DEVELOPMENT AND IMPROVEMENT OF SWEETPOTATO PICKLES

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ABSTRACT

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The suitability of sweetpotato for pickling was investigated. The use of low salt (LS) and high salt (H) was tried in the curing process. LS was found to be an effective method for curing sweetpotato. This process was further improved by heat and chemical treatments and reduction of curing time from 11 wks to 6 days was realized. Blanching was found to contribute a profound improvement on the quality of sweetpotato. The starchiness of pickle was greatly reduced through heat treatment before curing. The reduction of curing time still favored the production of relatively higher amount of acid which is necessary for the souring process.

The sweet-type Jamaica Sweet-mixed and Spread Relish pickles,were found to be more acceptable than the sour-type Genuine Dill pickles.

KEYWORDS: Genuine dill pickles. High and low salt curing. Jamaica sweet-mixed. Sweetpotato pickles. Spread relish.

INTRODUCTION

Pickling is one of the oldest methods of food preservation. Vegetables such as cucumbers, cauliflowers, olives, pepper, sayote, carrots, cabbage, papaya, peppers, tomatoes and some fruits like mangoes and citrus are used in pickling. This process is essentially a curing method involving lactic acid fermentation with a definite sequence of growth of various species of lactic acid bacteria which are responsible for fermentation. These bacteria have the ability to form lactic acid and other acids from carbohydrates (Radler, 1975).

Thus, they are essential in many fermentation processes especially in souring food materials for preservation.

Carbohydrates and other sugar-related compounds are important substrates for successful lactic acid fermentation. In cucumber pickling, the addition of 1% sugar (preferably dextrose) to brine greatly improves the quality of the product (Prescott and Proctor, 1937). Deficiency in sugar favors the growth of undesirable bacteria which can spoil the pickled products. De Leon and Garcia (1978) recommended the addition of sugar to brine at the beginning or during active fermentation to increase the number of acid formers for faster fermentation. The preservative effect of fermentation is due to metabolites that are produced by the microorganisms and the decomposition products from carbohydrates (Matz, 1962).

Sweetpotato is a carbohydrate-rich raw material which is a potential substrate for lactic acid fermentation. It is believed to facilitate the souring process in pickling. This study, therefore, aimed to produce pickles from sweetpotato; determine consumers' response to the product through sensory evaluation; and establish suitable curing and pickling techniques for sweetpotato.

MATERIALS AND METHODS

Curing methods for sweetpotato pickles

Preparation of materials for curing

Freshly harvested sweetpotato (VSP-2) tubers were used in the study. The tubers were washed and shredded (about 2.5 x 0.2 x 0.2 cm^3).

Curing process

The low salt (LS) and high salt (H) curing methods were used. Sweetpotato strips and shreds were fully immersed in brine solution during the curing process. In the LS curing, an initial brine solution of 30° salinometer was prepared and 3° increase in salt solution was made every week until 60° salinometer was reached. In the HS curing, an initial brine solution of 40° salinometer was prepared and a 2° increase was made every week until 60° salinometer reading was obtained. Microbial and physicochemical characteristics were determined every week.

Pickle preparation

LS curing method was used for sweetpotato pickles. Cured sweetpotato were harvested after reaching a salinometer reading of 60°. Pickles were prepared as sweet and sour with the following ingredients and proportions based on the weight of sweetpotato:

1. Vinegar - 40%
2. White sugar - 40%
3. Ground Ginger - 10%

After extracting the juice, the ground ginger was discarded. Cured sweetpotato strips and shreds were mixed separately with the above ingredients and allowed to stand for 2 wks before sensory evaluation.

Sensory evaluation

A laboratory panel of 25 judges composed of ViSCA and PRCRTC staff, who are regular panelists in sensory evaluations of rootcrop-based food products, were selected to evaluate the pickles. Four different sizes of cured sweetpotato (shreds 2.0 x 0.1 x 0.1 cm^3, 2.5 x 0.2 x 0.2 cm^3 and 5.0 x 0.1 x 0.2 cm^3; and strips 6.0 x 0.4 x 0.6 cm^3) were used. Evaluation was based on color, texture, flavor and general acceptability using a 9-point Hedonic Scale.

