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TNO/CSIR-FRI Pineapple Project

UTILIZATION OF ORGANIC SIDE-STREAMS OF PINEAPPLES FOR SMALL SCALE PROCESSING FOR THE LOCAL MARKETS IN GHANA

BY

C. Tortoe[1], C. Oduro-Yeboah[1], P-N. T. Johnson[1], E. Hoornstra[2] & T. Slaghek[2]

[1]CSIR-Food Research Institute, Accra

[2]TNO, Netherlands

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Contributors

CSIR-Food Research Institute

Charles Tortoe

Charlotte Oduro-Yeboah

Paa Nii T. Johnson

Appolonius Nyarko

Ama Veness

Emmanuel Alorsey

Agatha Amuzu

TNO-Netherlands

Erick Hoornstra

Ted Slaghek

1.0 Introduction

The second harvest of importance after bananas, contributing to over 20 % of the world production of tropical fruits is pineapple according to (Coveca, 2002). Nearly 70 % of the pineapple is consumed as fresh fruit in producing countries. Pineapple originated from Brazil and Paraguay in the Amazonic basin where the fruit was domesticated. It has been defined as the most probable area of origin the zone comprised from upper Panama and Brazil, Paraguay and Argentina, including the northern Amazonian forest and the semi-arid regions of Brazil, Venezuela and Guyanas (Collins, 1949; 1960).

Worldwide production started by 1500 when pineapple was propagated in Europe and the tropical regions of the world. The most spread variety is *Cayena lisa* (Smooth Cayenne) which was first introduced in Europe from French Guyana. It was until late XIX century when canned pineapple was produced commercially in Hawaii (Collins, 1949; 1960).

Food and Agriculture Organization (2004) estimates that Thailand, Philippines, Brazil and China are the main pineapple producers in the world supplying nearly 50 % of the total output. Other important producers include India, Nigeria, Kenya, Indonesia, México and Costa Rica and these countries provide most of the remaining fruit available (50 %). Pineapple dominates the world trade of tropical fruits, although other fruits have gained market share. According to Coveca, (2002) from the year 2000, pineapple trade took 51 % from a total of 2.1 million tons of the whole fruit market with mangoes taking the second place, with 21.7 %. Pineapple is the best positioned fruit since its trade is oriented to developed countries as Japan, the USA and the European Community. Consequently, during the past decade world production of pineapple as increased at a rate of 1.9 % per year, despite the occurrence of unfavourable weather and economic situations (FAO, 2002).

According to the Food and Agriculture Organization (2002; 2004) several new varieties of pineapples have been introduced to improve the quality of the fruit that reaches the international markets such as MD2 (Golden ripe, Extra sweet and Maya gold). These varieties are hybrids that were developed in Hawaii from *Cayena lisa* with an average weight ranging from 1.3 to 2.5 kg. It has an intense orange to yellow-

orange colour and a high sugar content of 15 to17 °Brix. The fruit is sweet, compact and fibrous. Main differences found with respect to the *Cayena lisa* variety are: better resistance to internal darkening, lesser ascorbic acid content more prone to rotting and sensitive to *Phytophthora.* The La Josefina variety was released in 1996 for the fresh fruit market. It is a hybrid developed from other two clones. Its production cycle is annual with a generation of 2 a 3 suckers per plant. Average fruit weight is 1.1 to 1.3 kg and contains an elevated sugar concentration (17 to 22 °Bx). Differences with respect to the *Cayena lisa* variety are: longer shelf life, greater sugar content and resistance to black heart disorder and shorter production cycles. Finally, variety RL41, is a hybrid obtained from cultivars *Cayena lisa* and *"Manzana"* with an average weight of 1.4 to 2 kg and a high sugar content, 15 to 18 °Brix. Compared to *Cayena lisa,* this variety has a greater ascorbic acid content and shorter production cycles, as well as lesser resistance to rotting but more resistant to flower induction (FAO, 2002).

Presently, only 8 % of pineapples are exported despite the fast expansion of the trade of fresh pineapple in the world. Costa Rica and Ivory Coast are the main suppliers of fresh pineapple (Table 1). Belgium, France, Germany and Netherlands participate in the world trade by re-exporting. With the exception of the Philippines, the six main pineapple producers in the world contribute minimal amounts to the market of fresh pineapple trade (FAO, 2002).

