QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES
DIVISION OF PLANT INDUSTRY BULLETIN No. 475

GINGER PROCESSING INVESTIGATIONS. 1. BATCH METHODS FOR SUGAR IMPREGNATION

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SUMMARY

Experiments to develop a commercial process for the sugar impregnation of ginger are described. The work included softening and cooking methods, syruping techniques and increasing of yields.

I. INTRODUCTION

For some decades prior to World War II, Chinese in the Canton-Hong Kong area supplied most of the world's needs of ginger in syrup (Wagner and Parey 1926; Anon. 1937). It was marketed under the following grades (Anon. 1937):—cargo ginger, young stem ginger, choice selected stem ginger, fourth quality, and crystallized ginger. Annual imports into Australia from Hong Kong, China and other countries during the late 1930s were approximately 1,000 tons, but with the outbreak of war in the Pacific in 1941 supplies to Australia were cut off and a strong impetus was given to the Queensland ginger industry, which had existed in a very small way at Buderim for about 20 years. The early establishment of a factory at Buderim assisted the rapid expansion of the industry, and production reached 720 tons in 1948. The ginger was brined at Buderim and later despatched to food processors in Queensland and southern States.

In view of the few technical data on syruping techniques available during the war years (Anon. 1908; Anon. 1923; Anon. 1926; Anon. 1929; Kurmara Das 1931), investigations of ginger processing methods were commenced at the Food Preservation Research Laboratory of the Queensland Department of Agriculture and Stock (now Department of Primary Industries).

II. INVESTIGATIONS

(a) Pre-syruping Treatments

The bleached and diced ginger obtained from Buderim was variable in texture but generally tough and fibrous. A cooking procedure to soften the texture and to assist in the absorption of the sugar was first investigated. Contrary

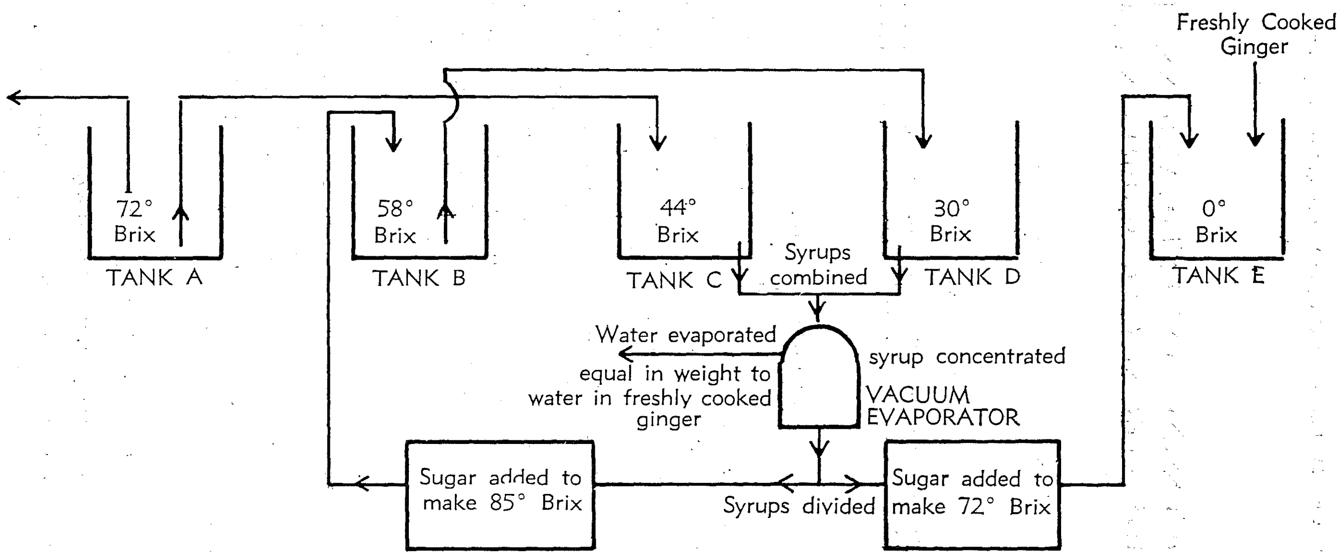

Fig. 1.—Flow diagram of 4-stage chain batch process.