Reduction of starch in sweetpotato

Heat treatment

Freshly harvested tubers of high pectin-containing sweetpotato (VSP-1, an orange variety) were selected for this study. The tubers were washed, peeled and shredded. Before curing, the shreds were divided into 2 lots. One lot was steamed and the other was blanched (dipped in boiling water). Steaming and blanching were done for 5 min. The physical characteristics of sweetpotato shreds from two heat treatments methods were compared during curing process.

Modified curing process

A modified HS curing process was used for heat-treated shreds. Raw shredded sweetpotato served as control. An initial brine solution of 40° salinometer was prepared. Curing was done for 1 wk. Salinometer reading was increased by 4° everyday until it reached 60° after 1 wk. The microbial and physicochemical changes of brine were monitored at 0, 1 and 6 days of curing process.

The sweetpotato shreds were also subjected to a 30- and 60-s blanching. Afterwards, these were compared with the raw shreds. Sampling was done on 0, 1 and 6 days of curing.

Sensory evaluation

Three different pickle types based on the recipes of de Leon and Garcia (1978), with some modifications, were prepared with alum treatment of 0.1%. These recipes were Spread Relish, Genuine Dill pickle, and Jamaica Sweet-mixed pickle.

The Genuine Dill and Jamaïca Sweet-mixed pickles were prepared 3 days before the sensory evaluation while the Spread Relish was prepared just before the evaluation.

Comparison of the three different recipe preparations was based on the general acceptability using 9-point Hedonic Rating Scale.

Physicochemical and microbial analysesof sweetpotato brine during curing process

The total titratable acidity (TTA), pH and degree of salinity, as well as the microflora of sweetpotato brine, were monitored in all curing processes. Differential media such as potato dextrose agar (PDA) + 10% tartaric acid for molds, malt yeast agar (MYA) + 0.2% sodium propionate for yeasts and glucose yeast peptone (GYP) + 0.5% calcium carbonate for bacteria were used for plating. The growth of bacteria, yeasts and molds were counted after incubation period of 24, 48 and 72-92 h, respectively.

RESULTS AND DISCUSSION

Use of unmodified curing process in some selected varieties of sweetpotato

LS vs HS curing method

The physicochemical changes of sweetpotato brine during LS and HS curing are presented in Table 1. The pH was the same in LS and HS except during the 6th wk where pH in HS was higher than that in LS. A significantly higher TTA value was observed in LS compared with HS during the 3rd wk of curing.

Yeasts and bacterial counts were generally higher in LS than in HS throughout the whole duration of curing (Table 2). It appeared that the growth of yeasts and bacteria was favored by the low amount of salt in the LS method. The low salt concentration was found to induce the growth of acid-forming microorganisms as reflected by high TTA values. The acid production is essential in the curing process. Microbial growth decreases as the salt concentration increases (Desrosier, 1978). It is postulated that with increasing concentration of salt, the amount of free water for microbial growth decreases. Mold growth, however, remained minimal in both LS and HS in the entire curing process.

Shredded (2.0 x 0.1 x 0.1 cm^3; 2.5 x 0.2 x 0.2 cm^3; 5.0 x 0.1 x 0.2 cm^3) and stripped (6.0 x 0.4 x 0.6 cm^3) sweetpotato were evaluated for their sensory qualities (Table 3). Results showed no difference in scores for color, texture, flavor and general acceptability. However, shredded

Table 1. pH and total titratable acidity (TTA) of Low Salt (LS) and Hgh Salt (HS) curing process.[1]

Fermentation time, wks	pH		TTA	
	LS	HS	LS	HS
0	5.63a	5.61a	0.11a	0.11a
1	3.56a	3.68a	0.75a	0.68a
2	3.55a	3.57a	0.64a	0.60a
3	3.55a	3.64a	0.63a	0.51b
4	3.55a	3.53a	0.55a	0.51a
5	3.52a	3.57a	0.60a	0.53a
6	3.62b	3.76a	0.58a	0.50a
7	3.54a	3.59a	0.51a	0.52a
8	3.45a	3.48a	0.54a	0.46a

[1]pH and TTA are averages of means for all varieties used during curing process; Mean scores in a column with common letters are not significantly different at 5% level according to Duncan's Multiple Range Test (DMRT).

