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TNO/CSIR-FRI Pineapple Project

Physiochemical, pasting and sensory properties of three varieties of pineapple flour for the confectionery industries



BY

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ABSTRACT

The organic side-streams of pineapple are an industrial waste contributing to environmental pollution. Two organic side-stream pineapple products, pineapple pulp flour and pineapple syrup were incorporated into confectionary products and improvement on sensory and nutritional attributes to enhance total utilization of pineapples. The study employed three varieties of pineapples, MD2, Sugar loaf and Smooth cayenne concentration on their physiochemical, pasting and sensory attributes.

The sensory characterise especially aroma and taste of baked products were considerably improved for baked products containing pineapple pulp flour and pineapple syrup. Taste and aroma for MD2 variety were remarkable than Sugar loaf and Smooth cayenne varieties. Thus, the results indicated that wheat flour incorporated with pineapple pulp flour and pineapple syrup yielded sensory enriched baked products.

INTRODUCTION

Pineapple (*Ananas cosmosus*) is a tropical fruit which grows in countries which are situated in the tropical and sub-tropical regions. It is native to Central and South America. Pineapple belongs to the Bromeliaceae family and grows on the ground. It can grow up to 1m in height and 1.5m wide. Other bromeliads live on trees (epiphytes). There are many cultivars of *Ananas*, but the predominant one is 'Smooth Cayenne' (Samson, 1986). Total pineapple production worldwide is around 16 to 18 million tons (Carvalho et al., 2008; Fernandes et al., 2008). Pineapple is an important food which can be eaten fresh or eaten

in a processed form. It is composed of nutrients which are good for human health. This is due to researches carried out on the relationship between nutrients in pineapple and human health. Processing pineapple in industries can leave a lot of waste which can cause serious environmental problems. Researches have been carried out recently to counteract this problem. Pineapple is largely consumed around the world as canned pineapple slices, chunk and dice, pineapple juice, fruit salads, sugar syrup, alcohol, citric acid, pineapple chips and pineapple puree. It is also exported to other countries as a fresh product. Sixty percent of fresh pineapple is edible (Samson, 1986). Pineapple mainly contains water, carbohydrates, sugars, vitamins A, C and carotene, beta. It contains low amounts of protein, fat, ash and fibre. Pineapples contain antioxidants namely flavonoids, vitamin A and C. These antioxidants reduce the oxidative damage such as that caused by free radicals and chelating metals. It also has the enzyme complex protease (bromelain). Bromelain contains peroxidase, acid phosphate, several protease inhibitors and organically bound calcium (Tochi et al., 2008).

Processed pineapple is a popular product which is exported by countries which produce pineapple. Brazil is considered the main pineapple producing country in the world since 2005 (Carvalho et al., 2008). During processing, nutritional quality of pineapple can be reduced but there are recent researches carried out which uses new technologies which tries to retain the nutritional quality of the pineapple fruit. This is to meet the consumer demand for healthy, nutritious and "natural" products (Deliza et al., 2005).

Pineapple waste is a by-product of the pineapple processing industry and it consists of residual pulp, peels and skin. These wastes can cause environmental pollution problems if not utilised. Recently there are investigations/studies carried out on how to utilise these

wastes. Pineapple peel is rich in cellulose, hemicellulose and other carbohydrates. Ensilaging of pineapple peels produces methane which can be used as a biogas. Anaerobic digestion takes place and the digested slurry may find further application as animal, poultry and fish feeds (Rani and Nand, 2004).

Processing of fruits produces two types of waste - a solid waste of peel/skin, seeds, stones etc -a liquid waste of juice and washwaters. In some fruits the discarded portion can be very high (eg mango 30-50%, banana 20%, pineapple 40-50% and orange 30-50%). Therefore, there is often a serious waste disposal problem, which can lead to problems with flies and rats around the processing room, if not correctly dealt with. If there are no plans to use the waste it should be buried or fed to animals well away from the processing site. In average the yield in processing ranges from 45% to 55%. End products include packed pineapple, which includes pulp from the cuts made to the base, crown and peel. This product may be done in small slices, chunks or bits. Pineapple juice is obtained from crushing fruit pieces and proper physical separation of the solids. Juice must be pasteurized and packed to extend its shelf life and a preservative or refrigerated storage may be used as additional barriers to microbial spoilage. No juice should reach the market if it becomes fermented or mixed with water. Packing may be plastic bottles or bags, coated cans, multilaminate (plastic, paper, metal foil) or any newer materials. The pH values of the product must be controlled so it remains agreeable for human consumption. It is a common practice to blend batches of juices to attain proper acidity and sensory qualities. Juices from other fruits can be blended with pineapple's and interesting mixtures make novel products

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.

There are a number of possibilities for use of some types of solid fruit wastes but there is as yet no evidence that any of these are economic. *It is stressed that a full financial evaluation should be done before attempting to introduce any of the ideas below.*

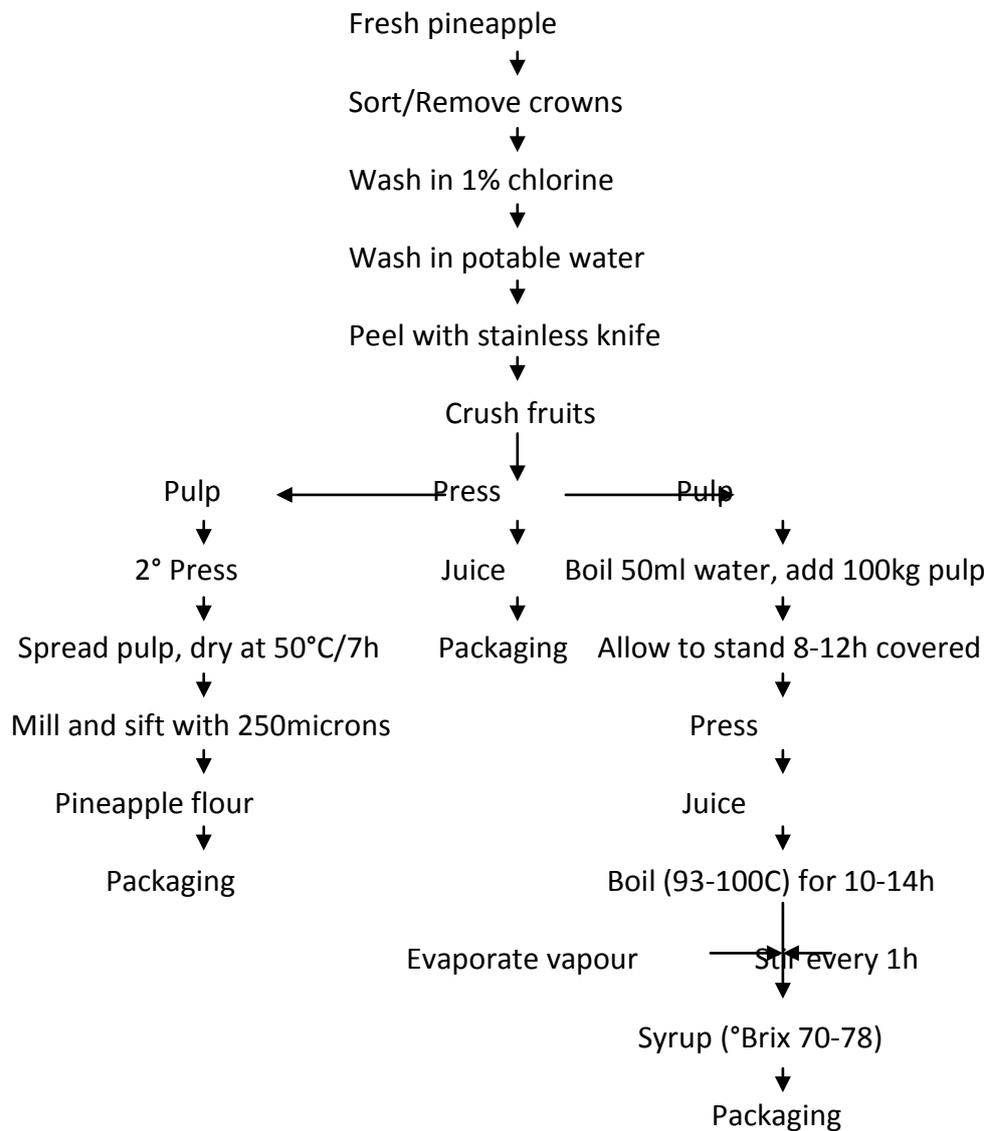
One of the main problems in using fruit wastes is to ensure that the waste has a reasonable microbiological quality. Only waste produced during the same day should therefore be used -it is not advisable to store-up wastes to use for example at the end of a week's production. Even with this precaution the waste is still likely to contain mouldy fruit, discarded during processing, insects, leaves, stems, soils etc which will contaminate any products made from it. Therefore, it is necessary to ensure that some preliminary separation takes place during processing (eg peel and waste pulp into one bin, mouldy parts, leaves, soil etc to another which is discarded, stones, seeds etc into a third bin).

