Research Article

Pineapple cookies characteristics and sensory hedonic acceptance

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Abstract

Pineapple (*Ananas Comosus*) which is one of Malaysia's fruit commodities confronted the challenge that causes an environmental problem where it produced many waste. Pineapple processing industry produced pineapple core which is slightly harder in texture. It is one of the major wastes generated with 15% of the fruit thrown away or becoming animal feed. Pineapple belongs to the member of the *Bromeliaceae*, a family of chiefly epiphytic herbs and small shrubs and it is commonly eaten and valued not only because of its flavour and aroma but also because of its dietary material and antioxidant characteristics, including vitamin C and carotenoid material. This study mainly focuses on producing cookies using pineapple core powder, a waste product resulting from canning process of pineapple. The cookies are being produced using 15%, 20% and 30% of pineapple core powder along with other ingredients. Pineapple core powder characteristics and acceptance on cookies were determined by colour analysis, water activity (a_w) and sensory evaluation. Pineapple core powder also has the potential to be used for other products in baking industry due to its high fiber content.

Keywords:

Pineapple Core, Color Analysis, Water Activity, Pineapple Powder

1 Introduction

Pineapple (*Ananas comosus*) is a type of tropical fruit native to the East Area of South America and was introduced to Malaya in the 16th century by the Portuguese. According to Shahbandeh (2019), the global production of pineapples in 2017 amounted to 27.4 million metric tons. In Malaysia, the pineapple plantation continues to expand in compost soil area located in Johor. Other than Malaysia, Thailand, Philippines, Indonesia, Hawaii, Kenya, Ivory Coast, Brazil, Taiwan, Australia, India and South Africa were also considered as the world's major producers of pineapple. After orange and apple juices, pineapple juice is the third most preferred worldwide. Primarily, this fruit contains water, carbohydrates, sugars, vitamin A, C, and beta carotene and it is also known as a fruit that contains low amounts of protein, fat, ash, fiber and antioxidants namely flavonoids.

Additionally, pineapple has enzyme complex protease which contains peroxidase, acid phosphate, several protease inhibitors and organically bound calcium named bromelain (Tochi, Wang, Xu & Zhang, 2008). Hebbar, Sumana and Raghavarao (2008) stated that the proteolytic enzyme present in the stem of pineapple (bromelain), is finding wide applications in pharmaceutical and food uses. For the whole utilization, pineapples offer additional advantages in particular, as a fibre source. Commercially, pineapple is mainly produced as canned fruits (Tran, 2006), chunk and dice, juice, fruit salads, sugar syrup, alcohol, citric acid, pineapple chips and pineapple puree for worldwide consumption but most of its edible part is not being used and became fruit wastes such as core, crown, and stem. Thus, this study used pineapple core to determine the acceptance of the powder produced from the waste part towards cookies.

The study on pineapple core powder can generate new knowledge on the use of fruit waste especially pineapple in other food products as a functional ingredient. The pineapple core is the second major bio-waste of a pineapple, thus when turned into powder, it can be utilized in the production of flavored drinks, baked items, and many more. The study on pineapple core powder not only provides revenue to the industry but it also helps to reduce the impact of waste disposal caused by pineapple wastes.

2 Literature Review

2.1 Pineapple composition

Pineapple is a common name for one member of the *Bromeliaceae*, a family of chiefly epiphytic herbs and small shrubs native to the American tropics and subtropics. Pineapple is the species of *Ananas, Tillsandia,* and other genera sometimes cultivated as ornamentals. This fruit is grown throughout warmer regions such as Thailand, the Philippines, and Brazil which were known as the largest producers of canned pineapple. In Malaysia, pineapples are mostly planted in the states of Johor, Sarawak, Sabah, Kedah, Selangor, Penang, and Kelantan. Among the varieties of pineapples planted in Malaysia are MORIS, MORIS Gajah, Josapine, Yankee, Gandul, N36, and MD2. However, only two local varieties namely Josapine and N36 have been successfully exported,

mainly to Singapore and the United Arab Emirates (UAE) due to its long shelf-life (Kasim, 2010).

