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Full Length Research Paper

A comparison of some physical, chemical and sensory attributes of three pineapple (A*nanas comosus)* varieties grown in Ghana

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The role of fruits and fruit juices in nutrition and health cannot be overemphasized. And as consumers look for better quality of fruits with regard to certain characteristics, new varieties are coming up to meet demand. It is against this background that this present study was carried out to assess the quality of MD2 pineapple variety with respect to the other varieties on the Ghanaian market. This study examined the physical, chemical and sensory quality of the MD2 pineapple variety compared to those of the sugarloaf and the smooth cayenne varieties on the Ghanaian market. Sugarloaf had the highest juice volume of 205.72ml/kg fruit, followed by MD2 (134-191) with smooth cayenne having the smallest volume. These differences were statistically significant, $p<0.05$. There were no significant flavor differences ($p> 0.05$); although there were significant differences ($p< 0.05$) in the overall preference for fruit juices which indicated that MD2 was most preferred pineapple fruit. MD2 compares very well with pineapple varieties already on the Ghanaian market. Its cultivation in Ghana has potential both for the local and international market and should be encouraged.

Key words: Fruit, pineapple, MD2, sensory evaluation, chemical attributes, fruit juice.

INTRODUCTION

Since its introduction to the European market in 1996, the MD2 pineapple variety has increasingly gained more attention than smooth cayenne, sugarloaf and other traditional pineapple varieties of commerce. The MD2 has been described as super-sweet, self ripening and having a longer storage life with a value twice as much as that of the smooth cayenne variety (Achuonjei et al., 2003). The production of MD2 in Ghana has been estimated to be 2% of total pineapple production with the smooth cayenne at the forefront (Trienekens, 2003). It has there-fore become necessary for Ghanaian growers to take advantage of the increasing popularity of MD2 if they are to maintain their share of the European market.

In Ghana, the volume of pineapple export in 2005 was 46694 tonnes as against 71804 tonnes in 2004. This marks a percent change of -34.97%. Pineapple export in 2005 had a value of $12,784,300 ($12.7 million) as Against $22,068,600($22 million) in 2004 representing a percent change of -42.07%. These earnings from pineapples stand out as markedly high when compared to its closest competitor, banana. In 2005, the volume of banana export was 1116 tonnes and in 2004, 725 tonnes reflecting a change of 53.93% with a value of $458,000 and $ 208,900 in 2005 and 2004, respectively, marking a change of 119.24% (ISSER, 2006).

It has been suggested that, the MD2 demands a cold chain supply in order to maintain a long shelf life. Its presence on the Ghanaian market with tropical weather conditions may likely affect quality attributes. The competition with other varieties like the sugarloaf and smooth cayenne that are more familiar to Ghanaian consumers should not be underestimated. Its potential on the local market will largely be based on its quality attributes.

A major question arises as to whether the MD2 can signifycantly alter the preferences of consumers in Ghana in a trend akin to that observed in Europe. Further, should the characteristics of the MD2 be perceived as superior to that of the already existing cultivars in Ghana and it is possible that, inevitable shifts in local market trends may well demand an increased production of the MD2 locally. This prospect may also create a significant economic re-

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percussion for the horticultural sector considering the fact that pineapple is among the top-five non-traditional export commodities in terms of foreign earnings in Ghana.

An assessment of the quality of MD2 with respect to the other varieties on the market will aid on-going research targeted at establishing the quality of MD2 pineapple in Ghana. This study examines the physical, chemical and sensory quality of the MD2 pineapple variety compared to those of the sugarloaf and the smooth cayenne varieties on the Ghanaian market. The implications for industry, nutrition and health are discussed.

METHODS

Freshly harvested pineapples of three varieties; MD2 at two different ripening stages, M1 (one-fourth of the shell colour yellow) and M3 (three-quarters of the shell colour yellow); smooth cayenne and sugarloaf were obtained from Blue Skies Products Company Limited and Kings Farms (Ghana). Samples were transported in paper cartons to the laboratory and kept refrigerated at 5-8ºC prior to analyses which run over a four-day period. Four replicates each of the three varieties were sampled for physical and chemical analyses.

Physical analyses

Fruits were weighed using a top loading balance (Salter-AND Model, Japan), the weight of the samples were determined. The volumes of the samples were also determined by the displacement method after Coulter and Lorenz (1991) and the density determined as weight per volume (g/cm^3). Using a pineapple slicer, the flesh of the pineapples was scooped, passed through a juice extractor and the juice collected. Volume of juice (mls) was measured using a measuring cylinder.

