EFFECTS OF IN-VITRO PROPAGATION AND FORCING ON THE QUALITY OF PINEAPPLE JUICE

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ABSTRACT

The effects of in-vitro propagation and forcing on the quality of juice from pineapple fruits (Ananas comosus (L)) using the cultivar "Sugar loaf" were investigated. Juice quality indices measured for in vitro propagated, forced fruits were pH 3.6 - 4.3, brix-acid ratio 16.2-30.7, reducing sugars 0.5-2.1. Values for naturally propagated and forced fruits were pH 3.5-4.5, brix-acid ratio 19.5-26.7, reducing sugars 1.5-2.5. There were no significant differences ($p > 0.05$) between the two sets of quality indices. Similar results were observed when the quality indices for juice from in vitro propagated and naturally flowered fruits were compared with those from naturally propagated and naturally flowered fruits. The results suggest that in vitro propagation and forced flowering may be used in the production of pineapple fruits without any significant difference on fruit juice quality.

Forced flowering also had no significant effect ($p > 0.05$) on the quality of fruit juice from naturally propagated "Smooth cayenne", another cultivar of (Ananas comosus (L))

Keywords:
Pineapple, *in vitro* propagation, forcing, juice, brix-acid ratio.

INTRODUCTION

Pineapple (*Ananas comosus (L)* has recently been identified as an important non-traditional export crop for Ghana. Currently new methods are being investigated to make available sufficient planting materials for farmers in order to expand the production base of the crop. In furtherance of this, research is being focused on *invitro* techniques for rapid propagation of plantlets. This technique however is associated with considerable variability in certain agronomic traits (Amoatey and Osei-Kofi, 1993; Jordens-Rattger, 1987; Wakasa, 1979). Amoatey and Osei-Kofi, (1993) reported significant variation in the weight, length and girth of tissue-cultured pineapple fruits. Commercial growers apply chemicals to induce their plants to flower early (forcing). This technique shortens the production cycle of the crop and leads to uniformity in flowering (Amoatey and Osei-Kofi, 1993). It is important to investigate the quality characteristics of juice from tissue-cultured pineapple fruits as well as those subjected to forced flowering. Such information is a pre-requisite to utilization and successful trade in pineapples subjected to such treatment. The objective of this study was to investigate the effects of *in vitro* propagation and forcing on the quality of pineapple juice.

EXPERIMENTAL

Planting, forcing and harvesting of Pineapples

Two pineapple cultivars, "Sugar loaf" and "Smooth cayenne" were used for this study. Naturally produced suckers and *in vitro* propagated plantlets of approximately same size were planted in the experimental farm of the Biotechnology and Nuclear Agriculture Research Institute at Kwabenya. There were six treatments altogether: Four "Sugar loaf" - 1) Natural propagation, natural flowering, 2) Natural propagation, forced flowering 3) *in vitro* propagation, natural flowering 4) in vitro propagation, forced flowering and Two for "Smooth cayenne" -1) Natural propagation, natural flowering, 2) Natural propagation, forced flowering. Each treatment was planted on a plot measuring 2.75 metres by 3.5 metres. There were 28 plants per treatment in four rows at spacing of 0.75 metres by 0.5 metres. Treatments were assigned to plots randomly and replicated four times. Twenty months after field planting, individual plants in the appropriate treatments were forced to induce flowering. Fruits were harvested four months after forcing as they ripened. For treatments which did not include forcing, plants were left to flower, fruit and ripen naturally. For each treatment replicate, three fruits were sent to the laboratory for analysis.

Extraction of pineapple juice

Juice was extracted from the fleshy edible portion of the fruit using a Kenwood Chef food processor with the colander/sieve attachment. The juice was filtered using Whatman filter paper (general purpose grade).

Chemical analysis

Soluble solids (^{0}Brix) were determined at 20^{0}C using Abbe refractometer (Bausch and Lomb Optical Co., Rochester, N.Y.).

pH of the juice was determined using a digital pH meter (Accumet Model 10, Fisher Scientific, U.K.).

