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Production of Pickled Baby Cucumber (*Cucumis sativus*)

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Abstract.

The cucumber is a member of the Cucurbitaceae family, along with squash and different kinds of melon. Cucumbers are high in water and low in calories, fat, cholesterol, and sodium. Cucumber contains nutrients vital for the body development. Baby cucumbers are fresh during the harvesting season but perishable under the prevailing conditions of temperature and humidity as well as lack of adequate storage facilities. An alternative way of preserving surplus baby cucumber could be fermented to pickle products. Preservation of the baby cucumber by fermentation can eliminate the undesired taste and improve flavor of the vegetable. Therefore we explored a lactic fermentation from baby cucumber by focusing on the effect of different parameters such as blanching time and temperature as pre-treatment, salt concentration, fermentation time to physicochemical, microbial and sensory characteristics of pickled baby cucumber**.** Experimental results revealed that blanching raw baby cucumber in water heated at 95^{o}C in 10 seconds with 0.25% $CaCl_2$, 7% salt in 15 days of fermentation was appropriated to get a pleasant pickled baby cucumber quality. Baby cucumber pickles are considered as one of the health supplements.

Keywords: *Baby cucumber, lactic fermentation, salt, blanching, physicochemical, microbial, sensory*

1. INTRODUCTION

Cucumber is a creeping vine that bears cylindrical fruits. It is known as Cucumis sativus it belongs to the gourd family cucubitacea. Here are several varieties of cucumber but the edible cucumber is classLfied under two groups the slicing and pickling cucumber.[1] As a food, cucumbers offer superior hydration, as they are about 95% water. They have been used for decades for their anti-inflammatory benefits on skin, soothing properties for digestion, and other therapeutic uses.[2] Aside from their cooling effect on skin, cucumber slices offer many benefits to the eyes and surrounding tissues through their hydrating properties, which work to reduce dehydration, their high levels of vitamin K that help reduce dark circles, and the lignans they contain for reducing inflammation.[3] It also has several health benefits such as: rehydrating the body, health regulating the blood pressure, body weight management, cholesterol reduction, cancer prevention, bone health, diabetes cure and antioxidant activity.[4, 5, 6, 7, 8, 9]

Pickling is one of the ancient ways of food preservation, and it was a possible way of preserving the foods, especially seasonal foods, before the invention of modern preservative machines like the refrigerator. Pickle is the good source of antioxidants, probiotics, vitamins (vitamin C, A, K, and folate), and minerals (iron, calcium, and potassium). The fermented vegetables or pickle products made with characterized probiotic strain confirms the supplementation of probiotics to the consumers.[10]

Baby cucumber is an underutilized vegetable crop and still now there is very limited research available regarding to processing of this vegetable into value added product. The baby cucumber vegetable, which typically has high fermentable sugar composition, could be exploited as a substrate for lactic fermentation. Quality of cucumbers commercially fermented in calcium chloride brine without sodium salts was examined.[11] Factors affecting the softening of pickled pasteurised cucumbers were verified.[12] A project was to ferment cucumbers in brine containing $CaCl_2$ as the only salt, to determine the course of fermentation metabolism in the absence of NaCl, and to compare firmness retention of cucumbers fermented in $CaCl_2$ brine during subsequent storage compared to cucumbers fermented in brines containing both NaCl and $CaCl_2$ at concentrations typically used in commercial fermentations.[13] Therefore, we utilized this vegetable as subtrate for lactic fermentation. We focused on the effect of different parameters such as blanching time and temperature, $CaCl_2$ concentration as pre-treatment; salt concentration and fermentation time to physicochemical, microbial and sensory characteristics of pickled baby cucumber.

