QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES
DIVISION OF PLANT INDUSTRY BULLETIN No. 477

GINGER PROCESSING INVESTIGATIONS. 3. IMPROVING THE QUALITY OF PROCESSED GINGER

By R. E. LEVERINGTON, D.I.C., F.R.A.C.I.

SUMMARY

Factors investigated included quality of the raw material, effect of pH on colour and flavour, fermentation, and crystallizing methods.

I. INTRODUCTION

During the early 1950s it became apparent that unless the quality of Australian ginger in syrup was vastly improved it could not hope to compete with the imported Chinese product. A close examination of many samples of both products, in both brine and syrup forms, showed that the local product was tough and had many thick stringy fibres (hereinafter called strings) running parallel to the vascular bundles. On the other hand, the Chinese ginger had a crisp texture and was generally free of fibres. It had been the custom of growers to harvest ginger not earlier than mid-April, when according to Groszmann (1954) the maximum green weight was normally reached. Although it had been found that after this time the rhizome became more fibrous, no serious effort had been made by the industry to purchase and market ginger on a quality basis.

In order to determine whether the Queensland ginger was at any stage in its growth period similar to Chinese in quality, observations on the texture of the rhizome were made at weekly intervals from the end of January 1955. It soon became evident that most of the rhizomes in February was similar in texture to Chinese, and subsequent syruping tests confirmed this.

An earlier harvesting period than that recommended by Groszmann (1954) was therefore indicated, and to confirm this, trials evaluating quality and yield at various stages were conducted on plants grown at the Maroochy Experiment Station.

"Queensland Journal of Agricultural and Animal Sciences", Vol. 26, 1969

TABLE 1

CHANGES IN GRADES OF GINGER PLANTED DURING AUGUST 1955

Date of Harvest	No. of Sound Plants Examined	Total Weight per Rhizome (Excluding Neck) (g)	Average Weight per Rhizome (Excluding Neck) (g)	Percentage Stringless (Excluding Neck)	Average Weight of Stringless per Rhizome (g)	Average Weight of Stringy per Rhizome (g)	Average Weight of Neck per Rhizome (g)	Percentage of Dry Matter in Neck	Relative Arbitrary Values of Crop
January 18 ..	23	910	40	85·5	34	6	13	5·8	..
January 25 ..	26	1,448	56	84·0	46	10	14	6·3	..
February 1 ..	25	1,955	78	77·8	61	17	15	6·5	..
February 8 ..	24	3,016	126	82·2	106	20	20	5·8	..
February 15 ..	24	4,100	171	74·5	127	44	19	6·5	..
February 22 ..	28	4,938	176	75·1	132	44	19	7·5	..
February 29 ..	30	6,692	222	72·2	160	62	14	8·0	2,000
March 7 ..	24	6,485	270	64·3	174	96	18	7·6	2,352
March 14 ..	21	8,113	386	64·2	248	138	19	7·5	3,347
March 21 ..	27	12,201	452	60·7	273	179	20	7·5	3,842
March 28 ..	20	12,114	607	54·3	329	278	21	7·2	5,000
April 4 ..	24	14,515	605	41·3	250	355	17	9·0	4,659

II. QUALITY IN RELATION TO TIME OF HARVEST

The first work undertaken was to find the percentage and average weight of stringless ginger at several harvesting times when plantings were made in August and October.

The first stage of the work was the development of a ginger "fibrometer", which was a physical device to determine the tenderness of the rhizome and not the percentage of fibre. The fibrometer consisted essentially of a steel plate $\frac{5}{16}$ in. wide, $1/64$ in. thick, and tapered to an 80° point at the lower end. This plate, suitably mounted to permit it to slide vertically on a rod, was placed laterally on the ginger and weights applied to the top. Stringless ginger, now known in the trade as "choice", was defined as that which permitted the blade to penetrate $\frac{1}{2}$ in. into the flesh when weights not exceeding $1\frac{3}{4}$ lb were applied to the plunger. Any ginger requiring a weight greater than this was classified as stringy ginger, now known in the trade as "first grade". Necks were classified as the first portion of the new plant growth development from the seed. These are normally very stringy, elongated, curved pieces suitable only for drying purposes. These preliminary studies formed the basis of a price structure which was immediately inaugurated by the Buderim factory, the growers being paid according to quality. The fibrometer was used to standardize the commercial grading of ginger, which is done manually by means of a sharp knife.