Table 2. Microbial counts of sweetpotato brine in the low and high salt curing process.[1]

Fermentation time, wks	Microbial count, cells/mL					
	Bacteria		Yeasts		Molds	
	LS	HS	LS	HS	LS	HS
0	1.7×10^{4}	3.8×10^{3}	$<10^{2}$	$<10^{2}$	$<10^{2}$	$<10^{2}$
1	1.6×10^{8}	1.1×10^{8}	$<10^{2}$	$<10^{2}$	$<10^{2}$	$<10^{2}$
2	1.2×10^{10}	5.6×10^{9}	1.7×10^{8}	2.5×10^{8}	$<10^{2}$	$<10^{2}$
3	1.3×10^{12}	1.4×10^{13}	3.1×10^{13}	9.0×10^{11}	$<10^{2}$	$<10^{2}$
4	1.2×10^{14}	8.1×10^{13}	1.5×10^{14}	8.4×10^{13}	$<10^{2}$	$<10^{2}$
5	1.1×10^{14}	1.1×10^{14}	1.1×10^{14}	5.9×10^{13}	$<10^{2}$	$<10^{2}$
6	8.7×10^{15}	1.3×10^{14}	8.3×10^{15}	1.1×10^{14}	$<10^{2}$	$<10^{2}$
7	2.2×10^{14}	2.0×10^{14}	4.3×10^{15}	7.8×10^{13}	$<10^{2}$	$<10^{2}$
8	7.5×10^{13}	1.1×10^{14}	6.8×10^{15}	8.4×10^{13}	$<10^{2}$	$<10^{2}$

[1]Microbial counts are averages of counts from 3 different varieties of sweetpotato with 2 replications in duplicates.

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Fermentation time, wks	pH		TTA	
	LS	HS	LS	HS
0	5.63a	5.61a	0.11a	0.11a
1	3.56a	3.68a	0.75a	0.68a
2	3.55a	3.57a	0.64a	0.60a
3	3.55a	3.64a	0.63a	0.51b
4	3.55a	3.53a	0.55a	0.51a
5	3.52a	3.57a	0.60a	0.53a
6	3.62b	3.76a	0.58a	0.50a
7	3.54a	3.59a	0.51a	0.52a
8	3.45a	3.48a	0.54a	0.46a

[1]pH and TTA are averages of means for all varieties used during curing process; Mean scores in a column with common letters are not significantly different at 5% level according to Duncan's Multiple Range Test (DMRT).

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Fermentation time, wks	Microbial count, cells/mL					
	Bacteria		Yeasts		Molds	
	LS	HS	LS	HS	LS	HS
0	1.7×10^4	3.8×10^3	$<10^2$	$<10^2$	$<10^2$	$<10^2$
1	1.6×10^8	1.1×10^8	$<10^2$	$<10^2$	$<10^2$	$<10^2$
2	1.2×10^{10}	5.6×10^9	1.7×10^8	2.5×10^8	$<10^2$	$<10^2$
3	1.3×10^{12}	1.4×10^{13}	3.1×10^{13}	9.0×10^{11}	$<10^2$	$<10^2$
4	1.2×10^{14}	8.1×10^{13}	1.5×10^{14}	8.4×10^{13}	$<10^2$	$<10^2$
5	1.1×10^{14}	1.1×10^{14}	1.1×10^{14}	5.9×10^{13}	$<10^2$	$<10^2$
6	8.7×10^{15}	1.3×10^{14}	8.3×10^{15}	1.1×10^{14}	$<10^2$	$<10^2$
7	2.2×10^{14}	2.0×10^{14}	4.3×10^{15}	7.8×10^{13}	$<10^2$	$<10^2$
8	7.5×10^{13}	1.1×10^{14}	6.8×10^{15}	8.4×10^{13}	$<10^2$	$<10^2$

[1]Microbial counts are averages of counts from 3 different varieties of sweetpotato with 2 replications in duplicates.

sweetpotato with smaller size had higher score for texture, flavor and general acceptability. Absorption of flavor from the solution of spices is obviously rapid in small-sized shredded sweetpotato.

