fruit tissue. Increased

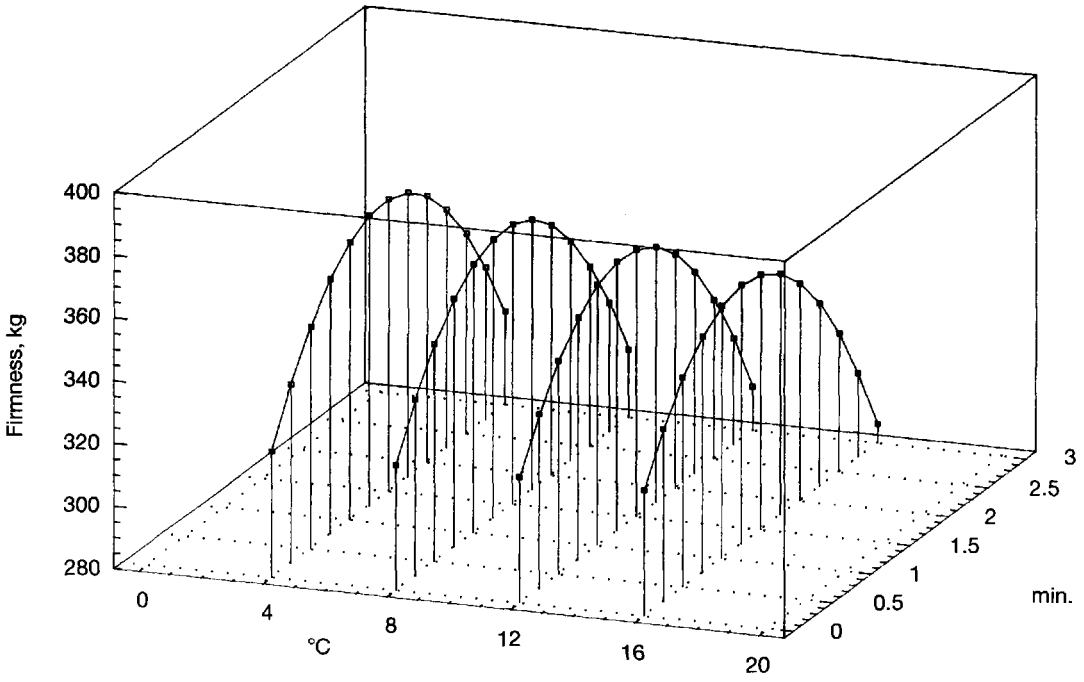


Fig. 2. Firmness (kg) as a function of storage temperature (°C) and blanching time (min) (experiment 3), after storage at 15°C for 12 months.

*Fasthed som funktion af lagringstemperatur (°C) og blancheringstid (min) (forsøg 3), efter lagring ved 15°C i 12 måneder.*

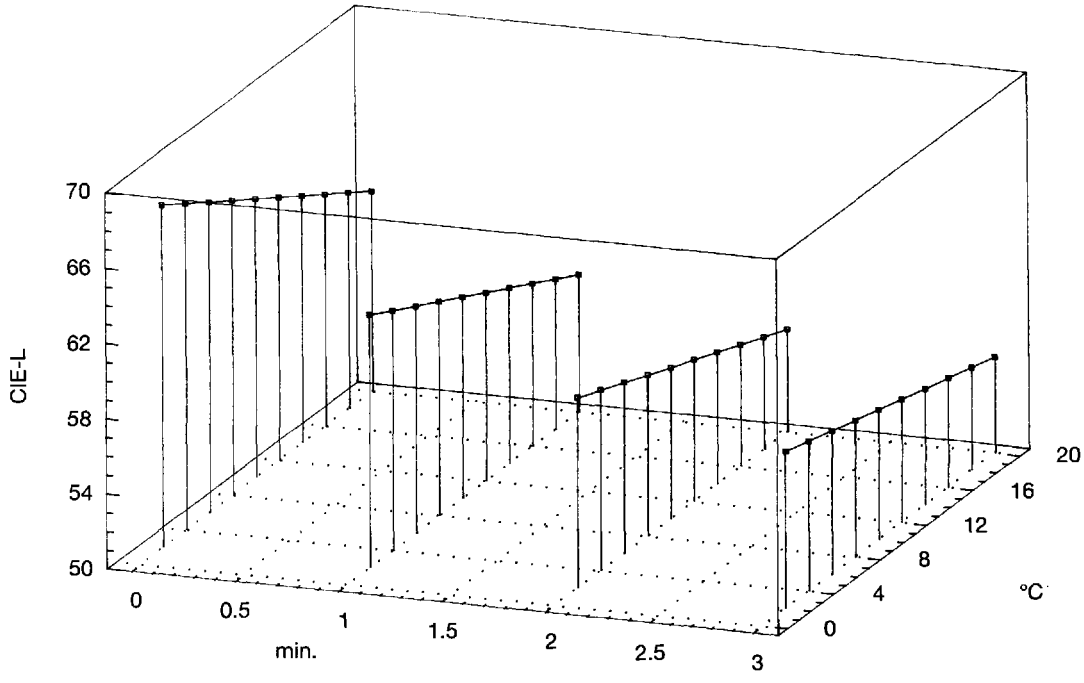


Fig. 3. Lightness as a function of blanching time (min) and storage temperature (°C) (experiment 3).

*Lyshed som funktion af blancheringstid (min) og lagringstemperatur (°C) (forsøg 3).*

brine exchange is an important effect of air removal. The above mentioned changes explain the change of firmness by increasing blanching time (Fig. 2). One step is air removal, which improve brine exchange followed by increased firmness and crispness. A second step is softening by heat. Softening and loss of crispness continue during pasteurization (Table 3), during storage and with increasing rate at increasing storage temperature. To obtain maximum firmness a blanching time of 1.3 minutes was necessary. The drained weight or yield of product increased with blanching time and reached a maximum at 2.5 minutes (Fig. 1).

Cucumber lightness L (100 = white) decrease by air removal during blanching and because of formation of brown degradation products. This is initiated at pasteurizing and continue during storage. A very attractive and uniform colour is obtained by blanching in the period of time (1 minute) necessary for air removal. During pasteurizing the lightness may remain constant.

Manuscript received 12 October 1988.