2. MATERIAL & METHOD

2.1 Material

Baby cucumber were cultivated and collected from My Xuyen district, Soc Trang province, Vietnam. They must be cultivated following VietGAP without pesticide and fertilizer residue to ensure food safety. After harvesting, they must be conveyed to laboratory within 8 hours for experiments. Apart from collecting baby cucumber, we also used other materials such as NaCl, $CaCl_2$, NaOH, phenolphthalein, phosphate buffer, onto MRS (de Man, Rogosa, and Sharpe)-agar. Lab utensils and equipments included knife, weight balance, cooker, fermentation vessel, pH meter, buret, stomacher, colony counter, micropippetor.

Figure 1. Baby cucumber *(Cucumis sativus)*

2.2 Research method

2.2.1 Effect of blanching temperature and time to physicochemical, microbial and sensory characteristics of pickled baby cucumber

Baby cucumbers were pre-treated by blanching in water containing 0.2% $CaCl_2$ with different time and temperature

(100°C in 5 seconds, 95°C in 10 seconds, 90°C in 15 seconds and 85°C in 20 seconds). Effectiveness of blanching time and temperature in baby cucumber fermentation was evaluated on value of pH, total acidity (%), lactic acid bactria (cfu/ml), sensory score.

2.2.2 Effect of $CaCl_2$ concentration in blanching to physicochemical, microbial and sensory characteristics of pickled baby cucumber

Baby cucumbers were pre-treated by blanching in water at 95°C in 10 seconds containing different $CaCl_2$ concentration (0.15%, 0.20%, 0.25%, 0.30%). Effectiveness of $CaCl_2$ concentration in blanching to baby cucumber fermentation was evaluated on value of pH, total acidity (%), lactic acid bactria (cfu/ml), sensory score.

2.2.3 Effect of salt concentration in fermentation to physicochemical, microbial and sensory characteristics of pickled baby cucumber

Baby cucumbers were fermented with different salt concentration (3%, 5%, 7%, 9%). Effectiveness of salt concentration in baby cucumber fermentation was based on value of pH, total acidity (%), lactic acid bactria (cfu/ml), sensory score.

2.2.4 Effect of fermentation time to physicochemical, microbial and sensory characteristics of pickled baby cucumber

Baby cucumbers were fermented with different fermentation time (5, 10, 15, 20 days). Effectiveness of fermentation time in baby cucumber fermentation was based on value of pH, total acidity (%), lactic acid bactria (cfu/ml), sensory score.

2.3 Physicochemical, microbial, sensory evaluation

The measurement of pH values were performed using pH meter. The total acidity was determined by titrating 10 ml of pickle extract in 50 ml Erlenmeyer flask using 0.1N NaOH and 1% phenolphthalein as the indicator. The total acidity are expressed as lactic acid (AOAC, 2000). Plate count of lactic acid bacteria were conducted following the method as described by Hadioetomo (1993), 10 ml of fermented fluid were diluted in 90 ml phosphate buffer and 1 ml were then pipetted onto MRS (de Man, Rogosa, and Sharpe)-agar and incubated at 37°C for 2 days before counting the colony formed. Sensory score was based on 9-point hedonic scale.

2.4 Statistical analysis

Data were statistically summarized by Statgraphics Centurion XVI.

3. RESULT & DISCUSSION

3.1 Effect of blanching temperature and time to physicochemical, microbial and sensory characteristics of pickled baby cucumber

Blanching is a short time heat treatment widely applied before processing (freezing, frying, drying, and canning) to inactivate deleterious enzymes and to destroy various microorganism present in fresh green vegetables. Commonly hot water blanching technique is applied in the food industries and particularly in the processing of green leafy vegetables.[14]

Baby cucumber were pre-treated by blanching in water containing 0.2% $CaCl_2$ with different time and temperature (100°C in 5 seconds, 95°C in 10 seconds, 90°C in 15 seconds and 85°C in 20 seconds). Effectiveness of blanching time and temperature in baby cucumber fermentation was evaluated on value of pH, total acidity (%), lactic acid bactria (cfu/ml), sensory score. Results were depicted in table 1. It's clearly noticed that blanching at 95°C in 10 seconds was optimal for baby cucumber fermentation. So we selected this value for next experiments.