This fruit is formed from the flowers and bracts and grows on top of a short, stout stem bearing stiff, fleshy leaves. Normally, pineapples are eaten fresh, tinned, or even made into juice. Pineapples are a composite of many flowers whose individual fruitlets fuse together around a central core. Each fruitlet can be notorious by an "eye," the rough spiny marking on the pineapple's surface. It has a wide cylindrical shape, a scaly green, brown or yellow skin and a regal crown of spiny, blue-green leaves and fibrous yellow flesh. The area closer to the base of the fruit has more sugar content and therefore creates a sweeter taste and more tender texture.

Matured pineapples can be eaten fresh as dessert or salads, cooked as mostly found in local delicacies or processed into juice and jams, among others. The juices from young pineapples are suitable for the treatment of various diseases because they are rich in nutrients such as bromelain and vitamin A and B1. Additionally, pineapple also contains citric acid that can effectively eliminate fat and help in reducing weight. Masniza, Jeng Yih, and Roji (2000) stated that two-third of pineapple is in the form of sucrose and the rest were glucose and fructose (12-15%) sugar. Bartolome, Ruperez, and Fuster (1995) also contented approximately two-third of the total sugar present is in the form of sucrose content. The amount of sugar varies in fruits and may depend on its stage of maturity during harvesting time, soil condition and its variety. The sugar concentration has not always been associated with the point of color, as agricultural and production factors will also impact the growth of sugar (Wijesinghe and Sarananda, 2002).

2.2 Benefits of pineapple

2.2.1 Potential anti-inflammatory and digestive

Pineapple is the source of bromelain, used as a meat-tenderizing enzyme, and high-quality fiber (d'Eeckenbrugge, Sanewski, Smith, Duval, and Leal, 2011) and it contains a considerable amount of calcium, potassium, fiber and vitamin C but low in fat and cholesterol. Other than that, pineapple is also a good source of vitamin B1, vitamin B6, copper and dietary fiber. Pineapple is a digestive aid and a natural anti-inflammatory fruit (Joy & Anjana, 2010). Bromelain is a complex mixture of substances that can be extracted from the stem and core fruit of the pineapple. Among dozens of components known to exist in this crude extract, the best-studied components are a group of protein-digesting enzymes (called cysteine proteinases). Originally, researchers believed that these enzymes provided the key health benefits found in bromelain, a popular dietary supplement containing these pineapple extracts. In addition, researchers also believed that these benefits were primarily limited to help with digestion in the intestinal tract.

2.2.2 Antioxidant protection and immune support of pineapple

Studies have shown that the residues of certain fruits can present a higher antioxidant activity than the pulp (Gorinstein, Zachwieja, Folta, Barton, Piotrowicz, Zemser, et al, 2001). Vitamin C is known as the body's primary water-soluble antioxidant that defends all aqueous areas of the body against free radicals that attack and damage the normal cells. Free radicals have been shown to promote the artery plaque build-up of atherosclerosis and diabetic heart disease which causes airway spasm that leads to asthma attacks, damage the cells of the colon so they become colon cancer cells, and contribute to the joint pain and disability seen in osteoarthritis and rheumatoid arthritis. This situation would explain why diets rich in vitamin C have been shown to be useful for preventing or reducing the severity of all of these conditions. In addition, vitamin C is vital for the proper function of the immune system, making it a nutrient to turn to for the prevention of recurrent ear infections, colds, and flu.

2.3 Health Risk

2.3.1 Pineapple allergy

Food allergy presents a variety of symptoms on the skin, gastrointestinal tract and respiratory tract (Taylor& Hefle, 2001). Even Pineapple is a great meat tenderizer, eating too much can result in tenderness of the mouth, including the lips, tongue and cheeks, but it should resolve itself within a few hours. If it does not, or if you experience a rash, hives or breathing difficulties, you should seek medical help immediately because he/she could have a pineapple allergy.