to the findings of Kurmara Das (1931), the autoclaving of ginger even for 10 min at 10 lb/sq. in. ruined the flavour and caused disintegration of the product. Ginger was boiled in water containing various concentrations of sulphuric acid for periods up to 3 hr. The acid was then neutralized with caustic soda and the ginger rinsed with several changes of water. The most satisfactory product was obtained by boiling in 0·06% solution of sulphuric acid for $1\frac{1}{4}$ hr, adjusting pH to 4 with caustic soda, boiling for another hour, and then rinsing several times.

(b) Simple Batch Process

Owing to the great demand for ginger the impregnation process had to be quick. A simple 4-day batch process was therefore developed in which the cooked ginger was first placed in a 70 Brix syrup. Next day the syrup was drained off and boiled, sugar was added, and the syrup was inverted to the required extent and then returned to the ginger. This procedure was repeated on successive days until the fifth day, when the equilibrium Brix had reached 72. At this stage the ginger was allowed to stand for several days before crystallizing, the method for which is discussed in a separate paper (Leverington 1969*b*). This procedure was adopted commercially, but it was found time-consuming.

(c) Chain Batch Process

A modified semi-continuous process in which one batch was at one of each of four stages in a chain was next developed. The procedure is best described by reference to Figure 1. The diagram represents the process at any one day. A was a completed batch which was discharged for packing in syrup or crystallizing. Its syrup was placed on C, thereby making its equilibrium Brix about 58° on the following day. B was at the third stage, and received a high Brix syrup to lift its equilibrium Brix to 72° on the following day. The 58° Brix syrup on B was fed on to D so that its equilibrium Brix was lifted to 44° on the following day. C and D syrups were combined, evaporated and divided so that by the addition of the requisite amount of sugar the required volumes of syrups of 85 Brix and 72 Brix were prepared for adding to B and E respectively.

The process worked very well until caramelization of the syrups in continuous use rendered them too dark. The problem was overcome by using a vacuum evaporator operated at 110°F to remove sufficient water to balance the fresh water being added in the new batch. In this way, excessive volumes of syrup were not built up.

Even though the colour problem was overcome, the circulating syrup continuously extracted the hot ginger flavour, greatly increasing any pungency to a point where the syrup was no longer suitable for impregnating fresh ginger. A sandwich or biscuit spread was developed to utilize this syrup by blending it with candied honey and sugar-impregnated ginger. Ether extractions of this pungent syrup yielded a fixed oil which closely resembled the gingerol described by Winton and Winton (1939). The yield of drained ginger having an equilibrium Brix of 72 was approximately 80% of the brined ginger weight.

(d) Improved Chain Batch Process

In the immediate post-war years the Australian industry continued to develop until marketing difficulties were experienced due to competition from the high-quality imported Chinese ginger. At this stage Departmental investigations were initiated to improve processing techniques so that processing costs could be reduced, and also to improve the quality of the product so that it was at least equal to the Chinese ginger. The second problem is dealt with in a subsequent paper (Leverington 1969*b*).

One factor increasing costs was the loss of yield of drained ginger due to shrinkage. This was the result of severe osmotic pressure effects due to the different sugar levels in the ginger and in the syrup. Experiments were directed towards finding a treatment which would render the ginger more receptive to sugar impregnation without shrinkage. Investigations were carried out on the following aspects:—

Cooking.—As the sulphuric acid and caustic soda treatment discussed under (a) was too harsh on texture, and blue anthocyanin pigments sometimes showed up during the early stages of syruping and persisted as dark colours throughout the process, an alternative procedure was sought. On experimenting with various concentrations of hydrochloric acid, tartaric acid and citric acid it was found that when citric acid was added at the rate of 0·5% of the weight of ginger to the first boil in water, the ginger was not only softened but retained a bright bleached colour. A ½ hr boil in this acid solution followed by two or three further ½ hr boils in fresh water left the ginger in a state more receptive to rapid sugar impregnation.