3.2 *Effect of $CaCl_2$ concentration in blanching to physicochemical, microbial and sensory characteristics of pickled baby cucumber*

Baby cucumbers were pre-treated by blanching in water at 95°C in 10 seconds containing different $CaCl_2$ concentration (0.15%, 0.20%, 0.25%, 0.30%). Effectiveness of $CaCl_2$ concentration in blanching to baby cucumber fermentation was evaluated on value of pH, total acidity (%), lactic acid bactria (cfu/ml), sensory score. Results were depicted in table 2. It's clearly noticed that 7% salt was optimal for baby cucumber fermentation. So we selected this value for next experiments.

A study evaluated the quality of fermented cucumbers produced commercially using an alternative calcium chloride ($CaCl_2$) brining process. $CaCl_2$ brined, fermented cucumbers were 1.8 N less firm, which remained signifcant in the finished product. Color differences evidenced by higher hue and lower chroma values were consistent with increased photooxidation in CaCl2 brined cucumbers. Commercial implementation of $CaCl_2$ brines for cucumber fermentation in open tanks variably resulted in texture and color defects that can impact product quality.[11] Factors affecting the softening of pickled pasteurised cucumbers were verified.[12]

Table 1. Blanching temperature and time to physicochemical, microbial and sensory characteristics of pickled baby cucumber

Blanching temperature and time	pH	Total acidity (%)	Lactic acid bacteria (cfu/ml)	Sensory score
100°C, 5 seconds	4.14±0.02^{a}	0.67±0.02^{b}	5.31 x 10^6±0.01^{b}	5.45±0.03^{ab}
95°C, 10 seconds	**3.85±0.01^{ab}**	**0.83±0.01^{a}**	**6.52 x 10^6±0.03^{a}**	**6.21±0.01^{a}**
90°C, 15 seconds	3.66±0.03^{ab}	0.71±0.01^{ab}	5.88 x 10^6±0.01^{ab}	5.69±0.01^{ab}
85°C, 20 seconds	3.59±0.00^{c}	0.55±0.02^{c}	5.04 x 10^6±0.02^{c}	4.22±0.01^{b}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

Table 2. Blanching $CaCl_2$ concentration to physicochemical, microbial and sensory characteristics of pickled baby cucumber

Blanching $CaCl_2$ concentration (%)	pH	Total acidity (%)	Lactic acid bacteria (cfu/ml)	Sensory score
0.15	3.85 ± 0.01^{a}	0.83 ± 0.01^{b}	$6.52 \times 10^{6}\pm0.03^{b}$	6.21 ± 0.01^{b}
0.20	3.78 ± 0.03^{ab}	0.86 ± 0.01^{ab}	$6.63 \times 10^{6}\pm0.02^{ab}$	6.34 ± 0.01^{ab}
0.25	$\mathbf{3.75\pm0.01^{ab}}$	$\mathbf{0.90\pm0.02^{a}}$	$\mathbf{6.75 \times 10^{6}\pm0.01^{ab}}$	$\mathbf{6.75\pm0.01^{a}}$
0.30	3.74 ± 0.00^{b}	0.91 ± 0.01^{a}	$6.77 \times 10^{6}\pm0.00^{a}$	6.39 ± 0.00^{ab}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

Table 3. Salt concentration (%) to physicochemical, microbial and sensory characteristics of pickled baby cucumber

Salt concentration (%)	pH	Total acidity (%)	Lactic acid bacteria (cfu/ml)	Sensory score
3	3.75 ± 0.01^{a}	0.90 ± 0.02^{b}	$6.75 \times 10^{6}\pm0.01^{c}$	6.75 ± 0.01^{b}
5	3.66 ± 0.00^{ab}	0.93 ± 0.02^{ab}	$7.13 \times 10^{6}\pm0.03^{ab}$	7.04 ± 0.03^{ab}
7	$\mathbf{3.60\pm0.01^{b}}$	$\mathbf{0.97\pm0.01^{a}}$	$\mathbf{7.34 \times 10^{6}\pm0.02^{a}}$	$\mathbf{7.13\pm0.01^{a}}$
9	3.70 ± 0.01^{ab}	0.92 ± 0.00^{ab}	$6.95 \times 10^{6}\pm0.01^{b}$	7.01 ± 0.01^{ab}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