2.3.2 Bromelain allergy

According to Rachell (2018), there are few side effects associated with bromelain. An extremely high amount of bromelain can cause skin rashes, vomiting, diarrhea, and excessive menstrual bleeding. Moreover, the bromelain in pineapple can also interact with some medications and causes a side effect. For those who took antibiotics, anticoagulants, blood thinners, anticonvulsants, barbiturates, benzodiazepines, insomnia drugs and tricyclic antidepressants should be careful not to eat too much pineapple to avoid any effect on their health. Eating unripe pineapple or drinking unripe pineapple juice is dangerous, reported the horticulture department at Purdue University. In this state, it is toxic to humans and can lead to severe diarrhea and vomiting.

2.3.3 Ulceration or canker sores

Eating a lot of pineapples can affect the skin and lips (Ramulu & Rao, 2003). The high fructose content of pineapple may not be beneficial for diabetics or people who are trying to lose weight. For example, 1 cup of sweet pineapple contains up to 84

calories and 17 grams of sugar. Another disadvantage of eating pineapple is that it commonly irritates the mucous membranes inside the mouth. The high acidity combined with bromelain can cause little ulcerations or canker sores to form on the tongue or surrounding areas. If the mouth is especially sensitive to pineapple, blending the fruit in a smoothie with yogurt should neutralize the malic and citric acids.

Thus, in this study pineapple core was made into powder and incorporated into cookies at 15, 20 and 30% content and its water, color and sensory analysis were described.

3 Methodology

Materials

Pineapple cores were purchased from the local market and stored in the chiller at the temperature of -4^{o}C. After being refrigerated, the pineapple core was manually cut into slices of 0.2 inches and put in the dehydrator for 68^{o}C for 26 hours. There is a great variation in the nutrient content between the base and the top of the fruit (Miller and Hall, 1953; Ramallo and Mascheroni, 2012), and only the central zone of the pineapple fruit was used in this experiment.

3.1 Methods

3.1.1 Development and standardization of pineapple powder-based product

The product was developed using pineapple core powder to formulate pineapple cookies and cake. This product was prepared using a standardized formula for cookies and treated with different ratios of pineapple powder at 15, 20 and 30%. The standard cookies formulation is stated in Table 3.1 below. For each recipe, three experimental samples were prepared. The recipes are as shown below:

Table 3.1: Pineapple cookies at 15, 20 and 30% formulation

No	Ingredients	Quantity			
		standard	**15%**	**20%**	**30%**
1	Butter, softened	1 cup	1 cup	1 cup	1 cup
2	Sugar	1 cup	1 cup	1 cup	1 cup
3	Brown sugar	1 cup	1 cup	1 cup	1 cup
4	Vanilla extract	2 tsp	2 tsp	2 tsp	2 tsp
5	Eggs	2 nos	2 nos	2 nos	2 nos
6	Baking soda	1 tsp	1 tsp	1 tsp	1 tsp
7	Hot water	2 tsp	2 tsp	2 tsp	2 tsp
8	Salt	1/2 tsp	1/2 tsp	1/2 tsp	1/2 tsp
9	All-purpose flour	$1^{1/2}$ cups	½ cup	1 cup	1 ½ cups
10	Pineapple powder	2 cups	½ cup	1 cup	2 cups

3.2.2 Methods of preparation

The cookies are prepared using the conventional method of cookies preparation. Butter is creamed with sugar and brown sugar until smooth. Beat in the eggs one at a time, then stir in the vanilla. Dissolve baking soda in hot water. Add to batter along with salt. Stir in all-purpose flour and then add pineapple powder. Drop a large spoonful of the batter into ungreased pans. Bake for about 20 minutes in the preheated oven (175°C), or until edges are brown. The product is ready in 1 hour.