In experiments in the 1956-57 season, samples were examined and evaluated by the fibrometer 2 days after harvesting. The results are tabulated in Tables 1 and 2 and represented graphically in Figures 1 and 2.

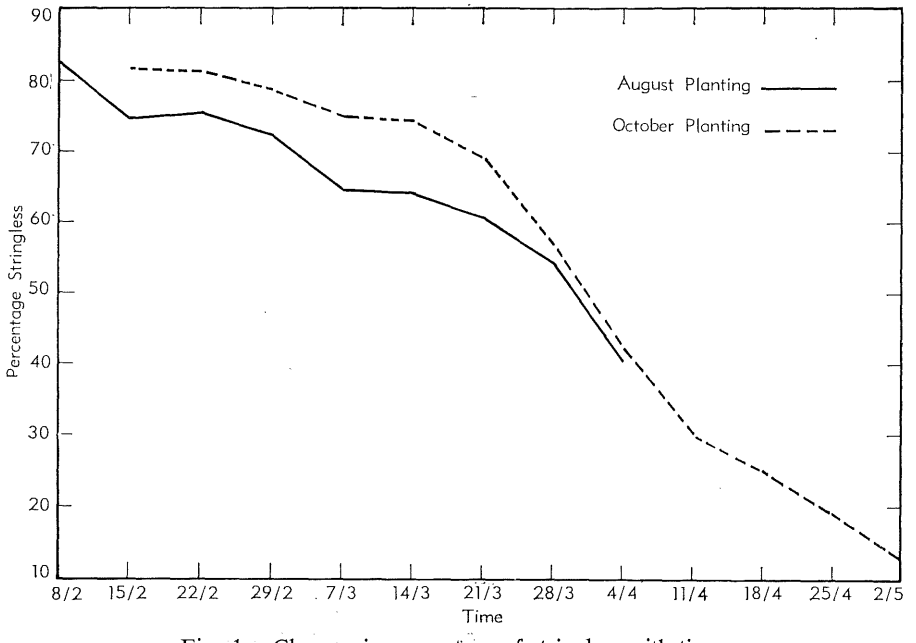

Fig. 1.—Changes in percentage of stringless with time.

TABLE 2

CHANGES IN GRADES OF GINGER PLANTED DURING OCTOBER 1955

Date of Harvest	No. of Sound Plants Examined	Total Weight per Rhizome (Excluding Neck) (g)	Average Weight per Rhizome (Excluding Neck) (g)	Percentage Stringless (Excluding Neck)	Average Weight of Stringless per Rhizome (g)	Average Weight of Stringy per Rhizome (g)	Average Weight of Neck per Rhizome (g)	Percentage of Dry Matter in Neck	Relative Arbitrary Values of Crop
February 15	18	1,559	87	81·5	71	16	15	6·3	..
February 22	29	3,914	135	81·0	109	26	17	7·4	..
February 29	21	2,702	129	79·0	102	27	14	8·0	1,210
March 3	30	6,485	216	75·0	162	54	18	7·8	1,980
March 14	30	8,610	287	74·5	209	78	19	7·5	2,597
March 21	27	9,206	340	69·6	237	103	18	7·2	3,024
March 28	21	7,833	372	57·3	213	159	13	7·2	3,110
April 4	26	13,040	516	42·7	220	296	16	9·0	4,007
April 11	28	17,275	616	30·1	185	431	14	10·6	4,465
April 18	22	12,498	568	25·3	144	424	12	10·6	4,004
April 25	24	14,751	615	19·4	119	496	17	10·0	4,203
May 2	29	18,893	644	13·0	84	560	16	10·0	4,232