Table 4. Fermentation time (days) to physicochemical, microbial and sensory characteristics of pickled baby cucumber

Fermentation time (days)	pH	Total acidity (%)	Lactic acid bacteria (cfu/ml)	Sensory score
5	3.60 ± 0.01^{a}	0.97 ± 0.01^{b}	$7.34 \times 10^{6}\pm0.02^{b}$	7.13 ± 0.01^{b}
10	3.56 ± 0.01^{ab}	1.02 ± 0.02^{ab}	$7.41 \times 10^{6}\pm0.01^{ab}$	7.34 ± 0.02^{ab}
15	$\mathbf{3.53\pm0.03^{b}}$	$\mathbf{1.09\pm0.01^{a}}$	$\mathbf{7.87 \times 10^{6}\pm0.03^{a}}$	$\mathbf{7.68\pm0.00^{a}}$
20	3.58 ± 0.01^{ab}	1.01 ± 0.01^{ab}	$7.38 \times 10^{6}\pm0.01^{ab}$	7.25 ± 0.03^{ab}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

3.3 Effect of salt concentration in fermentation to physicochemical, microbial and sensory characteristics of pickled baby cucumber

Commercial cucumber fermentation is a preservation method that depends on high sodium chloride (NaCl) concentrations. This salt concentration enables a natural fermentation to occur by selecting for the lactic acid bacteria present on the cucumbers and inhibiting salt-sensitive spoilage bacteria.[11] In the pickling industry, salt has historically been used for directing the fermentation of cucumbers, radishes, and carrots. [15, 16, 17, 18] Sodium chloride is an essential in food as it improves the preservative, technological and sensory quality of food.[19] NaCl is one of the most commonly employed agents for food conservation, allowing considerable increase in storage time by reducing water activity.[20] Baby cucumber were fermented with different salt concentration (3%, 5%, 7%, 9%). Effectiveness of salt concentration in baby cucumber fermentation was based on value of pH, total acidity (%), lactic acid bactria (cfu/ml), sensory score. Results were depicted in table 3. It's clearly noticed that 7% salt was optimal for baby cucumber fermentation. So we selected this value for next experiments.

Cucumber fermentations with and without NaCl in the fermentation brine were similar both in the chemical changes caused by the fermentative microorganisms and in the retention of firmness in the fermented cucumbers.[13]

3.4. Effect fermentation time to physicochemical, microbial and sensory characteristics of pickled baby cucumber

Naturally occurred lactic acid bacteria from the raw ingredients play an important role in fermentation of pickled baby cucumber.[21] Baby cucumber were fermented with different fermentation time (5, 10, 15, 20 days). Effectiveness of fermentation time in baby cucumber fermentation was based on value of pH, total acidity (%), lactic acid bactria (cfu/ml), sensory score. Results were depicted in table 4. It's clearly noticed that 15 days of fermentation was optimal for baby cucumber fermentation. So we selected this value for application.

4. CONCLUSION

Baby cucumber *(Cucumis sativus*) is a vegetable with good nutritional attributes but has short shelf-life under the prevailing weather conditions in tropical countries. Baby cucumber with their high composition of fermentable reducing sugars such as glucose, sucrose and fructose could serve as substrates for lactic fermentation thus transforming a perishable products to more stable and value added product. Pickled baby cucumber is one of the most consumed fermented vegetable in Vietnam. Therefore, production of pickle from this vegetable can help increase added values and reduce post-harvest losses.

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