MATERIALS AND METHODS

Pineapple pulp (263.3kg) after de-juicing pineapple fruits were obtained from Tilly Chill Enterprise, Achimota in Accra and Papsco Company in Spintex Road, Tema. Three pineapple varieties Smooth cayenne, Sugar loaf and MD2 were obtained. The pulps were

collected at different times. The pulp was pressed using a manual press and dried at 50°C using a Royce Roll Mechanical dryer. The dried pulp was milled using a hammer mill and sifted with a 250micron sieve. The flour obtained was packaged in air-tight polypropolylene bags.

Production of pineapple juice, flour and syrup



Method

Moisture Content

The moisture content of the dried pulp was analyzed in triplicates following methods in AOAC (2000).

Determination of water activity

Water activity was measured using standard methods in triplicates with a Rotronic Hygrolab 2 (Rotronic Ag Ltd. USA).

Physical and physicochemical properties

Colour measurement was performed on milled pineapple pulp samples using a Minolta Chroma Meter (Model CR 310, Minolta Camera Co. Ltd. Japan), using the L* a* b* colour system in duplicates. The Chroma meter was calibrated with a standard white background. (L* = 97.63 a*=-0.48 b* = +2.12) as described in the Hunter Laboratory Manual (2001).

Functional and rheological properties

The water adsorption index (WAI) and water solubility index (WSI) were performed according to Jin *et al.*, (1995) with minor modifications. Ground sample (5g) of pineapple pulp was passed through a 250 mesh screen and was combined with 30 ml of distilled water in a tarred centrifuge tube. The mixture was sealed, vortex, and allowed to hydrate for 10 min. The sealed tube was inverted 3 times at both 5 and 10 min to ensure proper mixing. After 10 min samples were centrifuged for 15 min at 3000 rpm using a Sorvall RC-5B Fixed Angle Rotor (DuPont Instruments, Wilmington, Del., U.S.A.) and the supernatant

was decanted into a pre-weighed aluminium dish. The tube was inverted for 5 min over the dish to catch residual moisture. The dish was allowed to dry overnight in a drying oven at 70°C and the centrifuge tube was reweighed to determine the weight of the sediment. WAI was calculated by dividing the sediment weight by the dry sample weight while WSI was calculated by dividing the dried supernatant weight by the dry sample weight (Jin *et al* 1995).

Total soluble solids

The Brix value of the smooth cayenne, sugar loaf and MD2 samples were determined at the various dilution levels, 10%, 20%, 30% and 40% using a Grant Refractometer. The refractometer was initially calibrated with distilled water and sucrose solutions before the determinations.

Swelling Capacity of pineapple pulp

The method according to Fleming *et al.* (1974) was used with modification. Pineapple flour (10g) was weighed into a 100ml graduated cylinder and tapped gently at the base for a few minutes to allow the flour to settle properly at the base. After noting the bulk volume, 100ml of water at room temperature (~ 30°C) was added, mixed well and allowed to stand. The volume of sample was read after 1, 5, 10, 15, 25, 30, 45, and 60 min. The experiment was done in triplicates and repeated using water at 70°C.

$$\text{Swelling Capacity}(\%) = \frac{\text{Final Swollen Volume} - \text{Initial Bulk Volume}}{\text{Initial Bulk Volume}} \times 100$$

RESULTS

Table 1 Weights of pineapple flours

	Wet Weight (kg)	Pressed Weight (kg)	Pressing time (min)	Drying time (hours)	Dried weight (kg)
Pineapple flour					
Sugar loaf	31.0	16.0	15	7.15	3.15
MD2	24.0	12.5	15	7.15	2.30
MD2	31.0	17.3	21	7.40	2.90
MD2	51.5	33.0	14	7.00	5.50
Smooth Cayenne	53.1	32.0	13	7.00	5.10
Smooth Cayenne	48.6	25.0	13	7.00	3.25
MD2	24.0	12.5	15	7.30	3.60
Total	263.2	148.3	106	50.0	25.80

Table 2 Moisture content and water activity of pineapple flours

Pineapple flour	Moisture Content	Water Activity
MD2	2.38 ± 0.045a	0.314 ± 0.005a
Sugar Loaf	3.46 ± 0.051b	0.382 ± 0.003b
Smooth cayenne	4.13 ± 0.010c	0.440 ± 0.005c

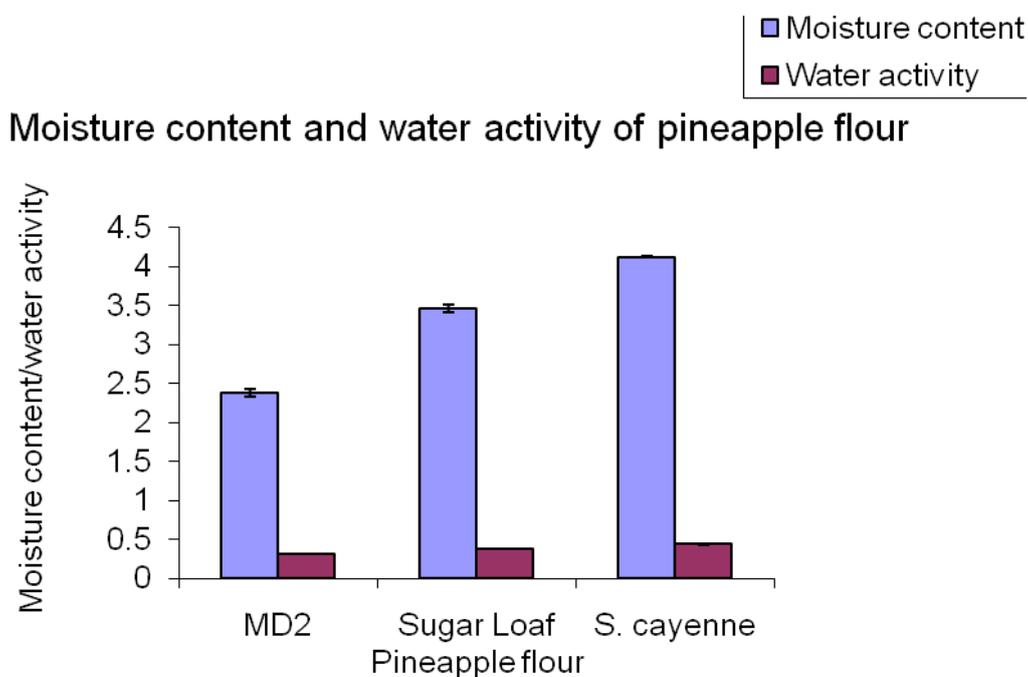


Figure 1. Moisture content and water activity of pineapple flour

Table 3 Water Absorption Index and Water Solubility Index of pineapple flours

Pineapple flour	Index (30°C)	
	WAI	WSI
MD2	4.15 ± 0.967b	0.150 ± 0.009b
Sugar loaf	4.35 ± 0.027b	0.239 ± 0.004c
Smooth cayenne	3.37 ± 0.527a	0.114 ± 0.005a