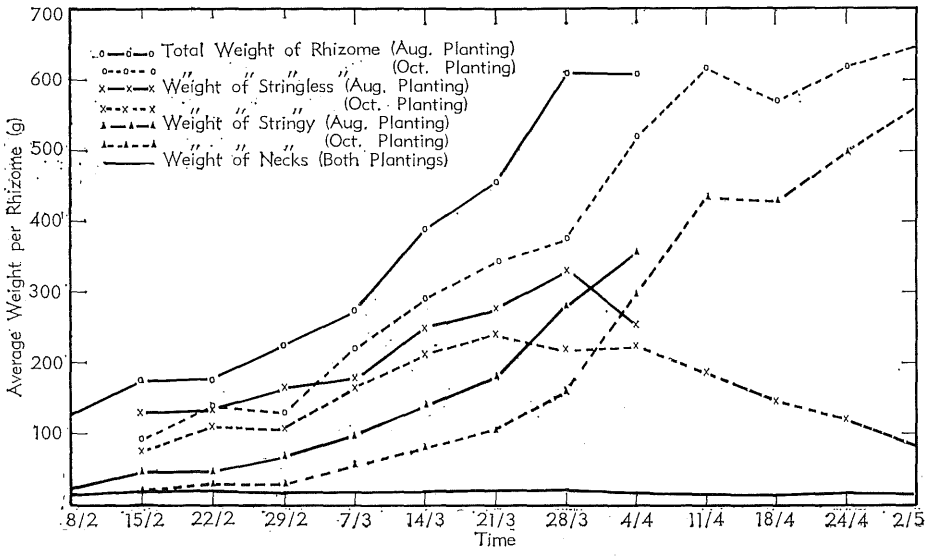

Fig. 2.—Changes in weight per rhizome with time.

Figure 1 shows that the percentage of stringless material was at its peak of about 80% in January and early February, and gradually fell until about March 14, the date of the commencement of flowering. It then fell more sharply until by the end of March the rhizomes of both plantings had only 50% of stringless material. Prior to this, the October planting had shown a higher percentage of stringless flesh. In both series the stringless portion had dropped to 40% within another week. By the end of April it was only 13% in the October-planted series. Harvesting of the August-planted series was completed by April 4.

Reference to Figure 2 shows that throughout the whole period when samples were drawn from both series, the August-planted series had higher weights, particularly on March 28, but 2 weeks later the October-planted series reached a similar average maximum weight and both series appeared to have ceased growing rapidly. Throughout the whole period when samples were drawn from both plots, August-planted had higher weights of stringless material than October-planted, particularly on March 28, when a peak was reached. The peak, which corresponds to 50% stringless, was very pronounced, particularly in the case of the early planting, suggesting that there is a short optimum period when the ginger should be harvested. It is considered that for commercial purposes this crop should have been harvested not later than March 31. The average weight of neck is almost constant. When the then current prices—10d. per lb for stringless, 6d. per lb for stringy, and 2d. per lb for neck—are applied to these results, it is evident that the early planting series was the most valuable when harvested on March 28, when the percentage of stringless was 54. Even higher premiums paid for stringless ginger in succeeding years made it more attractive for growers to harvest at an even earlier stage, viz. when the percentage of stringless was about 65–70.

In these trials, then, ginger planted in August gave better results than that planted in October. However, in both plantings the maximum average rhizome weight was of the same order, but the maximum average stringless weight was higher in the earlier planting. In the first planting the maximum average rhizome weight occurred at the same time as the maximum average stringless weight. In the second planting, however, the maximum average rhizome weight occurred 2 weeks after the maximum average stringless weight.

Another experiment was conducted in 1956-57 on similar lines, but owing to restriction of plant growth due to the soil condition, the ginger rhizomes were abnormally small and the recovery of stringless ginger appeared to reach a peak later than in the previous year.

In experiments conducted in 1957-58, the optimum harvest time was about the first week in April, while ginger harvested in 1959 had an optimum harvest time prior to March 9, apparently due to dry weather. Very little growth had occurred in the previous 3 weeks; when rain began to fall about this date there was a sudden surge in growth, but the strings grew at the same time and quality deteriorated quickly. Optimum harvest time for the 1960 crop occurred about the middle of March.

Experience over the five seasons showed that yield and percentage of stringless ginger per rhizome are dependent not only upon time of planting, mulching and soil conditions, but also on the weather, which appears to be capable of causing a variation of $\pm$ 2 weeks in optimum harvest time. To obtain the best return and also to prevent an accumulation of stringy material at the factory, it was necessary for weekly checks to be made by every grower on the proportion of stringless material in this crop from the end of January onwards.

III. EFFECT OF pH ON COLOUR AND FLAVOUR

The pH level of ginger syrups was varied from 3·5 to 5·5. There appeared to be no significant difference in colour of the final product, but flavour changed quite considerably. It was concluded that a pH of about 4·3 gave the most desirable flavour without upsetting the invert sugar/sucrose ratio, which requires rigid control to prevent crystallizing of the syrup. Too high an invert content causes weeping of the crystallized ginger, while too low a value causes hardening of the product due to sucrose crystallization. It was found that the optimum reducing sugar concentration was 25–33% of the total sugars.