Apart from canning and juice extraction, there are other utilisations of pineapple for feed production. The leaves are used in three forms: fresh, dried and in silage (Geo coppens, 2001). Hearts and peels from the canning operation are dried and mixed with molasses to produce a meal. Yield per hectare for crowns and hearts can be as high as 10 tons in fresh, which turns into 1 ton of dried product. Solids from the centrifuge from juice production are used as feed for pork (FAO, 2004).

Pineapples may offer additional advantages for a whole utilization, in particular as a fiber source. Among the qualities of the fiber is the texture, its length (60 cm), high water and dye holding capacity, high whiteness, brightness, resistance to salt and tension strength. Consequently, some producing countries exploit pineapple fiber for the paper and clothing industries. This fiber resembles silk in texture and color. It is used in some Asian countries for manufacture of high value garments. In the paper industry pineapple fiber has been found to produce fine and flexible sheets of paper.

Bromelin has been produced traditionally from stems in Hawaii. Currently it is been extracted in other countries as Taiwan, Thailand, Brazil and Puerto Rico. Typical use of bromelin has been as meat tenderizer and as component of pharmaceuticals (Morton, 1987).

Table 1.

Export of fresh pineapple as percentage share of total production per country.

Country	Percentage	Country	Percentage
Netherlands	88.9	Germany	11.2
Ivory Coast	82.2	Philippines	8.9
Belgium	78.9	Ecuador	5.1
Costa Rica	67.9	México	4.7
Honduras	61.3	Brazil	1.2
France	52.2	Thailand	0.2
Ghana	36.4	China	0.2
Malaysia	14.7	India	0.1
Nicaragua	12.9	Colombia	0.02
United States	12.5	Nigeria	0

Source: Statistical data base, FAO (2000)

Among the different medicinal and healing properties of pineapples fruit is antiparasitic, abortive, detoxifier, vermifuge and stomach disorder relief. It improves digestion, regulates stomach acidity, aids in detoxification processes, the neutralization of free radicals and blood clots, as aid in the treatment of rheumatoid arthritis, reduction of sciatica symptoms, collagen production, weight control and in the treatment of albuminuria. Evidence of these claims was generated from studies made in the US and Europe (Coveca, 2002).

One of the best known properties of pineapple is as a diuretic. This helps to eliminate toxins through the urine, helping patients with ailments of kidneys, bladder and prostate. Due to the fiber content of the pulp, pineapple prevents constipation and regularizes the intestinal flora. Furthermore, there is evidence of appetite reducer, heart protection and aid for fever, sore throat and mouth aches and inflammation. Lightly boiled ground pineapple can be used to clean infected wounds because it

eliminates dead tissues, not affecting live tissue, acts as disinfectant and accelerates cicatrization (Mundogar, 2004).

Pineapple is a rich source of Vitamin C as well as other vitamins and fiber. Pineapple's Bromelin stimulates digestion and the proper performance of the small intestine and kidneys; it helps in detoxification, normalizes colonic flora, helps in hemorrhoid alleviation, and prevents and corrects constipation. It has been used to heal colds, mouth, throat and bronchial infections. Cooked peel cleans blood and alleviates swellings. Juice helps to cure cystitis, and fevers (Gastronomia, 2004).

Fruit fibres are side-streams of the fruit processing industry, left behind when the fruit is de-juiced. Despite the benefits of fibre for human health – including boosting satiety, slowing glucose absorption, and functioning as prebiotics – fruit fibres often end up being thrown away or used as animal feed. Appropriate uses for the side-streams of pineapple including the crown, peels and the pulp after de-juiced is been sort diligently in literature to add more value to pineapple. It is also a concept for fruit product diversification. In this study the pineapple pulp and juice is been diversified in bakery products to add value to the organic side-streams of pineapple. In Ghana pineapple pulp after de-juiced is a big waste component draining the economy of the pineapple juice processing factories. Alternative uses of the pulp after de-juiced will bring a colossal economic relief for the processing industries in terms of waste cut and natural ingredients that can also boost food's fibre content.