Chemical analyses

Vitamin C was determined by the Dichloroindophenol method (AOAC, 1990). Acidity (pH) of the juices was evaluated using an electronic TOA pH meter (HM 305 Model, Japan) at 27ºC. Titratable acidity was assessed as outlined by AOAC, (1984). Soluble solids were determined using an Abbe refractometer (AOAC 932.12; 1995). Total carbohydrates were estimated by the Anthrone Method (Plummer, 1987). Sweetness Index (SI) was derived as the ratio of the percent soluble solids to titratable acidity and Astringency Index (AI) was expressed as the ratio of titratable acidity (g citric acid/100 g fruit) to soluble solids content (%) (Table 3b).

Sensory analyses

Organoleptic characteristics of the three pineapple juices were carried out. Thirty (30) panelists were randomly assigned the samples blindly for evaluation for sweetness, color, flavor and overall preference. The samples used for the sensory evaluation included 100% juice from each of the three varieties in addition to MD2 juice blended with smooth cayenne or the sugarloaf (all at the M3 maturity stage) in the following proportions: 80:20, 60:40, 40:60, 20:80. A total of 11 juice samples were evaluated using a seven-point hedonic scale. The sensory evaluation (Table 3a) was done in 2 days; day 1 was between MD2 and smooth cayenne and day 2 was between MD2 and sugarloaf. This was necessary to reduce respondent burden (and the risk of sensory fatigue) and also to ensure a fair comparison of MD2 to either variety but not between smooth cayenne and sugarloaf.

Data analysis

STATGRAPHICS Plus, version 3.0 (Statistical Graphics Corporation, STSC Inc, U.S.A.) was used to analyze the data, using one factor ANOVA (for pineapple) at three levels (Smooth cayenne, MD2 and Sugarloaf). Multiple Range Test (LSD) was used to assess differences between the varieties at 95% confidence level.

RESULTS

Physical evaluation

The densities of the MD2 samples ranged between 0.92 - 1.10 g, that of sugarloaf was 0.99-1.06 g/cm^3. The smooth cayenne recorded the lowest densities ranging from 0.94-0.99 g/cm^3. These differences, however, were not statistically significant ($p>0.05$). The volume of fruit juice obtained from the samples were significantly different ($p<0.05$). Sugarloaf had the highest juice volume of 205.72 ml/kg fruit, followed by MD2 at M3 stage, with values ranging from 143.12-191.43 ml, MD2 at M1 stage with a range between 134-182 ml. Smooth cayenne had the least volume between 91.7-108.65 ml.

Chemical evaluation

The chemical characteristics of the pineapples are shown in Table 1. The MD2 at the M1 and M3 stages had an ascorbic acid content of 54.17 and 49.59mg/100ml respectively. This was followed by Sugarloaf (42.11 mg/100 ml) with Smooth Cayenne having the least value (21.04 mg/100ml). The differences observed were statistically significant ($p<0.05$).

Titratable acidity was different among samples ($p< 0.05$). Smooth Cayenne showed the highest titratable acidity value, followed by the MD2 at the M1 stage.

Sugarloaf had the highest pH and Smooth Cayenne had the lowest values. The varietals differences were significant ($p<0.05$). However, pH variations between the two maturity stages of the MD2 (M1 and M3) were not statistically significant.

Total carbohydrates were highest for the MD2 at M3 followed by the Sugarloaf, Smooth Cayenne and then MD2 at M1. The differences were significant ($p<0.05$) and further analysis revealed that the sugar content of MD2 at M3 and of Sugarloaf are the same but higher than those of Smooth Cayenne and MD2 at M1. The total sugar content was significantly different for the MD2 at the two maturity stages.

Differences in the soluble solids content between the varieties were significant ($p<0.05$). Sugarloaf had the highest sweetness index of 15.14; followed by the MD2 (M3: 12.72 and M1:12.65) and the Smooth Cayenne had the lowest index of 6.98. These differences between the varieties were significant ($p<0.05$) but not between the

Table 1. Chemical attributes profile of the pineapples (Means (SD).

Varieties		pH	Soluble solids (%)	Acidity (%)	Vitamin C (mg/100 ml)	Total sugars (g/100 ml)	Sweetness index	Astringency index
MD2		5.40 (0.06)	14.5 (0.00)	1.15 (0.01)	51.88(3.24)	16.90 (8.61)	12.69 (0.05)	0.08 (0.00)
MD2	M1	5.35 (0.33)	14.50 (1.00)	1.16 (0.09)	54.17(4.49)	10.81 (1.02)	12.65 (1.81)	0.08 (0.01)
	M3	5.44 (0.33)	14.50 (1.00)	1.14 (0.06)	49.59(4.31)	22.98 (7.39)	12.72 (0.57)	0.08 (0.00)
SL		4.96 (0.02)	16.75 (0.96)	1.11 (0.05)	42.11(2.85)	17.50 (94.88)	15.14 (1.47)	0.07 (0.00)
SC		5.80 (0.02)	11.59 (2.30)	1.67 (0.08)	21.04(4.26)	12.39 (5.41)	6.98(1.67)	0.15 (0.03)

Table 2a. Organoleptic profile of MD2 and sugarloaf juice (Mean rank).