IV. FERMENTATION AND FLAVOUR

As a result of a number of observations it was concluded that the characteristic fermented flavour of Chinese ginger, described as a ginger-beer flavour, is due to a yeast fermentation which proceeds either during the syruping stages or during subsequent storage after reaching a Brix of over 70. Osmophilic

yeasts have been isolated from such samples. By inoculating the initial syrups with Chinese syrups it has been possible to reproduce the characteristic flavour of Chinese ginger, particularly if a high quality raw sugar is used for preparation. No difficulties were experienced in using raw sugar for processing even though it undoubtedly had a high thermophilic bacteria content.

The "hot" flavour of tough stringy ginger processed by early methods was looked upon with some concern by manufacturers. However, the improved processing techniques using choice stringless ginger resulted in a much milder flavour.

The addition of honey up to 15% of the weight of syrup produced a distinctive flavour in ginger in syrup.

V. CRYSTALLIZING METHODS

Examination of some imported samples of crystallized ginger showed variability of adhesion of the crystal coating. For the production of glace fruit, Creuss (1948) recommended the momentary dipping of the drained fruit in hot water to remove adhering syrup and then drying, thereby giving a good surface for adhesion. This technique was applied to ginger by dipping the drained product in boiling water for periods varying from 1 to 20 sec and dehydrating at 120°F for 1–2 hr. A dip of 10 sec gave the most satisfactory product without loss of impregnated syrup.

Anon. (1931), Campbell (1945) and Morris (1945) have described methods for the crystallizing of fruits by crystallizing sugar from saturated or supersaturated solutions of sucrose in which the fruit was immersed. These techniques were applied to ginger without success. After drying, the sucrose sugar crystal coating became very brittle and was readily cracked and brushed off when handled as it would be under commercial conditions. It was therefore considered that an adhesive was required to hold 1A sugar crystals to the ginger.

Solutions of gelatine of various strengths and temperatures, as well as hot pectin solutions, were used as adhesives in a series of experiments. Although some solutions gave fair results, the coating of sugar was usually uneven and adhesion was weak in the thickly coated areas. As the difficulties experienced were apparently due in part to the stiff nature of the dry gelatine or pectin, a flexible adhesive was investigated by adding varying concentrations of gelatine to 30, 40, 50 and 60 Brix syrups.

The most satisfactory crystallized ginger was obtained by dipping washed dried ginger in a gelatine sugar syrup containing approximately 10–20% gelatine and about 50% sugar, and then immediately rolling it in 1A sugar several times, screening between each rolling stage. The actual concentration of gelatine required depended upon the temperature and humidity conditions and the drying facilities available. As a general rule, the better the drying conditions the less gelatine required. The amount of sugar used for rolling the

ginger increased in wet weather. The sugar screened off was sticky, due to the pressure of small amounts of gelatine syrup, but this was utilized in the preparation of impregnating syrups. The use of hot sugar, such as that received direct from a refinery drier or sugar which has been standing in the sun, was found quite unsatisfactory as the sugar tended to be absorbed by the gelatine syrup instead of just adhering to it. 1A grade sugar crystals are considered more satisfactory than the fine castor grade for crystallizing as they dried evenly without the caking effect of the crystals.

VI. ACKNOWLEDGEMENTS

The writer wishes to express his appreciation for the co-operation of Mr. G. W. J. Agnew (Senior Experimentalist) and the staff of the Horticulture Branch stationed at Nambour for the field work carried out in connection with these trials.

REFERENCES

ANON. (1931).—Preserving fruits and vegetables. *Bull. Dep. Agric. Vict.* No. 43.

CAMPBELL, C. H. (1945).—"Campbells Book, Canning, Preserving and Pickling" (Vance Publishing Corp. : Illinois, U.S.).

CREUSS, W. V. (1948).—Coating of candied fruits with pectin glace. *Fruit Prod. J.* 28(2):39-59.

GROSZMANN, H. M. (1954).—Ginger production. *Qd Agric. J.* 78:259-62.

MORRIS, T. N. (1945).—"Principles of Fruit Preservation." (Chapman & Hall: London).

(Received for publication September 1961)

The author is an officer of the Horticulture Branch of the Queensland Department of Primary Industries and is stationed at the Food Preservation Research Laboratory, Hamilton Central.