2.0 Materials and methods

2.1 Pineapple varieties

Three pineapple varieties MD2, Sugar loaf and Smooth cayenne purchase from a pineapple supplier in Kasoa, Central Region were used in the study.

2.2 Sample preparation

Pineapples were carefully peeled and the fruit separated from the peel. The fruits were grind using Apex mill (Apex 314, Apex Construction Limited, London, England) and

the juice separated from the pulp. Fraction of the pulp (1.5 kg) was mixed with water (0.5 L) and boiled for 1 h to dissolve the free sugar fragments. The mixture is filtered and the residue is pressed on the filter. The residue is washed with water (0.5 L) and pressed. Water is evaporated until about 200 ml dry weight (about 50%) resulting in the syrup (brown slurry). The residue from the filtrate is dried at 60 °C and grinded into a pulp powder. The sample processing was done for 17 pieces of each pineapple variety.

The juice was divided into two portions. An anti-oxidant (sodium metabisulphite) was added to one part of the juice and the initial pH and Brix measured.

2.3 Packaging

The hot fill and methods were employed during the packaging of the juice. During the hot fill part of the juice was heated in a bowl maintained in a water bath of 85 °C and kept for 10 mins when temperature is more than 80 °C. During repasteurisation, juice is packed into packaging material and heated afterwards (packages in a water bath of 85 °C and kept for 10 mins when temperature is more than 80 °C).

Three packaging materials, glass bottles (control), PET bottles and plastic pouches of high and low density polypropylene materials were used in the study. The samples were stored at 30 °C for 30 days and the sensory/quality (taste, browning, package integrity), pH and °Brix measured.

2.4 Bakery products

Using a formulation of wheat flour and pineapple brown slurry at a ratio of 1:10 and wheat flour and pineapple pulp powder at ratio of 1:10, queens cakes were baked using a household oven (General Electric, London, England) for each of the three pineapple varieties. In all cases the control flour was wheat flour (Table 2). The raw materials were acquired from local supermarket (EverGreen, Accra) and stored in glass or plastic containers at 30 °C or under refrigeration, depending on the recommended storage conditions of each material. Extra wheat flour was incorporated in the control sample in exchange for pineapple brown slurry and pineapple pulp powder. The dough for the product was obtained by mixing the ingredients and filled

in greased aluminium cake sheets and baked at 200 °C for 20 mins. The products were allowed to cool to room temperature after baking and packed in polypropylene pouches and sealed until further analysis.

Table 2
Formulation of bakery products using pineapple brown slurry and pineapple pulp powder

Ingredient (g)	Product type		
	Control Queen cake	Queens cake with pineapple brown slurry	Queens cake with pineapple pulp powder
Wheat flour	920.0	920.0	920.0
Pineapple brown slurry	-	92.0	-
Pineapple pulp powder	-	-	92.0
Sugar	200.0	200.0	200.0
Margarine	250.0	250.0	250.0
White flour	250.0	250.0	250.0
Egg (pcs)	12	12	12
Nutmeg	7.0	7.0	7.0
Vanilla(ml)	5.0	5.0	5.0
Extra wheat flour	92.0	-	-

2.5 Laboratory test panel

A laboratory test panel comprising five technicians experienced in product sensory test was setup to ascertain the sensory attributes of the baked products. A 7-point hedonic scale of preference was scored for the following sensory attributes: taste, mouth feel, hand feel, texture, crust colour, crumb colour, air cells, crumb homogeneity, sponginess, flavour and general acceptability. In the hedonic scale 5 represent extremely desirable, while 1 represents extremely undesirable for taste, mouth feel, hand feel, flavour and general acceptability. In the crust colour, 5 represents extremely brown and 1 is extremely yellow; crumb colour, 5 is extremely yellow and 1 is extremely creamy; texture, 5 is extremely soft and 1 is extremely hard; sponginess, 5 is extremely sponge and 1 is extremely compact; air cells, 5 is extremely small, 1 is extremely large; crumb homogeneity, 5 is extremely homogenous, 1 extremely heterogeneous.

2.6 Data Analysis

The result of the evaluation was analyzed using analysis of variance (ANOVA) and mean separation carried out using Duncan Multiple range Test.