3.2.3 Test methods

a) Water analysis

Water activity is the ratio of the vapor pressure of water in a material or substance to the vapor pressure of pure water (Barbosa-Canovas, Fontana, Schmidt, & Labuza, 2007). According to this experiment, pineapple core powder was used from the same sample to observe the water activity of this product.

Procedures

1. Use the same sample from pineapple core powder for the three experiments.
2. Place the powder in small plates to analyze the water activity.

b) Colour analysis

The pineapple core powder color was measured by using Chroma Meter CR-410. For this test, the L, a, and b value color scale to indicate color management.

Procedures

1. Use the same sample of pineapple powder, test for the color changes in pineapple core powder.

c) Sensory analysis

For this study, the sensory evaluation was determined using hedonic test taste on samples with 15%, 20% and 30% of pineapple core powder. Thirty-five respondents participated in the sensory evaluation of the pineapple core powder cookies. The cookies were evaluated based on appearance, texture, taste, consistency and attributes. Samples were prepared according to the sensory evaluation protocol for the hedonic test. Panels were given 1 piece of 2 x 2cm size cookies for 15, 20 and 30% formulation respectively. The samples were coded with 3 digits number and plain water was given to cleanse the palate in between samples.

4 Findings

4.1 Analysis and discussion

For this part, the pineapple core powder was subjected to color analysis and water activity content. Wheat flour, which was used as a control was also examined in comparison.

4.1.1 Analysis of water activity

Water activity (a_w) is defined as the ratio of water-vapor pressure (p) to the pressure of pure water (p_o) at the same temperature. The term water activity refers to the unbound water, where the water activity will be higher if less water is tightly bound to a binder such as sugar, salt, or glycerol. Since pineapples are known to be high- calorie fruits, it also contained vital nutrients and can be consumed in a small portion. Water content could become a potential for food deterioration. The water activity determination for pineapple core powder is conducted using the Rotronic HP23-AW-A Water Activity Meter. The unbound water for pineapple powder results as follows:

Table 4.1 Pineapple core powder

Flour/Powder	a_w or range/ temperature	Experiment 1 / 0-7 days	Experiment 2 / 7-21 days	Experiment 3 / 21-30 days
Pineapple	0.644 - 23.5°C	0.599- 23.7°C	0.597 – 24.2°C	0.589 - 24.2°C
Wheat	0.644 - 23.5°C	0.628 - 23.6°C	0.628 – 24.3°C	0.626 – 24.4°C

The result showed that pineapple core flour has the most stable water activity (a_w) than the wheat flour. The result indicates that a_w for pineapple core flour is 0.589 at 24.2°C as compared to 0.626 for wheat flour. Water activity below 0.62 ($a_w < 0.62$) is the limit for pathogenic bacteria growth. Thus, pineapple flour will be stable and safe for consumption.

4.1.2 Colour analysis

Color is important to match the standard and customer satisfaction of the products. According to Soronja-Simovic, Pajin, Subaric, Dokic, Seres and Nikolic (2017), color differences of the flour were expressed in terms of L* (lightness), a* (redness to greenness-positive to negative values, respectively) and b* (yellowness to blueness-positive to negative values, respectively). According to Bas (2017), Commission Internationale de l'Eclairage (CIE), the L*a*b* color space was modeled after a color opponent theory stating that two colors cannot be red and green at the same time or yellow and blue at the same time. It also stated that Deltas for L* (ΔL*), a* (Δa*) and b* (Δb*) may be positive (+) or negative (-), but the total differences, Delta E (ΔE), and it is

always a positive value. Below, the researcher shows the formula of color differences and the results shown in table 4.2 below.