Average of three determinations ± standard deviation

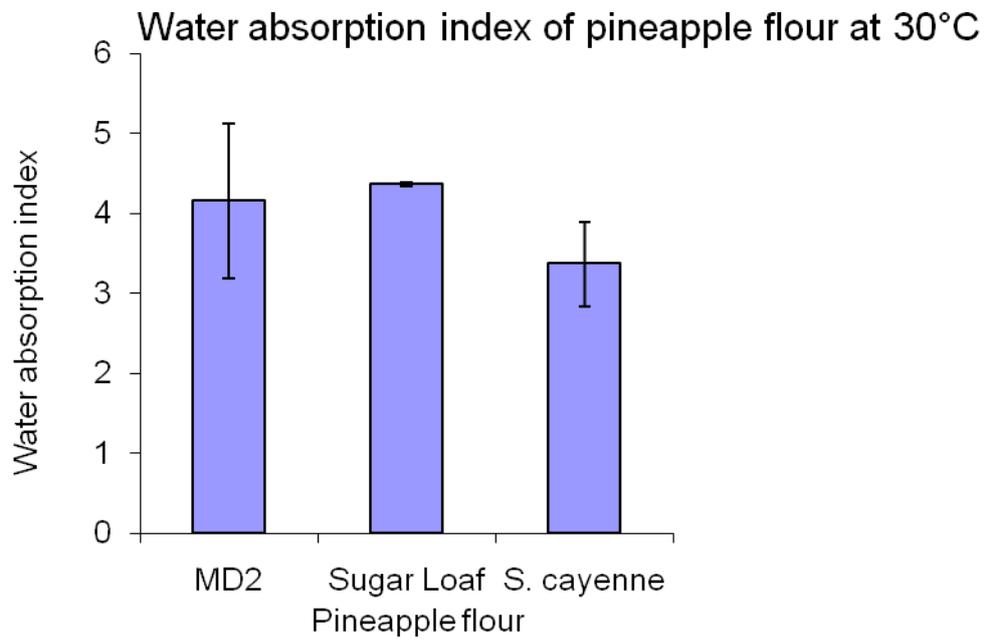


Figure 2. Water absorption index of pineapple flour at 30°C

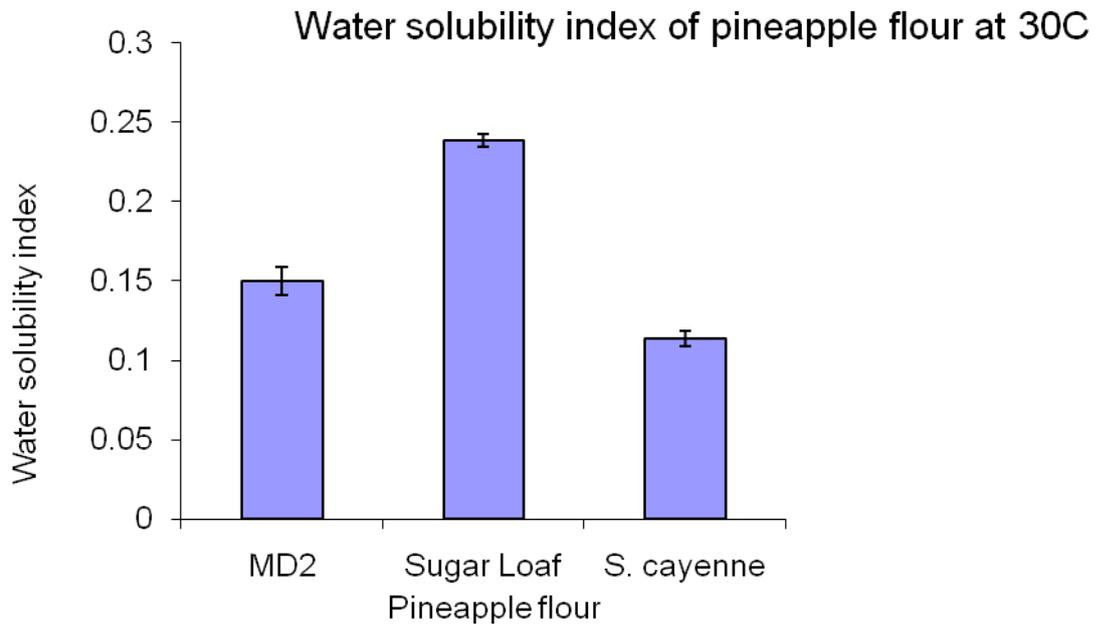


Figure 3. Water absorption index of pineapple flour at 30°C

Table 4 Swelling capacity of pineapple flours

Pineapple flour	Swelling capacity (%)	
	30°C	70°C
MD2	429.21 ± 1.34	435.01 ± 1.80
Sugar loaf	460.44 ± 1.77	466.88 ± 1.94
Smooth cayenne	361.41 ± 2.01	425.47 ± 1.22

Average of three determinations ± standard deviation

Swelling capacity of pineapple flour

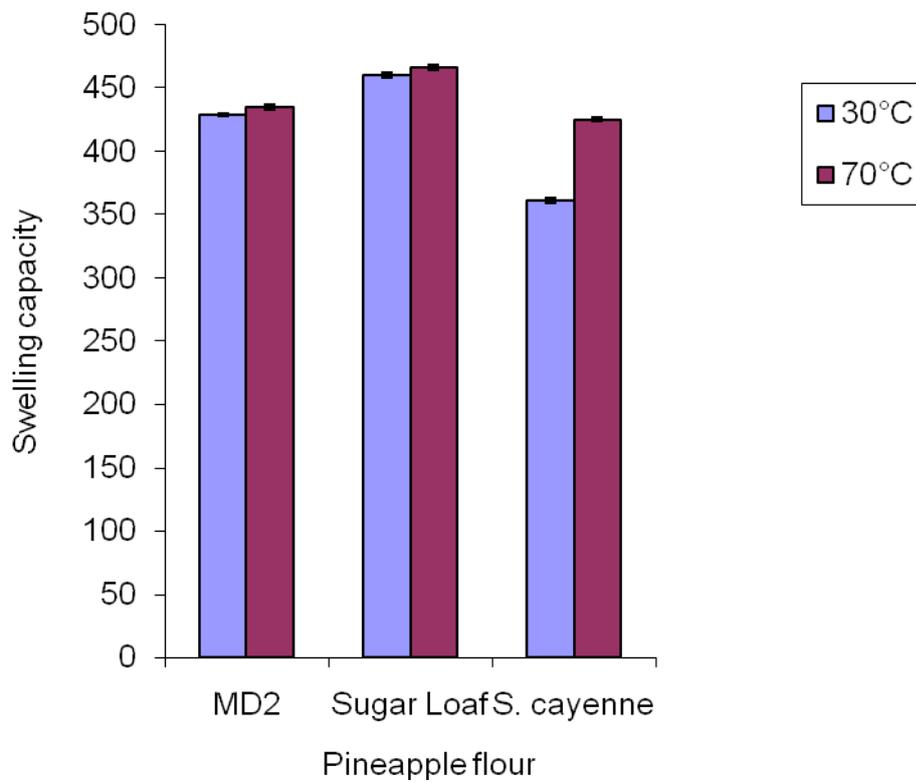


Figure 4. Swelling capacity of pineapple flour at 30°C and 70°C

Table 5 Total Soluble Solids (°Brix) of pineapple flours at various dilutions

Pineapple flour	° Brix (Dilutions)	
	5%	10%
MD2	2.20 ± 0.0b	4.27 ± 0.07c
Sugar loaf	2.80 ± 0.12c	5.80 ± 0.00b
Smooth cayenne	1.80 ± 0.12a	3.87 ± 0.07a

Average of three determinations ± standard deviation

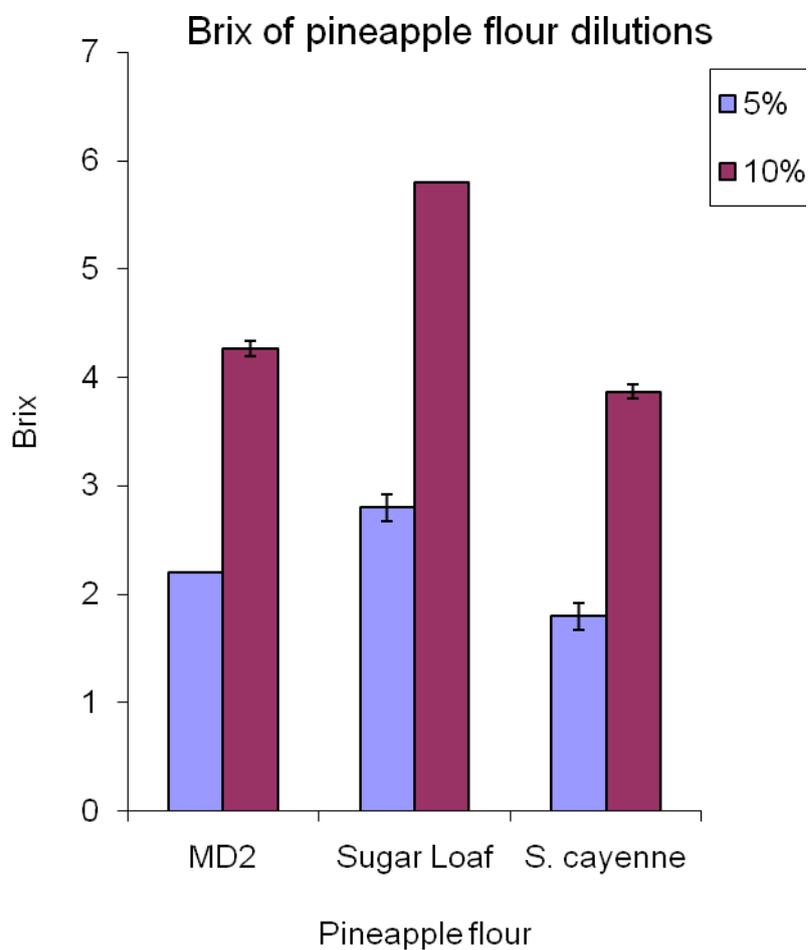


Figure 5. Brix of pineapple flour dilutions

Table 6 Colorimetric measurement of pineapple flour

Pineapple flour	L	a	b
MD2	77.24 ± 0.784b	5.28 ± 0.104a	15.21 ± 0.121b
Sugar loaf	75.17 ± 0.508a	5.58 ± 0.041a	15.37 ± 0.178b
Smooth cayenne	77.51 ± 0.133b	7.03 ± 1.199b	10.63 ± 0.081a