Reduction of Starch in Sweetpotato

Heat treatment

An attempt to reduce the starchiness of sweetpotato for pickles was done through heat treatments (i.e., by steaming and blanching) prior to curing. Steaming sweetpotato shreds resulted in uneven cooking and lumping (Table 4). The shreds directly exposed to the steam were cooked while those not directly exposed were not. The shreds that were on the outermost layer exposed to the steam were overcooked and they lumped together. Blanching, on the other, gave very good results, in that the sweetpotato shreds were evenly cooked, and thus had even texture.

Table 3. Mean sensory scores for acceptability of varying sizes of pickled sweetpotato (VSP-2) under LS curing process.[1]

Size	Sensory qualities				
	Color	Texture	Flavor	General Acceptability	Comments
Shredded					
2.0 x 0.1 x 0.2 cm³	6.71a	5.84a	5.84a	5.44a	starchy
2.5 x 0.2 x 0.2 cm³	6.62a	5.60a	5.36a	5.12a	starchy
5.0 x 0.1 x 0.2 cm³	6.71a	4.96a	4.72a	4.64a	starchy
Stripped					
6.0 x 0.4 x 0.6 cm³	6.79a	4.84a	4.88a	4.52a	starchy

[1]Mean scores in a column with common letters are not significantly different at 5% level according to DMRT.

Table 4. Comparison of steaming and blanching method of heat treatments of sweetpotato shreds before curing.

Criteria	Heat treatment	
	Steaming	Blanching
Evenness of cooking	Uneven	Even
Color	Uneven	Even
Texture	Uneven	Even
Appearance	Tended to form lumps	No lump formation
Size	Very irregular	Mostly regular
Cooking time	Longer	Shorter

The microbial counts of sweetpotato shreds during LS curing showed that raw shreds had higher level of yeast and bacterial counts compared with either steamed or blanched shreds (Table 5). Molds remained minimal even after 6 wks of curing the heat-treated shreds. This level, however increased appreciably after 6 wks in raw shreds. Yeasts in both raw and heat-treated shreds generally increased as curing progressed. Bacterial counts, however, decreased after the 1st wk of curing in both raw and steamed shreds but not in blanched. It could be possible that some antagonistic relationship existed between the same type or species of microorganisms during the curingprocess. This can be based on their activity or the products they produce which might be inhibitory to other microorganisms. The high amount of acid produced during the entire curing period were noted in raw and steamed shreds (Table 6). The growth of a large number of bacteria, especially at the early stage of curing, could be the contributory factor to acid production. Steaming might have killed the microorganisms responsible for souring, hence, the low amount of acid observed in steamed shreds.

Table 5. Microbial counts of sweetpotato shreds under unmodified low salt curing [1]

Type of microorganism	Curing time (wks)	Treatment: Raw	Steaming (5 min)	Blanching (5 min)
Bacteria	0	4.9×10^3	$<10^2$	$<10^2$
	1	1.7×10^6	7.2×10^7	$<10^2$
	6	8.3×10^5	1.6×10^6	2.3×10^6
Yeast	0	3.4×10^3	$<10^2$	$<10^2$
	1	3.9×10^5	5.2×10^7	9.6×10^6
	6	8.7×10^5	2.0×10^{10}	1.0×10^8
Molds	0	$<10^2$	$<10^2$	$<10^2$
	1	$<10^2$	$<10^2$	$<10^2$
	6	3.8×10^3	$<10^2$	$<10^2$

[1] Starting from the 7th day of fermentation, there was progressive softening of steamed and blanched sweetpotato shreds up to 6 wks with film yeast contaminants.

Table 6. Physicochemical changes of sweetpotato shreds under low salt curing [1]

Physicochemical attributes	Fermentation time, wks: 1	2	3	4	5	6	7	Mean
Total titratable acidity (TTA)								
Raw	0.99	0.96	0.58	1.08	0.82	0.80	1.14	0.92b
Steaming	0.64	1.42	1.59	1.98	1.68	1.18	1.20	1.34a
Blanching	0.28	0.77	0.76	0.83	0.63	0.73	0.66	0.66c
Mean	0.54d	1.06b	0.98bc	1.29a	1.04a	0.90c	0.99bc	
pH								
Raw	3.28	3.33	3.70	3.30	3.41	3.29	3.26	3.36a
Steaming	3.54	3.36	3.27	3.34	3.23	3.44	3.35	3.34b
Blanching	3.41	3.21	3.16	3.25	3.18	3.18	3.17	3.22c
Mean	3.40a	3.30c	3.38b	3.22e	3.29c	3.30c	3.26d	
Salinometer (°Brix)								
Raw	22	25	21	30	32	30	40	
Steaming	20	40	40	50	40	45	40	
Blanching	22	25	27	31	30	25	30	

[1] Mean scores in a column and a row with common letters are not significantly different at 5% level according to DMRT.