Freezing.—Because freezing of vegetables causes certain cellular breakdown, consideration was given to softening the somewhat tough-textured ginger by freezing. Sample lots each of 1,000 g were frozen in flat trays at 0°F, thawed out several days later and then processed alongside a sample from the same brined ginger, using a 2-stage quick syruping in the case of A, B, C and D shown in Table 1, and the abovementioned 4-stage process on D, E, F, G and H shown in Table 2.

TABLE 1

CHANGES IN DRAINED WEIGHT (g) OF GINGER DURING 2-STAGE PROCESS AND YIELD OF PRODUCT

Sample No.	A	A1	B	B1	C	D
Treatment*	F	N	F	N	F	F
Sample weight (g)	100	100	100	100	100	100
Drained weight after thawing (g) ..	108	—	104	—	81	77
Drained weight after cooking (g) ..	108	109	107	106	104	110
Drained weight after processing (g) ..	121	88	130	88	115	120
Gain or loss drained weight after processing (g)	21% gain	12% loss	30% gain	12% loss	15% gain	20% gain

*F = Frozen before processing.
N = Not frozen at any stage.

TABLE 2

CHANGES IN DRAINED WEIGHT AND EQUILIBRIUM BRIX OF GINGER DURING 3–STAGE AND 4–STAGE PROCESS AND YIELD OF PRODUCT

									Means	
Sample No.	E	E1	F	F1	G	G1	H	H1		
Treatment*	F	N	F	N	F	N	F	N	F	N
Sample weight (g)	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Drained weight after thawing (g)	896	..	938	..	930	..	1,000	..	..	..
Drained weight (g)										
After cooking	1,060	1,040	1,062	1,046	1,058	1,020	1,094	1,092	1,068	1,049
After 1st stage (*a*) Brix	45	46	21	21	41	39	44	43	..	..
(*b*) Drained weight	1,184	1,088	1,140	1,084	1,176	1,050	1,200	1,094	..	..
After 2nd stage (*a*) Brix	57	56	39	39	54	50	54	54	..	..
(*b*) Drained weight	1,262	1,152	1,208	1,144	1,224	1,090	1,292	1,168	..	..
After 3rd stage (*a*) Brix	72	71	56	56	65	64	64	65	..	..
(*b*) Drained weight	1,360	1,192	1,390	1,162	1,292	1,099	1,356	1,208	..	..
After 4th stage (*a*) Brix	..	..	72	73	71	72	73	72	72	72
(*b*) Drained	..	..	1,388	1,188	1,320	1,110	1,416	1,214	1,373	1,176
Gain in drained weight after processing (%)	36·0	19·2	38·8	18·8	32·0	11·1	41·6	2	37·3	17·6

* F = Frozen before processing.
N = Not frozen at any stage.

TABLE 3

CHANGES IN BRIX (B) AND DRAINED WEIGHT (D.W. IN g) OF STRINGLESS GINGER AND YIELD OF PRODUCT (6–STAGE AND 7–STAGE IMPROVED CHAIN BATCH PROCESS)