Titratable acidity (expressed as citric acid) was determined on 10 g / juice according to Ruck (1963).

Total and reducing sugars were determined by the method of Lane & Eynon (Ruck, 1963).

Statistical analyses

Two-way analysis of variance was used to determine the effects of the independent variables, *in vitro* propagation and forcing on the quality of "Sugar loaf" fruit juice whilst one-way analysis of variance was used to determine the effects of forcing on quality of "Smooth cayenne" fruit juice.

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Table 1. Effects of *in vitro* propagation and forcing on the quality of "Sugar loaf" pineapple juice

Parameter	NP[1]/NF[2]	IVP[3]/NF	NP/FF[4]	IVP/FF
pH	2.0 ± 0.2[5] (3.8 - 4.2)[6]	4.0 ± 0.3 (3.7 - 4.4)	4.1 ± 0.4 (3.5 - 4.5)	4.1 ± 0.3 (3.6 - 4.3)
Acidity	0.6 ± 0.1 (0.5 - 0.7)	0.6 ± 0.1 (0.5 - 0.8)	0.7 ± 0.1 (0.6 - 0.9)	0.7 ± 0.2 (0.5 - 0.9)
°Brix	14.3 ± 1.9 (12.0 - 16.5)	12.9 ± 0.7 (12.2 - 14.0)	14.7 ± 1.8 (11.5 - 16.4)	12.2 ± 3.6 (7.0 - 16.7)
°Brix/Acid Ratio	24.3 ± 4.5 (17.1 - 28.7)	23.8 ± 3.3 (19.7 - 27.3)	23.3 ± 2.6 (19.5 - 26.7)	21.7 ± 5.1 (6.2 - 30.7)
% Reducing sugars	2.3 ± 0.4 (1.9 - 3.1)	2.2 ± 0.7 (1.3 - 2.9)	1.9 ± 0.4 (1.5 - 2.5)	1.2 ± 0.7 (0.5 - 2.1)
% Total sugars	12.0 ± 4.3 (5.3 - 15.6)	10.9 ± 3.5 (7.6 - 16.4)	10.0 ± 3.4 (7.6 - 15.8)	11.3 ± 3.3 (6.5 - 15.6)
% Red./Total sugar ratio	21.6 ± 8.8 (14.2 - 35.6)	20.3 ± 5.0 (17.3 - 32.1)	20.2 ± 4.5 (15.2 - 26.7)	13.6 ± 11.1 (3.4 - 28.9)

[1]natural propagation [2]natural flowering [3]*in vitro* propagation 4forcing
[5]mean (8 values) ± s.d. [6]range

Table 2.. Effects of forcing on the quality of "Smooth cayenne" pineapple juice.

Parameter	NP[1]/NF[2]	NP/FF[3]
pH	3.7 ± 0.2[4] (3.5 - 4.0[5])	4.1 ± 0.1 (4.0 - 4.3)
Acidity	0.7 ± 0.1 (0.6 - 0.8)	0.7 ± 0.1 (0.6 - 0.9)
°Brix	15.3 ± 0.8 (14.0 - 16.5)	15.2 ± 0.2 (14.5 - 15.9)
Brix/Acid Ratio	22.4 ± 3.5 (18.9 - 28.7)	20 9 ± 3.9 (16.4-28.0)
% Reducing sugar	2.5 ± 1.1 (1.1 - 4.2)	2.4 ± 1.0 (0 8 - 3.4)
% Total sugars	10 ± 3.0 (7.4 - 14.9)	12.5 ± 1.4 (10.5 - 14.4)
Reducing/Total sugar ratio	25.5 ± 9.5 (10.6 - 34.9)	18.2 ± 8.1 (5.9 - 24.6)

[1]natural propagation [2]natural flowering [3]forcing [4]mean (8 values) ± s.d. [5]range

RESULTS AND DISCUSSION

Effect of in vitro propagation and forcing on "Sugar loaf" fruit juice quality.