	Colour	Sweetness	Flavour	Overall preference
100 %MD2	2.17	3.73	3.20	3.97
100 % SL*	3.97	4.27	4.03	4.33
80%MD2-20%SL	2.37	2.70	3.20	2.63
60%MD2-40%SL	2.73	3.67	3.43	3.33
40%MD2-60%SL	3.47	3.47	3.43	3.17
20%MD2-80%SL	3.83	3.13	3.70	3.17

*SL= sugarloaf.

Table 2b. Organoleptic profile of MD2 and smooth cayenne juice (Mean rank).

	Color	Sweetness	Flavor	Overall preference
100%MD2	2.17	3.17	2.97	3.27
100%SC**	3.97	3.30	3.17	3.73
80%MD2-20%SC	2.37	3.03	3.37	3.23
60%MD2-40%SC	2.73	2.87	3.47	3.50
40%MD2-60%SC	3.47	3.10	3.20	3.63
20%MD2-80%SC	3.83	3.57	3.30	3.63

**SC= smooth cayenne. Like extremely, 1; Like very much, 2; Like slightly, 3; neither like nor dislike, 4; Dislike slightly, 5; Dislike very much, 6; Dislike extremely, 7.

varieties were significant ($p<0.05$) but not between the two maturity stages of MD2. The Smooth Cayenne had the highest astringency index of 0.15. The Sugarloaf had the lowest index of 0.07, whilst MD2 at M1 and M3 each had 0.08. The astringency index of the Smooth Cayenne was significantly different ($p<0.05$) from that of the Sugarloaf and MD2 at the two maturity stages. No significant difference was found between the Sugarloaf and

Table 3a. ANOVA summary table for sensory tests [F-Ratios (P-value)].

Source of variation	Color	Sweetness	Flavor	Overall preference
Variety Mix	5.77 (0.0168)	3.44 (0.0644)	2.25(0.1345)	0.00 (0.9499)
Ratios	9.84 (0.0000)	1.95 (0.0855)	0.77(0.5683)	3.05 (0.0103)

*Values represent F-Ratios (P-value).

Table 3b. ANOVA summary table for chemical and physical analyses.

Source of variation	pH	Soluble Solids (%)	Acidity (%)	Vitamin C (mg/100ml)	Total Sugars (g/100ml)	Sweetness Index	Astringency Index	Density (g/cm^3)	Vol. of juice per kg pineapple (ml/kg)
Pineapple variety	8.77 (0.0024)	8.74 (0.0024)	56.39 (0.0000)	52.96 (0.0000)	4.47 (0.0251)	22.44 (0.0000)	17.56 (0.0001)	1.62 (0.2358)	20.81 (0.0000)

*Values represent F-Ratios (P-value).

the MD2 at M1 and M3. There was no significant differrence between the MD2 at the two maturity stages

Sensory evaluation

For organoleptic characteristics of the pineapples, the colour of 100% MD2 (M3) juice was most preferred (Tables 2a and 2b). For fruit juice blends, samples containing higher proportions of MD2 at M3 were most preferred. The MD2-Smooth Cayenne juice blends generally had lower rankings than the MD2-Sugarloaf blends. 80% MD2-20% Sugarloaf was the most preferred of the MD2-Sugarloaf blends whilst 60% MD2-40% Smooth Cayenne was the most preferred of the MD2-Smooth Cayenne products. Blends of MD2 and Sugarloaf were more preferred to products containing 100% of either the MD2 or the Sugarloaf.
Blends of the Sugarloaf and the MD2 were less preferred to MD2-Smooth Cayenne as judged by their higher mean rank sums. Product compositions with higher amounts of the MD2 were preferred to those with higher concentrations of Sugarloaf or the Smooth Cayenne, but the differences were not significant.

There was no significant effect on flavour ($p > 0.05$), however, there was significant difference ($p < 0.05$), in the overall preference for flavor. MD2 was most preferred. Addition of Sugarloaf at 20% to the MD2 is seen to create detectable differences in overall preference. Preferences for the Smooth Cayenne-MD2 blends were seen to decrease with increasing amounts of the Smooth Cayenne.