ΔL* (L* sample minus L* standard) = difference in lightness and darkness (+ = lighter, - = darker)
Δa* (a* sample minus a* standard) = difference in red and green (+ = redder, - = greener)
Δb* (b* sample minus b* standard) = difference in yellow and blue (+ = yellower, - = bluer)

$$\Delta E^*_{ab} = \sqrt{(L^*_2 - L^*_1)^2 + (a^*_2 - a^*_1)^2 + (b^*_2 - b^*_1)^2}$$

Table 4.2 Colour differences between pineapple core flour and wheat flour

	T[1]		Differences(ΔPW_{ab}) between pineapple powder and wheat flour
	Wheat Flour	Pineapple Powder	
Sample 1 (O-7 day)	L= 90.33 a= 4.81 b= 6.21	L= 71.15 a= 12.23 b= 29.23	**30.87**
Sample 2 (7-21 days)	L= 90.30 a= 4.83 b= 6.18	L= 71.74 a= 12.10 b= 29.33	**30.55**
Sample 3 (21-30 days)	L=90.29 a= 4.84 b= 6.17	L= 71.73 a= 12.13 b= 29.32	**30.55**

For 0-7 days, the color difference between pineapple core powder and wheat flour is 30.87. For 7-21 days, the color difference between pineapple core powder and wheat flour is 30.55 while for 21-30 days, the color difference is 30.55. Looking at L* a* b* values for each result, we can objectively determine that the color did not match. Pineapple flour is browner than the wheat flour. This is most probably due to the process of making pineapple flour that does not have any bleaching elements. Pineapple which has high simple sugar could have been caramelized while in the drying process. Thus, it has been shown by its higher value since day 1 through day 21. But the color remains the same range and did not get darker than a value of 12.13.

4.1.3 Sensory analysis

According to Abdullah (2004), the scales for sensory evaluation must be meaningful to the respondents. Therefore, consumer's acceptance involves the inspection of a product by the senses such as sight, smell, taste, touch and hearing for various quality attributes like appearance, flavor, aroma, texture and sound (Sharif, Masoos, Hafiz & Muhammad, 2017). The sensory analysis has been done for pineapple cookies incorporated with 15, 20 and 30% pineapple core powder. Respondents evaluated the cookies based on 5 points Likert scale; 5 as the most acceptable and 1 as not accepted.

Table 4.3: Hedonic taste acceptance for cookies incorporated with 15%, 20% and 30% Pineapple core powder (n=35)

Products	15% Pineapple Core powder	20% Pineapple core powder	30% Pineapple core powder
Appearance	Acceptable	Acceptable	Acceptable
Aroma	Acceptable	Acceptable	Acceptable
Consistency	Acceptable	Acceptable	Acceptable
Taste	Acceptable	Acceptable	Acceptable
Texture	Acceptable	Acceptable	Acceptable

Based on the results shown in table 4.3, most of the respondents accept the appearance, texture, taste, consistency, and aroma of the pineapple cookies when 15%, 20% and 30% of pineapple core powder were incorporated. The taste of cookies was all acceptable regardless of the pineapple core powder content in the cookies.

5 Conclusion

The development of pineapple core powder from pineapple core is feasible from all varieties of pineapple products in the market. Since pineapple core is significantly high in fructose, glucose and sucrose compared to the other parts of pineapple waste such as peel and crown, turning it into powder for other products will potentially reduce the waste by-product. Pineapple waste contains many reusable phytochemicals that can provide a high value for the industry. Thus, this value-added information on pineapple core and would be useful for other research purposes and potential use for developing other food products especially baked products.

6 About the author

Nur Farah Syazana is doing her post-graduate study in MSc. Foodservice Management. She will be completing her study in December 2019.

Chemah Tamby Chik has been involved in food product research and development since 2006. Dr. Chemah has a Ph.D. in Food Science and has co-authored Guidelines to Food Innovation book that could be found in UiTM Press. She is currently involved in several projects to empower entrepreneurs in small-medium enterprises.

Dr. Norhidayah Abdullah teaches courses in Food Product Development in the faculty. She and Noradzhar Baba has participated and won a number of food product developments competition at national and international level.

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