To prevent uneven cooking or overcooking of sweetpotato shreds, heat treatment through blanching was reduced from 5 min to 30 and 60 s. Further softening of sweetpotato shreds was prevented by reducing the curing time from 6 wks to 6 days. Table 7 presents the microbial counts of sweetpotato shreds using the modified HS curing.

Bacteria were checked to a minimum level even after 6 days of curing while the yeasts gradually increased in heat-treated shreds but not in the raw. Molds increased in numbers in 60 s-blanched shreds after 6 days of curing. Despite the minimal level of microbial counts, an increase in acid was observed; the amount of which was greater in raw than in the blanched shreds (Table 8). The pH of the blanched shreds was higher than the raw shreds. Pickles from sweetpotato shreds and strips which were blanched at 30 and 60 s prior to curing were found to be more acceptable compared with the raw shreds and strips (Table 9).

When 60 s-blanched and cured sweetpotato shreds were used in three pickle recipe preparations, results showed that Jamaica Sweet-mixed and Spread Relish were more acceptable than Dill pickle type (Table 10). This result indicates greater preference of consumers for the sweet-type pickles. Jamaica Sweet-mixed is a combination of sweet and sour tastes

Table 7. Microbial counts of sweetpotato shreds under modified high salt curing.

Type of microorganisms	Curing time (days)	Treatment: Blanching 30s	Treatment: Blanching 60 s	Treatment: Raw
Bacteria	0	9.9×10^3	$<10^2$	$<10^2$
	6	$<10^2$	$<10^2$	$<10^2$
Yeasts	0	3.4×10^3	$<10^2$	$<10^2$
	6	$<10^2$	4.6×10^3	1.0×10^4
Molds	0	$<10^2$	$<10^2$	$<10^2$
	6	$<10^2$	<102	1.8×10^5

Table 8. Physicochemical changes of sweetpotato shreds under modified high salt curing.[1]

Physicochemical attribute	Fermentation time, days							
	0	1	2	3	4	5	6	Mean
TTA								
Raw	0.10	0.46	0.83	1.38	1.73	1.91	2.23	1.24a
30-s blanching	0.07	0.56	0.58	0.67	0.68	0.67	0.81	0.58b
60-s blanching	0.11	0.28	0.46	0.65	0.74	0.56	0.58	0.51b
Mean	0.01f	0.44e	0.62d	0.90c	1.05c	1.08b	1.24a	
pH								
Raw	5.42	3.88	3.80	3.69	3.45	3.34	3.26	3.83b
30-s blanching	5.78	3.96	3.67	3.52	3.46	3.44	3.35	3.96a
60-s blanching	5.83	4.24	3.63	3.50	3.48	3.45	3.44	3.94a
Mean	5.68a	4.19b	3.70c	3.57c	3.46e	3.41e	3.34e	

[1]Mean scores within a column and a row with common letters are not significantly different at 5% level according to DMRT.

Table 9. Mean sensory scores for acceptability1 of sweetpotato (VSP-1) pickles under the modified high salt curing.[1]

Treatment	Mean sensory scores
Shredded	
Raw	5.66c
30-s blanching	6.58ab
60-s blanching	6.92a
Stripped	
Raw	4.88d
30-s blanching	5.92bc
60-s blanching	5.82c

[1]Mean scores within a column with the same letters are not significantly different at 5% level according to DMRT.

Table 10. Sensory evaluation of sweetpotato shreds under different recipes cured by modified high salt process.[1]

Recipes	Mean sensory scores
Jamaica Sweet-mixed	7.74a
Spread Relish	8.02a
Genuine Dill	4.08b

[1]Mean scores within a column with common letters are not significantly different at 5% level according to DMRT.

while the Spread Relish is flavorful because of the added mayonnaise. In Spread Relish, the cured orange sweetpotato shreds seemed to be a good substitute for carrots, the most common ingredient in the preparation.

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