3.0 Results

3.1 Pineapple juice sugar content and acidity

Two side stream products from pineapple, pineapple brown slurry and pineapple pulp powder were developed. A natural juice and juice augmented with anti-oxidant were also developed from pineapple. Table 3 shows the fresh weights of the pineapple varieties with the highest pulp and juice recorded for sugar loaf variety followed by MD2 and smooth cayenne. Interesting the dried pulp of MD2 was greater than both sugar loaf and smooth cayenne although the fresh pulp of sugar loaf (10.5 kg) was more than MD2 (9.0 kg). This indicated that sugar loaf has less compact fibre in texture and tend to lose more juice during extraction than MD2, which is more compact and fibrous. Similarly, is an indication that sugar loaf variety has abundant juice (6.7 L) than MD2 (6.0 L). MD2 variety has intense orange to yellow-orange colour and sweet as indicated by the high soluble content (15.2 ^{o}Brix) followed by sugar loaf and smooth cayenne. The reverse was recorded for acidity (Table 4).

Table 3:
Pineapple weights

Variety	Fresh (kg)	Peel (kg)	Pulp (kg)	Juice (L)	Dried pulp (g)	Flour (g)
MD2	17.0	8.0	9.0	6.0	200.0	189.5
Sugar Loaf	17.0	6.5	10.5	6.7	120.0	115.5
Smooth cayenne	20.0	11.5	8.5	4.9	142.0	133.8

Table 4:

Initial pH and Brix of pineapple juice

Variety	pH	°Brix
MD2	3.83	15.2
Sugar Loaf	3.60	14.6
Smooth cayenne	3.46	11.0

3.2 Microbial growth

Microbial growth was recorded in all the pineapple juice without an anti-oxidant (sodium metabisulphite) after 30 days of storage. The natural juice in all three different packaging materials supported microbial growth (Table 5). The effect of browning was observed in juice without an anti-oxidant (sodium metabisulphite). Browning was more prominent in MD2 than smooth cayenne and sugar loaf due to its intense colour. This indicates that an anti-oxidant is required for a successful stored juice.After 30 days storage the pH of the juice showed no significant difference. The final pH was in a range of 3.50-3.86 similar to the initial pH range of 3.46-3.83. However, there were significant variations with a decrease in the final °Brix of 10.0-14.4 compared to initial °Brix of 11.0-15.2. The decrease in sugar content was as a result of its utilization during microbial growth.

Table 5.

Microbial growth and final pH and °Brix of pineapple juice after 30 days storage

Pineapple juice	pH	°Brix	Comments
MD2 (Without Additive)	3.86	13.3	Growth and browning
MD2 (Additive Added)	3.85	14.4	No growth and browning
Sugar Loaf (Without Additive)	3.64	11.8	Growth and discolouration
Sugar Loaf (Additive Added)	3.64	13.8	No Growth and discolouration
Smooth cayenne(Without additive)	3.51	10.0	Growth and browning
Smooth cayenne(Additive Added)	3.50	10.4	No growth and browning

3.3 Sensory analysis

The laboratory test panel of six technicians' 7-point hedonic scale of preference scores for taste, mouth feel, hand feel, texture, crust colour, crumb colour, air cells, crumb homogeneity, sponginess, flavour and general acceptability showed no comparative differences for pineapple brown slurry, pineapple pulp powder and wheat flour (control) baked products. However the taste resulting from pineapple brown slurry and pineapple pulp powder baked products was slightly stronger than the (wheat flour) control baked product.

4.0 Conclusion

Appropriate processing methods and alternative products were developed from organic side streams of pineapple. Pineapple pulp powder (PPP) and pineapple brown slurry PBS were two diversified products from pineapple organic side streams. The anti-oxidant prevented microbial growth in juices for all storage materials. Aroma and taste of baked products were considerably improved for PPP and PBS baked products compared to control baked products. Sugar loaf variety showed remarkable taste and aroma over MD2 and Smooth cayenne varieties. Thus, baked products prepared from wheat flour incorporated with PPP and PBS yielded sensory enriched properties. Further trials on different pineapple product formulations are required. Proximate analyses of developed products are required. Microbial analysis of packaged juices also needed. HPLC analysis for sugars of the PPP and PBS are required.

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