Mean of five determinations ± standard deviation

Colorimetry of pineapple flour

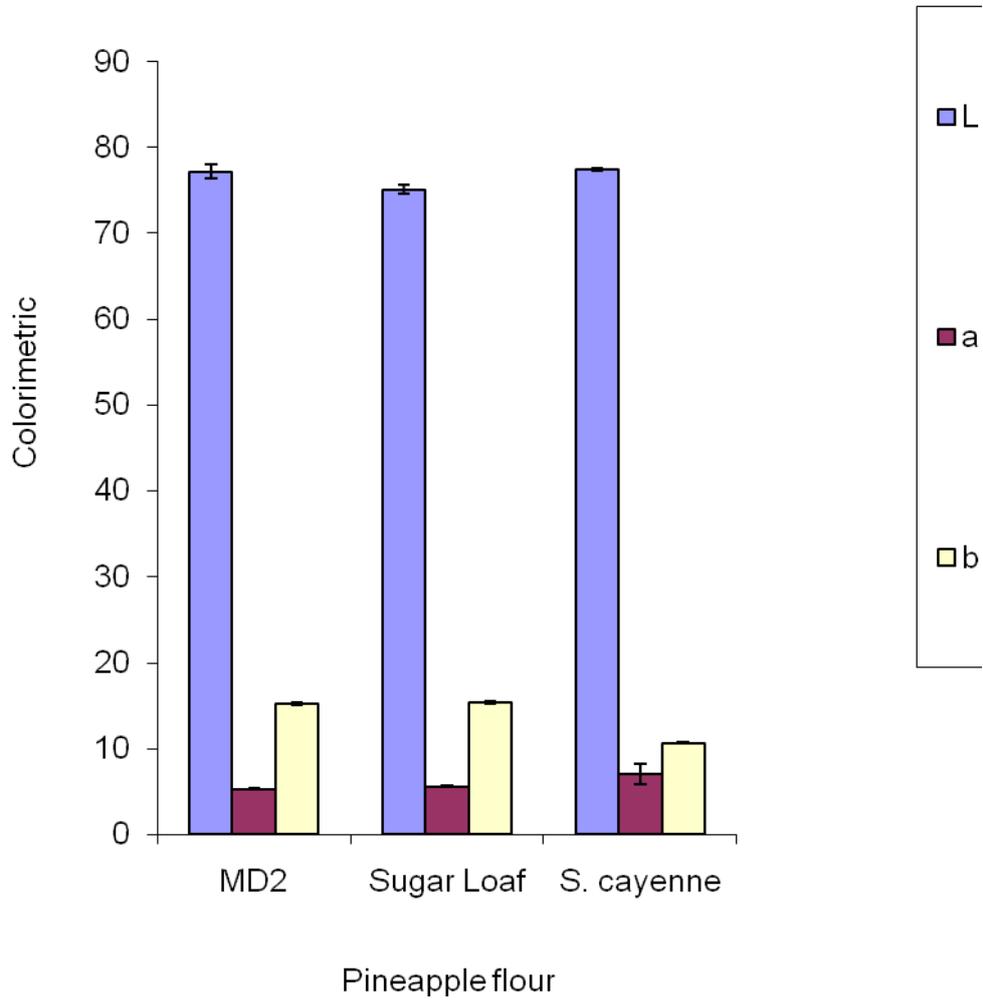


Figure 6. Colorimetric measurement of pineapple flour

Table 7 Average sensory parameters on pineapple flour from three locations

Sensory	Average Parameters					
	Appearance	Aroma	Texture	Taste	Overall	Average
Average						
Cake A	6.8	7.1	6.8	7.2	7.0	7.0
Cake B	5.4	5.5	5.9	5.7	5.7	5.6
Cake C	6.2	6	6.1	6.3	6.5	6.1
Average Cape Coast						
Cake A	7	7.5	7.5	7.5	7.8	7.5
Cake B	7.5	7.7	7.9	8.1	8	7.8
Cake C	6.3	6.1	6.7	6.2	6.2	6.3
Average Legon						
Cake A	5.2	6.6	6.1	6.5	6.3	6.1
Cake B	4.9	4.2	3.9	3.7	3.7	4.2
Cake C	5.3	4.5	6.5	6.8	6.7	5.8
Average Takoradi						
Cake A	8	7.4	7.6	7.5	7.1	7.6
Cake B	6.7	6.4	7	6.8	7	6.7
Cake C	7.1	7	6.7	7.9	7.3	7.2