The quality indices for fruit juice of "Sugar loaf" pineapples are shown in Table 1. The values for pH, titratable acidity and reducing sugars for the naturally propagated and naturally flowered fruit juice were similar to the values for juice from *in vitro* propagated and naturally flowered fruits. Slight differences between the two sets of values for Brix and total sugars were however observed. The two sets of quality Indices for juice from "Sugar loaf" fruits which were subjected to forced flowering also exhibited slight differences. Statistical analysis of the data indicated no significant differences ($p > 0.05$) between the quality indices of juice from the four sets of "Sugar loaf" pineapple fruits analysed. These results suggested that *in vitro* propagation and forcing had no significant effects on the quality of "Sugar loaf" fruit juice.

Effects of forcing on "Smooth cayenne" fruit juice quality

Table 2 shows the quality indices (pH, °Brix/acid ratio, reducing sugars and total sugars) of juice from naturally propagated "Smooth cayenne" fruits subjected to natural or forced flowering. The mean values for the two sets of data were similar. Analysis of the data indicated no significant difference ($p > 0.05$) between the chemical indices of juice from forced and naturally flowered fruits.

The Brix index which measure soluble sugars is associated with sweetness whilst acidity is associated with the astringency of the fruit juice. As the fruit ripens it becomes sweeter and less acidic and astringent. The Brix/acid ratio is an important index of fruit juice quality; in particular sweetness. Juices with higher Brix-acid ratio are sweeter. The Brix-acid ratio gives an indication of the suitability of the fruit for fresh use or processing into juice. For canning, a Brix-acid ratio of 16 is recommended (Purseglove, 1988). The Brix-acid ratio of unprocessed fruit juice is influenced by several factors; notable among them are cultivar, altitude at which they are cultivated, maturity or date of harvest and post-harvest handling. The observed variations in the Brix-acid ratio and the concentration of reducing to total sugars (Tables 1 & 2) may in part be attributed to differences in the stage of maturity and ripeness of the fruits at the time of harvest. In this experiment fruits were considered ripe for harvest by visual appraisal based on the experiences of the researchers. The concentration of reducing sugars in the fruit is an indication of degree of ripening (Wrolstad and Shallenberger, 1981). The wide variation in the ratio of the concentration of reducing/total sugars in the fruit juices observed in this study might also suggest differences in the maturity of the fruits at the time of harvest. It has been noted that when flowering is induced the fruits may not reach the same degree of ripening at the same time because of differences in the stage of maturity of the plant at the time of applying chemicals to induce ripening (PY *et al*., 1987), however it is difficult to assign the observed variations to any particular treatment because juice samples from fruits from both forced and naturally-flowered plants exhibited wide variations in the indices measured.

It has been reported that grapefruit with Brix-acid ratio of 7.0 had lower consumer preference scores than juice with ratio above 11.0 (Fellers *et al*., 1988). Fruit juice with naturally high Brix-acid ratio may not only be suitable for fresh use but also for blending with other juices with lower ratio but attractive bright colour or other sensory index (Chang *et al*., 1994).

"Sugar loaf" pineapple is less important than "Smooth cayenne" in international trade (Purseglove, 1988) because of its relatively higher sugar content and consequent greater susceptibility to post-harvest spoilage. If "Sugar loaf" pineapple is amenable to rapid propagation by tissue-culture without any negative impact on the fruit-juice quality, its high sugar content can be positively utilized in juice blends. Future studies will focus on Brix-acid ratio and its influence on consumer acceptance of the juice.

CONCLUSIONS

Juice from *in-vitro* propagated "Sugar loaf" pineapples had comparable quality (pH, titratable acidity, °Brix) as juice from naturally propagated fruits. Forcing in combination with *in vitro* propagation had no significant effect on "Sugar loaf" fruit juice. Forcing also had no significant effect on the quality of naturally propagated "Smooth cayenne" fruit juice. *In-vitro* propagation may be exploited for mass propagation of "Sugar loaf" planting material whilst forcing may be used to shorten the production time of these two cultivars of pineapple.

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