DISCUSSION

Specific gravity may be useful as a fruit grading index for differentiating eating quality as well as maturity. A greater density corresponds to a greater fruit weight that may possibly imply a larger serving size and a more compact texture. Translucency has been correlated with specific gravity although the latter is a better indicator of eating quality than the former (Smith, 1988).

Since the desire of some consumers is for more of the juice than the flesh, the volume of juice extractable from a particular variety becomes important indicating which of the varieties may be most profitable in commercial pineapple juice manufacture. From the results, sugarloaf is seen to have more juice, less fibre and more sugar presenting the best prospects and advantages in this enterprise. However, sugarloaf with a greater juice volume may be prone to bruising and other post harvest mechanical injuries to greater extents than the MD2 and the smooth cayenne.

Ascorbic acid content of fruits in general is an important quality index due to its health significance as a vitamin and cellular antioxidant. Furthermore, in food processing, ascorbic acid functions as an antioxidant by being preferentially oxidized (Bartholomew et al., 2003, Ngoddy and Ihekoronye, 1985). Ascorbic acid value of pineapple is largely variable depending on factors such as

the cultivar, stage of maturity, conditions of storage and the part of fruit. It ranges from 20/100 to 34.44 mg/100 ml (Collins, 1968; Ngoddy and Ihekoronye, 1985). The vitamin C content of the MD2, sugarloaf and smooth cayenne is consistent with the entire varieties meet the dietary requirement of vitamin C but MD2 has the best potential due to its very high levels on weight for weight basis than the other varieties. The amount of vitamin C in a fruit has been linked with internal browning associated with post harvest chilling injury (Miller, 1951). Internal browning is a minor problem if fruit ascorbic acid is greater than 500 µM (Teisson and Combres, 1979). The MD2 with a higher ascorbic acid concentration may have an advantage over the sugarloaf and the smooth ca-yenne in reducing post harvest quality changes linked to chilling injury (Paul and Rohrbach, 1985).

Fruit acidity increases with maturity (Gortner and Singleton, 1965); however, MD2 at maturity stages M1 and M3 appear to have little or no effect on titratable acidity (Kotey, 2006). The higher acidity of the smooth cayenne may imply a longer storage life and a possibly higher astrin-gency index. Under high temperatures, gelling, properties may be affected when acidity is high due to the hydrolysis of sucrose and pectin methoxyl groups. Sugarloaf with a high pH may be less suitable for jam manufacture than the Smooth Cayenne and the MD2 since its glycoside linkages would remain relatively less stable at low acidity. The pH values obtained reflects to a significant extent the microbial stability of the various varieties. The MD2 and Smooth Cayenne with lower pHs' will be expected to keep better than the Sugarloaf. Acidifiers may be needed to enhance the keeping properties of Sugarloaf products.

Senescence is enhanced by increasing sugar content in fruits. This has implications for sugarloaf and MD2 at M3 maturity stage which puts them at an increased risk of deterioration than the smooth cayenne. Soluble solids are also known to impact sweetness index than does the total sugars (Bartholomew et al., 2003). The soluble solids content is also used as an indication of fruit maturity and quality (Paul, 1993) and for pineapples, they range between 10.8 - 17.5% (Dull, 1971) with very little variations between varieties. However, the slightly higher values for sugarloaf are consistent with the sweetness rankings. Studies by Sideris and Krauss (1934) indicate that, fruits which have a sweetness index greater than 19 are regarded as sweet and less acid by taste. The data for Sugarloaf are within these limits. The implication is that, sugarloaf has an intense flavour and possibly, a higher consumer preference than the MD2. Smooth cayenne would most definitely have the lowest consumer preference.

Astringency or tartness was similar for the MD2 and the sugarloaf. This is probably due to the nullifying impact that acidity has on sweetness. These values indicate that, though the sweetness of the sugarloaf is appreciably higher, their eating quality may be similar. The smooth cayenne with a light yellow colour complemented the golden brown colour of MD2 to give a darker rich yellow colour for their blends. It is likely that, 20% of MD2 present in the product was just sufficient to balance out any contrast between the smooth cayenne and the sugarloaf indicating that the colour of MD2 is sufficiently deep enough to cancel out any disparities. The MD2 thus significantly impacts on colour with its golden brown colour being the preferred choice colour.

Conclusion/Implication

MD2 compares very well with pineapple varieties already on the Ghanaian market. Its cultivation in Ghana has potential both for the local and international market and should be encouraged. Due to its rich dark yellow colour, it could be added to juices with pale yellow colour to enrich them. MD2 variety has a great potential in the horticultural industry.

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