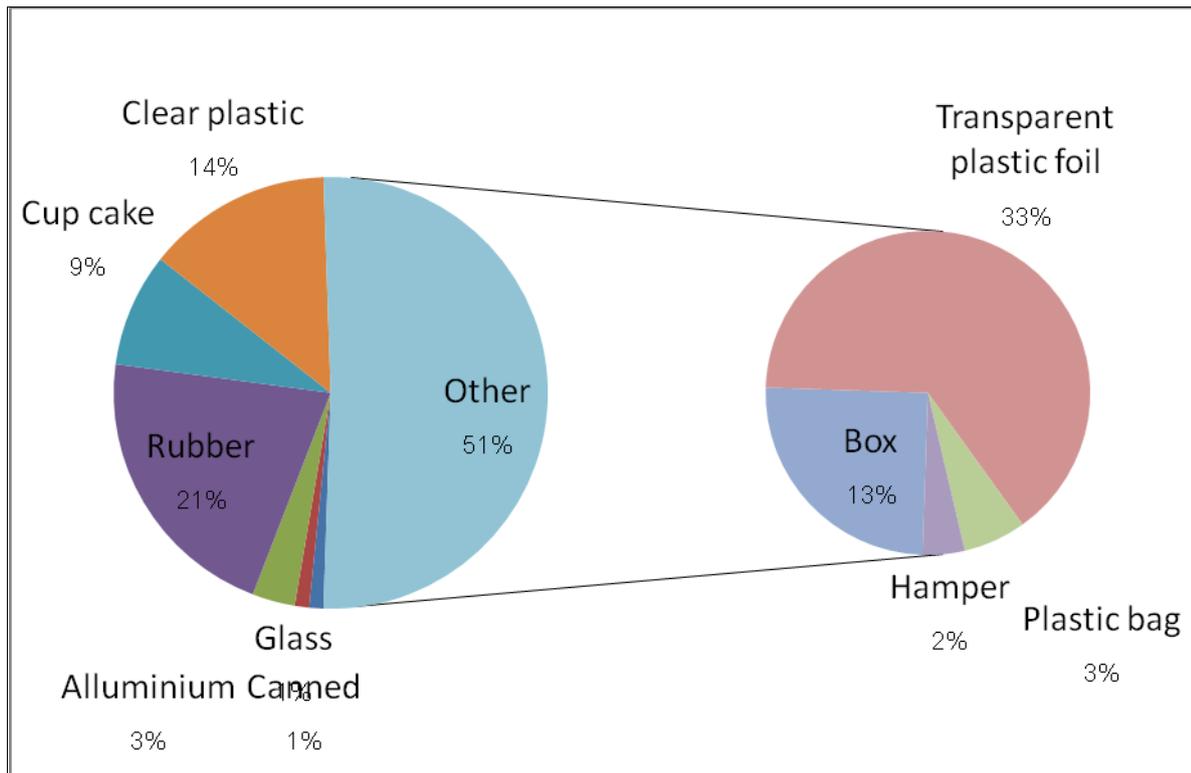


Figure 7. Packaging materials for pineapple flour

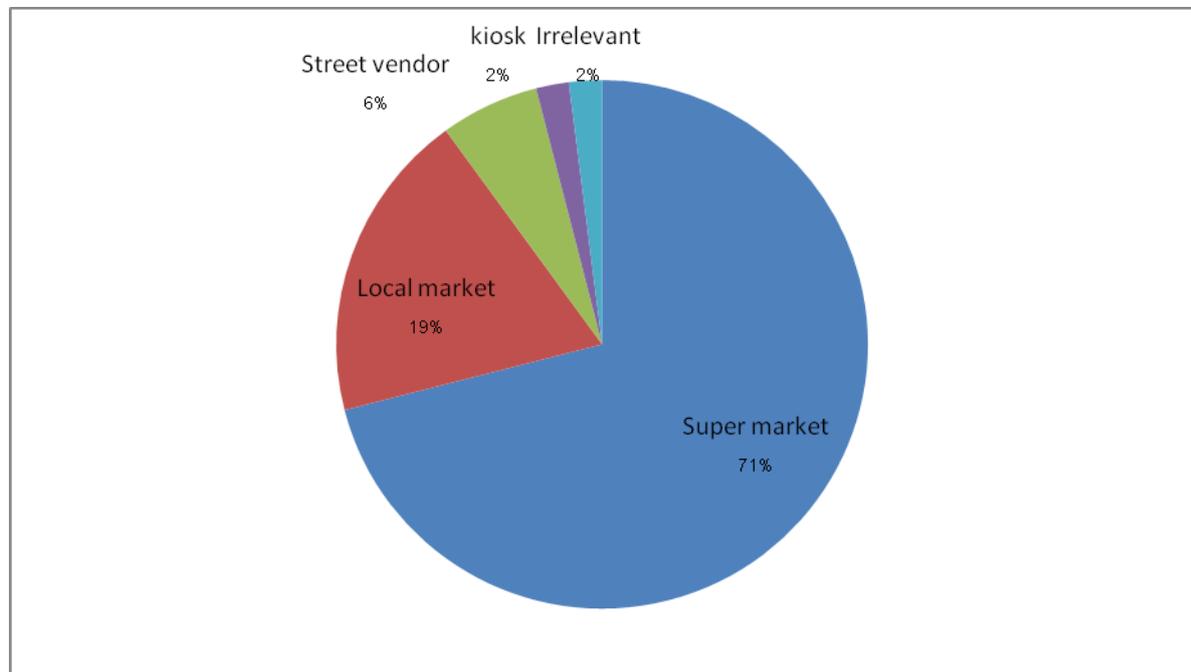


Figure 8. Favoured purchasing location for pineapple flour

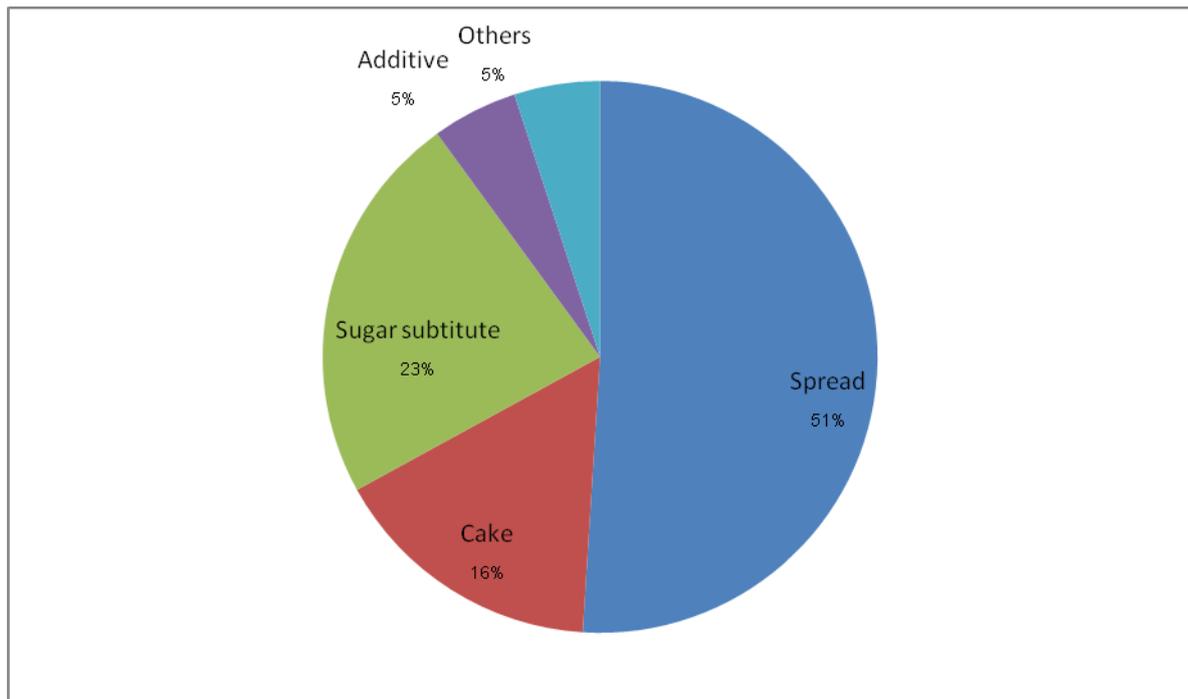


Figure 9. Uses of pineapple syrup

DISCUSSIONS

Syrup

The syrup was overall appreciated, although nobody was particularly excited about it. Especially the color and general appearance of the product were regarded as unpleasant. Further, some respondents found the taste too bitter. Most mentioned potential uses were as an additive to drinks or food, for baking, and as a spread. Fiber chunks clearly failed this first consumer test, as they consistently received low grades in all aspects. Some respondents were not even willing to try the product due to its unpleasant appearance and not a single respondent ate all of his/her sample. The product was therefore discarded and will not be researched further.

Flour

As the graph reveals, the pineapple flour on its own was unsurprisingly not received very well. However, this is no cause for concern as this is a common outcome for products that are used as ingredients only. As for uses, 80 percent of respondents think the flour could be used in brown bread. Other mentioned uses were pancake, cake and for cooking.

Cake

Three different kinds of cake were given to the panel to try and compare, namely cake with pineapple flour, cake with pineapple syrup, and a standard control cake. Overall, the control cake received the highest marks. The cake containing syrup was also appreciated, with 20 percent of respondents ranking it best. The pineapple flour cake received the lowest grades. However this slightly negative likely has its roots in a mistake in baking, as an unacceptable high percentage of pineapple flour was used.

Indication

Out of the products tested only syrup and cake containing syrup or flour are worth further investigation. Pineapple flour remains a promising product, but is not viable to research on the consumer market. Finally, fiber chunks are completely discarded as they were widely met with disgust.

Description Consumer Research

The consumer research was a natural follow-up to the sensory evaluations in which several products that had been considered preliminarily were proven to be unacceptable to the Ghanaian consumer. The sensory evaluation revealed pineapple flour and syrup's

use in pastries to be promising as well as the use of syrup on its own. After some initial product tests as to the percentages of syrup and flour to be added to cake (the pastry chosen as representative), consumer research was done on 4 products: syrup and 3 types of cake, including a control cake, cake with syrup, and cake with pineapple flour. To get a representative result on the likeliness of the acceptance of the above products by the Ghanaian consumer market, it was deemed necessary to conduct a national survey. To conduct such a survey would cost thousands of Euros with a commercial marketing research agency. We therefore enlisted Ghanaian SIFE students from 9 different universities to conduct consumer surveys in their respective regions. The spread of the universities would ensure a fairly representative result, while a training given to the students in Accra would ensure the validity of the research. The training was given in a two day workshop format. A professor from the University of Accra, Prof Sefa-Dedeh, instructed the students on food research and consumer research in general, the students created a questionnaire and interview outline together, and practical training was given as to how to carry out the research. At the end of this two day “conference” the students were given samples of the products and returned home to do the research.

The questionnaire was created in collaboration with the Professor and some experienced food scientist students and it combines all the relevant questions on food items with a format easily understandable for the Ghanaian consumer (the 10 cm scale). While this scale is usually not used in research in Europe or North America, we were instructed by the Professor to use it for its appropriateness in Ghana. The questionnaires and interviews were conducted in conducive environments in the same way as the sensory evaluations. Exact instructions on how it was done can be found in the appendix to this section. After

the survey, the students all returned to Accra where we gathered to obtain the results. Most students were able to hand in all the data, which can be observed on the dropbox folder. The data is analyzed below. For a discussion on the research approach's effectiveness, please refer to the appendix of this section.

Analysis + Outcome Syrup Research

As described above, the consumer research on syrup by itself was organized and carried out together with and in the same manner as the research on cake. The main difference in methodology was the comparative aspect of the cake study. The novel cake with the pineapple

ingredients has a readily comparable substitute, which allows us to infer a potential market share in comparison to ordinary cake. In the case of the pineapple syrup, no comparable product against which the syrup could be held is available. Consequently, the results have to be interpreted with more care since a reference point is missing. Nevertheless, the data generated by the survey provides us with interesting insights and a rough indication of demand in the form of a percentage of consumers that are willing to purchase the product.

The graph above depicts the average national scores for each attribute of the pineapple syrup. In total, 117 respondents from 5 cities produced useful answers. Across these cities, results 25 have not differed significantly. We can hence assume that the overall average is representative for urban areas in Ghana in general. Evidently, the visualization suggests a positive attitude towards the product and all investigated characteristics. Despite these positive averages for all attributes, consumers did raise criticism when

asked for comments. The rather strong specific taste split the respondents in two: On the one hand it was often criticized for being “too bitter” or “too sharp”, which is reflected in the relatively low score for taste. Especially during the in-depth interviews the taste was repeatedly mentioned as being “dissatisfactory.” On the other hand, there were respondents specifically praising the taste. Also the color of the syrup was often mentioned as a displeasing factor for being too dark and “brownish”. Another issue was the thickness of the syrup. Consumers who would like to use it for spread found it too fluid, while the ones who would like to mix it in drinks considered it to be too thick.

Although the system has low explaining power revealed by a low R-squared of 0,320, it does reveal an order of importance in the characteristics of syrup. As expected, taste tops the list, which is a great matter of concern due to the negative reception of this characteristic in the syrup. Color and aroma follow taste in importance. This confirms the result that many respondents were concerned about the look of the syrup. Thickness is deemed less important by the respondents who do not base their overall judgment on this aspect. One should pay attention that this does not mean that thickness is not important in product development: many consumers commented on the thickness with regards to the use of the syrup regardless of how much it affected their overall rating of the syrup. We must make a side note here: The above regression was only made to reveal the order of importance of the characteristics for respondents and consumers in general. By no means should the regression be regarded as a mathematical equation by which to calculate whether a particular respondent or customer will like the product. Perhaps it could serve this purpose once product refinement is completed and a second national

survey is conducted, but the use of this would be questionable. The same goes for the regression on the cakes in the next subsection.

Purchasing decision

The direct question whether consumers would purchase the products produced coherent results with the consumers' evaluation. Over 90 percent of respondents indicated to be at least likely to buy the product, and almost half said they would definitely acquire the syrup when available at the price of 0.5 Cedis.

Analysis + Outcome Cake Research

As said above, we did consumer research on both the syrup by itself and pastries containing syrup or pineapple flour. The consumers were given three types of cake labeled cake A (control cake), cake B (syrup), and cake C (pineapple flour). Cake B and cake C were variations of the control cake with laboratorial tested quantities of syrup and pineapple flour added to them. Consumers were presented with labeled samples of all three of them. Without knowing which one is which, they were required to answer questions about the cakes' appearance, aroma, texture, taste, and overall likeability. The results hopefully indicate the acceptance of the Ghanaian market of the products with a breakdown for particular characteristics. The outcomes will follow below.