Sample No.	Brined Weight	Cooked Weight	Stage 1		Stage 2		Stage 3		Stage 4		Stage 5		Stage 6		Final Stage		Yield
			B	D.W.	B	D.W.	B.	D.W.	B	D.W.	B	D.W.	B	D.W.	B	D.W.	
Local Ginger—Not Irrigated																	
A	394	400	11·0	414	19·5	403	32·5	428	43·0	440	52·0	461	65·0	492	71·0	528	32% gain
D	400	405	10·5	425	19·0	432	32·0	444	46·0	450	55·0	452	63·5	464	72·5	480	20% gain
G	400	419	13·0	401	24·5	390	32·0	420	47·0	432	58·5	436	..	..	71·5	487	22% gain
K	158	168	12·0	173	21·0	180	33·0	198	43·0	206	54·0	218	66·0	222	73·5	225	42·5% gain
N	401	413	10·5	435	21·0	444	31·5	455	48·0	465	57·5	474	62·0	486	72·5	489	22·0% gain
Q	403	407	11·5	390	23·5	378	35·5	392	50·5	410	62·0	416	..	..	71·5	431	7·0% gain
Mean (Approx.)	359	368	11·4	373	21·4	371	32·8	387	46·2	401	56·8	409	..	..	72·1	440	22·5% gain
Equiv. Drained Weight when Brined Weight = 1,000 g	1,000	1,023	..	1,039	..	1,032	..	1,078	..	1,115	..	1,140	..	..	..	1,225	
Chinese Ginger—Not Irrigated																	
B	400	403	11·0	419	20·0	415	28·5	436	45·0	466	56·0	480	64·0	465	72·5	484	21% gain
E	400	421	10·0	422	23·0	442	35·5	437	43·5	454	55·5	466	..	..	70·5	498	24·5% gain
H	400	405	10·5	408	20·0	439	33·0	440	46·0	431	65·0	431	..	..	75·5	479	19·7% gain
H_1	400	410	11·5	422	21·5	432	32·0	450	44·0	463	57·5	483	..	..	74·5	495	24·0% gain
L	214	218	11·0	234	21·5	240	31·0	253	44·5	260	55·5	276	64·0	282	73·5	292	27·0% gain
O	401	428	11·0	405	22·0	392	35·0	391	47·5	405	58·0	424	..	..	70·5	417	4·0% gain
R	400	410	11·0	412	25·5	434	39·5	449	46·5	434	66·5	439	..	..	75·5	468	17% gain
Mean (Approx.)	374	385	10·9	389	21·9	399	33·5	408	45·3	416	59·1	424	..	..	73·2	447	19·8% gain
Equiv. Drained Weight when Brined Weight = 1,000 g	1,000	1,030	..	1,040	..	1,068	..	1,092	..	1,111	..	1,122	..	..	..	1,196	
Chinese Ginger—Irrigated																	
C	398	404	10·5	429	22·0	426	33·5	444	44·0	451	54·0	454	64·5	453	74·5	447	12·2% gain
F	400	413	9·5	386	21·0	360	35·0	355	44·5	350	57·0	347	..	..	70·5	392	2% loss
J	400	419	10·5	421	20·0	414	36·5	421	51·0	450	65·5	446	..	..	75·0	489	22·2% gain
M	200	204	11·0	218	21·0	215	30·0	240	44·0	252	55·0	259	64·5	260	74·0	284	21·0% gain
P	400	414	10·5	409	21·0	390	37·5	392	48·0	399	56·5	405	..	..	70·5	429	7·2% gain
S	400	420	10·0	423	25·0	425	37·5	431	50·0	456	65·5	439	..	..	75·0	475	18·7% gain
Mean (Approx.)	366	379	10·3	381	21·6	372	35·0	381	46·9	389	58·9	391	..	..	73·6	419	14·5% gain
Equiv. Drained Weight when Brined Weight = 1,000 g	1,000	1,035	..	1,040	..	1,015	..	1,040	..	1,062	..	1,068	..	..	..	1,145	

highest yield it is desirable to keep the ginger covered with liquid at all times. This was particularly important during the cooking stages, when considerable shrinkage due to evaporation and pressure from the upper layers occurred unless discharging and refilling was done rapidly or the principle of overflow rinsing was applied.

III. CONCLUSIONS

It was shown that the quality of the locally processed product could be improved until it was approximately equal to that of the imported product. Processing costs could be reduced by more efficient syruping techniques, and fibrous ginger could be processed to give good yields. Choice tender stringless ginger had been produced by correct harvesting techniques, but the recovery after syruping was variable, apparently because this ginger was very susceptible to osmotic pressure changes even when 6-stage and 7-stage processes were used. Investigations to overcome this problem are discussed in another paper (Leverington 1969*a*).

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(Received for publication September 1961)

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