Outcomes Questionnaires

The first survey format that we presented several potential consumers with was a questionnaire with structured questions in which consumers had to rank every aspect of the cakes on a scale from 1 to 10 and thus compare the cakes to each other. In the

appendix you will be able to find an exemplar of this questionnaire. The questionnaire showed an unquestioned tendency for consumers to prefer the control cake (A) over the other two cakes and the pineapple flour (C) cake over the syrup cake (B). In fact, there is no single case in which the averages of the 140 consumers surveyed showed another order of preference:

All of these differences between what we call “within population means” are also statistically significant, meaning that we can confidently infer from our sample of 140 respondents that there is a difference in preference for the cakes for the population at large as well (and this difference in preference follows the order above). This seems to suggest a rather unpromising result was it not for some modifications. That is, some regions showed a different balance or order of preference. As evident below, Cape Coast respondents seemed to prefer cake B, the syrup cake: And cake C, the pineapple flour cake, seems to win in the overall averages for both the results of the University of Ghana in Accra and the Takoradi ratings: Similar findings are found when one counts the amount of times that Cake C and B are rated above Cake A on some or all of the characteristics. Cake C obtains a higher overall rating than Cake A on some 60 occasions, and Cake B obtains a higher overall rating than cake A on some 53 occasions: All of this can be inferred to mean that there are consumer segments that prefer the syrup cake and the pineapple flour cake. We cannot assume that the products as such are in their ideal state; however. Even though there seem to be select consumer groups preferring either one of the additives, the question is at what quantities and with what product characteristics. With regard to the syrup, what seems to matter most is the percentage of the product added to the cake and the sugar content or Bricks of the syrup itself. Respondents were

asked for additional comments and several comments pertained to these aspects of the syrup cake. At times, cake B was perceived as too sweet. One person even claimed he could taste an early form of “fermentation.” Often, respondents also commented on the burnt taste and the 31 “unique” but “funny” after-taste of cake B, one of which added that it was sad that the pineapple flavor was almost entirely gone. Respondents also often did not like the aroma of cake B and the color of the cake was deemed too dark. The first comments definitely pertain to the amount of sugar in the syrup, while the last comments pertain mostly to the amount added. More careful formulation analyses and standardization of the syrup itself could overcome many of the objections that respondents had to the syrup cake. With regard to pineapple flour, the percentage of the product added to the cake seems to matter as well in addition to the quality and type of the pineapple used to create the dried chunks from which the flour is milled. Comments by respondents were often aimed at cake C’s crumbliness, an undesirable characteristic. Further formulation analyses could reveal a more appropriate percentage of pineapple flour to add to the cake and improve cake C’s standing on this aspect. Cake C was also said to have an aftertaste with a distinguishable pineapple flavor. The color seemed more attractive than cake B’s to most respondents. The pineapple flavor was positively received by most respondents and further standardization of the pineapple flour could prove whether better quality fiber chunks affect the quality of the pastry and whether the type of pineapple used matters as to quality and/or fibrousness (which makes the cake more or less crumbly). That leaves us with the question of how the responses were distributed and what respondents considered the most important characteristics in the cakes. First of all, to observe the distribution of responses we take the histograms of the overall ratings of both cake B and C: Both sets of responses seem to be tri-modular, do not comply with

normal probability, and have large standard deviations of 2,5 and 3. This implies a wide range of consumer preferences with regard to pastries and the presence of a market niches, but it may also suggest a certain measure of confusion in the answering of respondents. Without a doubt, the distribution of the above responses affects the validity of a regression taken of the characteristics. To reveal the importance of the different characteristics in the cake, a regression might still be informative though. For cake B, the regression is as follows (significant at 0%, all variables significant except aroma, high explanatory power with Rsquared being 0,841): Overall rating Cake B = -0,228 + 0,146 (appearance) – 0,031 (aroma) + 0,200 (texture) + 0,722 (taste)

For cake C the regression is (significant at 0%, all variables significant except appearance, medium explanatory power with R-squared being 0,513):

Overall rating Cake C = 1,325 + 0,049 (appearance) + 0,146 (aroma) + 0,177 (texture) + 0,470 (taste). This clearly establishes taste as the most important characteristic in any of the cakes, compromising the position of cake B as most negative comments were directed towards its taste. Texture seemed to be the next most important matter according to consumers, revealing the significant work that needs to be done to make the pineapple flour cake more consistent and less crumbly. Aroma and appearance seemed the least important to consumers, which slightly contradicts the comments that were often directed against both of them for cake B.

With regard to packaging, most of the traditional packaging methods were suggested:

As we are assuming that our impact is mainly through imparting knowledge to a retailer who will package the pastries themselves, and as cake was only representative of the types of pastries that can be created with the syrup and flour, this information is not

absolutely pertinent to survey the demand of the Ghanaian market for the products. It is interesting to note; however, that many respondents suggested to package the cakes in traditional packaging material with one or two modifications. That is, according to most respondents it would be wise to differentiate the product through extra labels and packaging features. The products were received as highly differentiated products. With this and the related price differential in 33 mind, it would be wise to look at additional packaging features that would allow one to differentiate the product even further.

Outcomes Interview

The outcomes of the interview mostly revealed what has already been discussed as the results of the questionnaires, albeit going into slightly more detail. A brief discussion is warranted here. Most interviewees agreed that cake A was the better cake and that cake A and C had a distinctly better aroma than cake B. B was also deemed to be a bit heavy in the stomach, probably owing to the fact that the concentrated sugary substance made the cake more potent and physically heavier at the same time. Cake B's taste reminded people of something familiar, usually something fruity, but most were not able to distinguish what exactly. This is probably due to the fact that the pineapple flavor has almost completely been lost, resulting in the inability of consumers to identify the taste. Perhaps the most revealing aspect about cake B in the interviews was that one respondent said that the ingredients of cake B are maybe "out of balance." This can be used as direct input, repeating what was said in the previous subsection: there is a need for more formulation analysis to optimize the products. For example, is there a need to add a little less syrup or to substitute it directly for the sugar in the cake? All consumers agreed that the presented products were market worthy and that a price differential for

the added characteristic was in order. This goes for Cake B as well as for Cake C. The question is; however, whether consumers would indeed want to pay more for a product that they deem less desirable on most characteristics. One can expect this price differential to have either one of two effects: either consumers are going to assume that the products have added features (such as nutritional value) and be willing to spend more on the product or the select consumer group identified before will vaporize in the face of a price that supersedes the perceived added benefits. The only way to find out which effect is going to take root is to conduct a test market. Once a willing retailer is willing to standardize a pastry with one of the additives, then, we can test market the effect of price and competition on the prospective products. At the moment of writing, initial steps have been taken with this on pineapple flour cake at the supermarket Koala. The initial results of this test market can be read from the section on industry research. Most of the interviewees had a tendency to view cake A and cake C as similar, some even guessing that cake A was the one with pineapple flour in it. This perceived similarity can be perceived to be either positive or negative. On the one hand, the fact that Cake C is perceived as similar to cake A will guarantee a certain measure of acceptance of the pineapple flour pastry on the Ghanaian market. Once the pineapple flour pasty starts to be perceived as too similar, though, the price differential discussed before might not be achievable.

Conclusion and Verdict on Using Syrup and Flour in Pastries

The consumer research reveals that using syrup and pineapple flour as additive to pastries is welcomed by a select consumer group, but a lot of product refinement needs to happen before it can confidently be introduced on the market. There is a definite case for the

pineapple flour. It adds fiber content to the product increasing its nutritional value and giving the product a differential; consumers tasted the pineapple flavor given the pineapple flour an extra feature 34 as a flavor additive; and consumers often preferred cake C in general. Three things need to happen before we can definitely take a verdict on pineapple flour as a pastry additive; however:

1. Formulation analyses need to take place to find the correct quantity to add to pastries.
2. Tests need to be done on how the type and quality of the pineapple chuff affects the taste of the pineapple flour and pastry.
3. Test markets need to reveal whether consumers are willing to pay the price differential needed to make up for the slightly higher costs of pineapple flour as compared to wheat flour. The verdict on syrup is slightly harder: Consumers seemed to like this product less in the consumer survey, they were not really able to identify the pineapple taste, there is no known added nutritional benefit, and the question is whether there is an advantage in using it as a substitute over sugar. The bad aroma and the color it gives to the pastry seem to say no. Still, there was a consumer group that seemed to prefer cake B; the syrup seems to be a cheap substitute for sugar; and in the consumer research on the syrup by itself consumers often identified pastries as the food item to use syrup as an ingredient in. There is thus an argument to keep pursuing syrup as an additive in pastries, but several conditions need to be fulfilled:

1. Formulation analysis needs to be conducted on syrup's use in cake. Special attention needs to be paid to whether syrup should be used to replace the sugar in the product.
2. Tests need to be done to identify the right sugar content and Bricks in the syrup.

3. Test markets need to not only test what price consumers are willing to pay for the cake, but also whether they are actually willing to repurchase the product after initial consumption.

4. Once the above steps have been carried out, more thorough cost analysis needs to be done in collaboration with an industry partner to ensure a cost advantage over sugar as the syrup's competitive advantage seems to lie in its cost effectiveness at the moment.

Summing it all up, the pineapple flour seems to need refinement as a pastry additive but the initial results are definitely positive. The syrup seems to have potential but further product refinement will have to prove whether this potential can actually be used.

Pineapple Supply Chain Research

The following section analyses the pineapple supply chain. First the different players along the pineapple supply chain will be identified and the actual existence of pineapple over crop will be critically assessed. Subsequently the relative power and the relationship of the different players in the value chain is analyzed. Finally we will conclude on the potential of collaboration between the identified players. For a short analysis of the Ghanaian dried fruits supply chain as a benchmark please refer to the appendix of this section. The three pineapple species In Ghana three different sorts of pineapple are grown 1) Sweet Cayenne 2) MD2 and 3) Sugar loaf. We will now elaborate on each pineapple species individually and conclude on the existence of over crop in Ghana.

35 Big pineapple farmers are exclusively growing MD2 or Sweet Cayenne, which are used for export or further processing, e.g. in form of pineapple juice. Only a limited amount of smaller farmers are growing these species, due to higher costs for fertilizers and

protective plastics against parasites. About 70% of industrial production of MD2 and Sweet Cayenne are exported.

Sugar loaf is exclusively grown by small farmers. In contrast to MD2 and Sweet Cayenne, Sugar loaf requires less investment when cultivating. For most small farmers Sugar loaf is the only financially and technologically feasible sort to grow.

Due to the high demand of processors and export markets, there is no over crop of MD2 or Sweet Cayenne. Seasonal overproduction however has been found for sugar loaf. Almost all over crop is sold for prices as low as 15 pesuas, not covering the initial costs. During our research different players in the value chain as well as players in different regions gave contradicting information on whether over crop of pineapples would exist. This can be explained by a regionally dispersed value chain facing communication and logistic problems, resulting in the parallel existence of farmers who suffer from overproduction but also small processors which face a shortage in their supply. However, overproduction was consistently mentioned in the farming of Mango, Tomatoes, Peanuts and Oranges.

The Farmers

Pineapple farmers in Ghana can be divided in two main groups:

- 1) Big industrial farmers mainly producing for export and industrial processing
- 2) Small farmers growing for the local market and small processors (the majority of the industry). Small farmers are mostly found to be inflexible in their choices of production. They are mostly focusing on only one product, facing high exposure towards changes in demand. The inflexibility in choice of production stems mainly from two reasons:

- 1) Financial constraints on specific sorts (as found for MD2 & Cayenne)

2) Persistent conforming to traditions.

Independently of their size, farmers have the least power in the value chain. Particularly small farmers suffer from lacking downstream communication, full exposure of seasonality and lacking access to market. For example additional profit margins from fair-trade and organic product certifications end up at the exporters and processors, crossing over most farmers. In our interviews it was consistently mentioned that farmers could be united easier than the remaining players in the pineapple value chain. Farmers are already partially united and they started to recognize the potential benefits from cooperating and forming associations. This is 36 mainly due to a bigger need for collaboration in order to survive. There are successful projects where farmers share expensive but crucial equipment such as pumps or fertilizers.

Processors

Fruit processors in Ghana, again can be divided in mainly two groups:

- 1) Big scale, industrial fruit processors serving both export and local markets.
- 2) Small-scale local processors, serving their regional markets.

Blue sky is the biggest fruit processor in Ghana. It mainly produces for export; however it also started dominating the local market. In general there are very few big processor companies. These processors are only buying from big farmers. Buying from different small farms would not be attractive from a logistical point of view. Smaller processors source in most cases from smaller local farmers. Also here, the communication between the players is bad. Moreover small processors are logistically limited to local suppliers. Big processors are the most powerful players of the pineapple supply chain. If there is not enough pineapple supply in Ghana, they even import pineapples from Ivory Coast or other

neighboring countries. Among processors, it can be difficult to achieve collaboration since many processors regard each other as competitors that cannot be trusted. However, this way of thinking is gradually making way for a more collaborative approach, with processor associations being founded at the moment (e.g. Tropix). The Supermarkets Supermarkets have been identified as the quality drivers in the pineapple supply chain. They control the quality levels in the whole value chain of the products they are selling. Most recently their market share has increased significantly. Last year the market share of the biggest supermarkets in Ghana increased by 20 to 30% on average.

The potential market

Bakery market

As identified in the sub-section above both the syrup as well as the fiber can be used in cake and bread. The following section analyses the bakery market in Ghana. First the local supply chain will be analyzed. This analysis focuses specifically on the logistics and different players along the chain. Secondly the local market will be briefly characterized, followed by the needs of bakeries in Ghana. This section sources from set of interviews with bakeries, a cake shop, supermarkets and one of the three flourmills in Ghana.

The supply chain 37 Small bakeries, supplying only their local area, characterize the Ghanaian bakery market. Our research indicates that there are no central big industrial bakeries. Interviewed bakeries indicated that approximately 50% of their total costs are transportation costs. Due to the high cost factor of transportation, as well as a strongly limited infrastructure in Ghana, bakeries are limited to local logistics. Bakers indicated that they would not be interested in buying fibers or syrup if this would be connected to additional transportation efforts.

Generally bakeries source their supplies only from local sellers. These sellers source their goods from wholesalers who either buy in the open market or source it from central exporters/producers. Flour and margarine are the two main ingredients, which are produced centrally in Ghana. Flourmills have their own distribution networks, characterized by several layers and master distributors. The small Ghanaian bakeries are active as individual players in the market. Their low bargaining power towards suppliers originates from their lack of cooperation and united activity in the market. According to the interviewed bakeries it would be difficult to unite the different SME bakeries, due to a lack of reciprocal trust and very strong competitiveness. Bakeries showed interest in producing the fiber flour themselves, in order to decrease their dependency on the already overly powerful suppliers. There are three centralized flourmills, supplying the whole Ghanaian market. These are Gafco, Irani brothers and Takoradi Flourmill. Gafco is with a daily production of 165 tons of flour the smallest mill. Irani brothers produces approximately three times this amount. In interviews with Gafco the very high competition between the three mills was emphasized. Wheat flourmills are not capable of grinding the fiber chunks and Gafco would have to invest in new machinery in order to produce the fiber flour. Therefore Gafco was not interested in producing the pineapple flour themselves. However they indicated interest in buying the ready-made pineapple flour in order to distribute it along with their existing products.

The local market Bread and cake belong to the daily nutrition of the Ghanaian consumer. There are three types of bread on the Ghanaian market: sugar bread, butter and tea bread. When baking cake, it would be crucial to grasp the local taste. Therefore when using the flour or the syrup it would be key to distinguish how the traditional taste of the end product changes. For example Bekasin failed when entering the Ghanaian market

because of underestimating this conservatism in the Ghanaian consumers' taste. Their mistake was trying to introduce to many different new variations of cake which the Ghanaian consumers did not want to buy.

According to Gafco, small innovations still would take place, as e.g. the use of brown flour. However brown flour is only offered in small quantities and only on special request.

Needs

Products need to fit with the local environment. The climate influences shelf life and the above-described limits in logistics require a stable supply with consistent quality. Next to transportation energy was identified as a major cost driver. The nutritional value of products 38 slowly rises in importance, as well. When talking to bakeries or a famous Ghanaian caterer, the general lack of fibers in the local diet was well known and seen as a problem. However, when substituting a currently used ingredient, either cost savings or significant quality improvements would have to be the implied benefits. Interesting aspects of the pineapple flour mentioned by bakeries were the possibility to name the bread pineapple bread, as well as the increasing nutritional value of the end product.

Syrup would be only interesting if it was a cheaper substitute for sugar. Since sugar has to be imported, it is the most expensive ingredient in cake and bread. Some bakeries are currently using local honey as a cheaper substitute. For both products it would have to be assessed how taste, structure, propulsion and shelf-life changes, when using the syrup and the flour. Interviews with bakeries showed clearly that flour could be interesting, however the mere fiber chunks not. Gafco agreed that quality improvements due to the usage of flour are the only possible benefit. This is due to the very low percentage of flour substituted.

Chocolate Market

Having consulted industry experts and food engineers chocolate products were identified as an additional potential product category using the syrup. The following chapter first analyses the Ghanaian supply chain for chocolate products, secondly characterizes briefly the local chocolate market. Subsequently it will be concluded on the main characteristics and needs chocolate products have to fulfill, in order to be successful on the Ghanaian market.

The supply chain

Ghana is one of the biggest exporters of cocoa, which is the fundamental ingredient for chocolate. However at present there is only a very limited amount of cocoa processors as e.g. chocolate manufacturers in Ghana. International chocolate producers see Ghana as too small for being able to host the huge chocolate production industry. Therefore the preeminent majority of cocoa is exported without further processing. The few processors of cocoa, again mainly produce for export to Europe, the United States and Asia.

The typical Ghanaian cocoa farmer is smaller than the pineapple farmer. There are almost no big, industrialized cocoa farmers in Ghana. Most farmers do not know the products they are growing the cocoa for. Consequently most Ghanaians do not identify themselves with chocolate. The result is a lack of communication between processors and farmers. For example most farmers do not know which chemicals hamper the quality of the end products, resulting in quality losses of the cocoa in further processing. The communication lack is reinforced by the intermediation of governmental wholesalers, which buy the

cocoa for a fixed price from the small farmers, and sell it centrally to processors and exporters.

The local market

The Ghanaian market for chocolate almost does not exist. As above-mentioned, at present there are only very few local chocolate producers, which in addition mostly produce for export. However pushing chocolate on the local markets has been already intensively discussed among Ghanaian NGOs and GOs trying to help the local cocoa farmers. For example the local chocolate market has been one of the main topics during the last workshop of the African cocoa coalition roundtable.

Two main reasons were identified for chocolate products not being successful on the Ghanaian market. 1) Due to mostly imported chocolate and the high sugar content, chocolate currently is too expensive for the Ghanaian consumer. 2) The present power supply in most regions of Ghana, including the Capital, is not sufficient to provide the required cooling for the products. The lack of current competition results in a very limited variety of different tastes and products. Currently the most consumed chocolate product is chocolate milk. However also there, most products are imported and therefore too expensive for the majority of Ghanaian consumers.

Needs

In the above analysis two fundamental requirements of chocolate products prevailed, in order to be successful in Ghana. Firstly chocolate products must not need extensive cooling and secondly they have to be cheap. The syrup is cheaper than sugar, which is the biggest cost driver in chocolate. Thereby it could be used as a cheap filling, requiring less

chocolate and thus making chocolate snacks affordable to the average Ghanaian consumer. Additionally it could constitute a cheaper basis and sweetener for creating a chocolate drink.

Industry Market Research

Since May 2010 test productions with bakeries and a chocolate producer have been run. The partners are two bakeries, two supermarkets, two caterers and a chocolate producer. The specific selection of the partners aims to grasp different markets, both upper-class citizens of Accra (supermarkets) as well as the lower layers of society (SME bakeries). Furthermore partners with different production processes and scales have been selected. This test production is destined to assess how the end-products are affected in taste, smell and sales by adding either flour or syrup. The following section presents each industry partner involved in the testing of the products as well as his activities and feedback. In the end, all feedback will be amalgamated to arrive at an assessment of products' potential in the B2B sector. As there are no results available for the syrup yet, this analysis will exclusively focus on the pineapple flour.

Cocoa Processing International (CPI)

Description

Cocoa Processing International (CPI) is an export company manufacturing various basic cocoa products located in Tema. The founder is Karl Bittong, a German entrepreneur who already founded many companies in Western Africa. Due to health related issues, Karl retired from the company but still runs his own laboratory conducting tests and research for the CPI.

Notably, neither CPI nor Karl himself produce end-consumer products for the local market. They are therefore only interesting in the experimentation phase, and will probably not become a supply chain actor for our products.

Activities

Following Karl's suggestion, in April the pilot equipment was moved to an affiliated pineapple processor, where new syrup was to be produced and experimented with by Karl. However, Karl had to spend several weeks in hospital, which is why the equipment remained idle. It was therefore taken from Karl and located back to Innova Juice Processing. Nevertheless, Karl is still willing to experiment with the pineapple products. In particular, he is aiming to produce samples of:

- Pineapple syrup with peanut coated in various chocolates
- Bits of fiber chunks coated in various chocolates
- Combinations of syrup, fiber chunks, and dried fruits with chocolate
- Pineapple syrup mixed with cocoa as toffee filling
- Pineapple syrup mixed with cocoa to create a chocolate-pineapple drink

Feedback

Karl provides feedback directly to FRI.

SME Bakeries

HP Bakery

Description

HP is a medium sized bakery, producing approximately 3000 breads per day. HP supplies small stores, street vendors as well as hotels.

Activities

HP was interested in trying out the pineapple flour in their bread. In the beginning of May 5kg of fiber flour were distributed to HP. They substituted two percent of the wheat flour with pineapple flour to produce a sample of breads.

Feedback

The bread containing pineapple flour did not rise, rendering heavy and flat loafs. Besides, the pineapple flavor of the bread was “unacceptable”. HP has opted out of the project after these negative results.

Theophilus Mintah

Description

Theophilus owns a small bakery specialized in bread (sugar, butter, brown and T-bread), producing approximately 600 loafs a week. The bread is sold and delivered to 12 littleretailers around town. Besides, the three person bakery recently started producing muesli/granola.

Activities

Theophilus has been supplied with pineapple flour to experiment with it in his bread. As of

now, he has baked 4 different kinds (brown bread, butter bread, sugar bread and tea bread), using approximately one percent of pineapple flour. He also signaled interest in the syrup, but prefers to leave that for a later stage.

Feedback

According to Theophilus, “the product is very good for the bakery industry”, even “wonderful”. However he is not entirely sure about using it in ordinary production, since the details of distribution, price, and knowledge property are not clear yet.

Supermarkets

Koala and Shoprite are two of the biggest supermarkets in Accra. They both have their own bakery and produce their own bread, cakes, pies and other products. Both supermarkets mainly serve the upper-class society, which is less price-sensitive and more willing to try out innovative products.

Shoprite

Description

Shoprite is the most exclusive supermarket chain in Ghana, with its biggest outlet in the Accra mall. The bakery section offers a diverse range of products from budget breads and cakes to high-end pastries.

Activities

The head of the bakery signaled interest in the syrup as well as the flour to conduct various experiments. The flour has been sent to Shoprite in May, but has not been used

since. According to the management, the tests need to be conducted by a food expert that only occasionally visits the bakery. When and if the tests will actually be carried out remains uncertain, and the people in charge have proven very evasive and unhelpful.

Feedback

N.A.

Koala

Description

Koala Supermarket is the most centrally located supermarket in Accra; and is supplied by an external bakery owned by the firm. Smaller and less exclusive than Shoprite, Koala caters to the needs of upper-class and tourists in Osu.

Activities

Koala's bakery has already produced and sold pound cake containing the pineapple flour. As soon as the syrup is available, they are willing to also run a production with it. If the outcome of the tests is positive, Koala is planning to dedicate a stand in the market for pineapple products and thus test market them. In the course of this test market, Koala will gradually raise the price of the products to gain a feeling for demand and price sensitivity for the products. If this test reveals a market for the products, Koala is willing to directly introduce the products into its product mix.

Feedback

The pineapple pound cake has about the same baking qualities as a normal one, although the outcome is darker, more crumbly and slightly heavier. The taste of the cake remains the same, but it acquires a distinct and pleasant pineapple flavor.

Caterers

FLAIR

Description

The biggest caterer in Ghana, FLAIR, is supplying all kinds of events like governmental receptions, weddings etc. They also have a good relationship with a television cooking show. Notably, bakery products represent only a tiny share of FLAIR's products and are only produced occasionally. Nevertheless FLAIR was very interested in the product, mainly because of its nutrition and health aspect.

Activities

FLAIR received 5 kg of pineapple flour, which it used to bake cakes and cookies. For the cakes 25% of pineapple flour in relation to wheat flour was used, for the cookies even one third. In October, FLAIR will need new flour to run more tests. In addition to these experiments in-house, FLAIR has given some of the flour to The African Culinary Network (BETUMI), which is currently experimenting with the flour as well.

Feedback

The cake and the cookies produced by FLAIR were of mediocre quality, which is likely due to the high share of pineapple flour. The products displayed a crumbly structure, very dark

color and bitter aftertaste. Nonetheless, the cookies proved to be tasty in combination with ice cream. Future feedback will be given to the FRI; The African Culinary Network will report to SIFE Erasmus.

God's Favour

Description

God's Favour is a small pastry-caterer specialized in doughnut (olieballen) production. The company is owned by a lady called Esther, employs two people and produces an average of 2000 doughnuts a day. These doughnuts are then packaged in plastic bags containing 11 doughnuts, which are picked up by 10 to 15 street vendors. Esther sells each bag for 80 Pesewas, and they are sold to the end consumer in the streets for 1 Cedi.

Activities

Esther was supplied with pineapple flour to produce samples of the doughnuts with flour. She produced three variations with different amounts of pineapple flour. She would also be willing to test the pineapple doughnuts on the market, but only after the flour has been approved by the Ghana Standards Board.

Feedback

Esther evaluated the pineapple flour as making a positive contribution to the flavor of the doughnuts as long as the right percentage is added. Unfortunately, she was not able to provide the percentages she used. The doughnuts with a rather low share of pineapple flour had a better flavor than the normal ones. If the share is increased, the doughnuts receive a bitter aftertaste. The color becomes slightly darker with increasing amounts of

pineapple flour, and the doughnuts are less dry. Frying time and properties of the doughnuts remain unaffected.

RECOMMENDATIONS

Proximate analysis for the three varieties of pineapple flours must be undertaken to establish the flours proximate values.

Further formulations and combinations with wheat flour must be conducted to arrive at suitable formulations and combinations for various bakery products.

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