PREPARATION OF PINEAPPLE CAKE AND EVALUATION OF ITS PROXIMATE AND BIOACTIVE COMPOUNDS

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Roll No: 0119/03

Registration No: 661

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The thesis submitted in the partial fulfillment of the requirements for the degree of Master of Science in Applied Human Nutrition and Dietetics

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DEDICATED TO MY RESPECTED AND BELOVED PARENTS AND TEACHERS

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List of Abbreviation

Abbreviations	Elaboration
TPC	Total Phenolic Content
TFC	Total Flavonoids Content
DPPH	2,2-diphenylpicrylhydrazyl

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Abstract

The goal of the study was to determine whether pineapple powder can be combined with wheat flour to create a cake and to examine its impact on the cake's proximate composition, bioactive components, and in vitro antioxidant activity. Drying and grinding procedures were used to create the pineapple powder. The method was used to make cakes from a mixture of whole wheat flour and 10% pineapple powder. The proximate composition and bioactive contents of a cake manufactured with wheat flour (10%) and a pineapple-based cake (control) were examined. All the collected data were statistically analyzed to determine the level of significance. A better-quality, more nutrient-dense, and fiber-rich cake was produced when wheat flour was substituted with 10% pineapple powder (carbohydrate 67.72 percent, protein 7.71 percent, fat 2.10 percent, ash 0.96 percent, and fiber 3.83 percent). The Total Phenolic Content (TPC) for the pineapple-based cakes ranged from 4.33 to 4.56 (mg GAE/100 g). The pineapple-based cake has a substantially higher TPC than the control (p<_0.05). The total Flavonoids Content (TFC) of pineapple base cakes varied from 61.22 to 72.98 (mg QE/100 g). The antioxidant activity was increased when pineapple powder (10% pineapple) was added to ordinary cake (2.10 to 2.38 percent). Considering its nutritious and bioactive components, the newly developed cake made with pineapple powder was determined to be more palatable.

Keywords: Cake, pineapple powder, proximate composition, bioactive contents, antioxidant activity

CHAPTER-I

INTRODUCTION

1.1 Background

One of the most popular fruits grown in tropical and subtropical nations, including Bangladesh, is pineapple (*Ananas comosus*), which is a member of the Bromeliaceous family (Bartholomew and Maleieux,1994). Pineapple is fourth among all fruits grown in the nation in terms of both production and total area (BBS, 2009). In Bangladesh, enormous quantities of pineapples of various sorts are grown annually. According to Bartolome et al. (1995), pineapples contain a significant amount of water, organic acids, carbohydrates, sugars, carotene, and vitamin C. They also contain a variety of minerals that are beneficial for a better digestive system, preserving a healthy body weight, and ensuring a balanced diet. Calcium, chlorine, phosphorus, salt, and other minerals are typically present in fresh pineapple (Hossain et al., 2015). Additionally, pineapples have low fat and high crude fiber content, making them an ideal ingredient for making healthy snacks to eat in between meals (Sabahelkhier et al., 2010). Dietary fiber, an indigestible component of plant foods that passes through the digestive system, absorbs water to facilitate urination, modifies the architecture of the gastrointestinal tract by altering how other nutrients and chemicals are absorbed, and generally helps to relieve constipation (Eastwood and Kritchevsky, 2005). For some people with illnesses, the use of pineapple in the diet is occasionally advised. In order to help in the digestion of proteins and break down proteins into amino acids, the U.S. National Library of Medicine recommended bromelain as a proteolytic digestive enzyme (Chaudhary et al 2019.) Increased intake of fruits and vegetables due to their rich bioactive compounds reduces the incidence of nutrition-related chronic diseases which is currently an issue of great public health concern (Morris et al., 2018). Furthermore, apart from health benefits, pineapples also provide vibrant tropical flavor and juiciness. Fresh pineapple fruits or fresh pineapple juices are commonly consumed in Bangladesh. Pineapple can be eaten fresh, canned, or juiced, and it can be found in a variety of foods, including desserts, fruit salads, jam, yogurt, ice cream, candy, and as a complement to meat dishes. It is commonly used to make preserves, refreshing beverages, powder, leather, squash, nectars, toffee, jam, and syrup (Chaudhary et al., 2019). Pickles may be made using green pineapple as well. These goods can be quickly popularized in both local and foreign markets due to their great nutritional value and therapeutic importance (Joy, 2010). Jam, jelly, and pickles made from pineapple are commonly accessible at local markets in Bangladesh (Hossain et al., 2015).

However, modern food processing firms are experimenting with or utilizing new technology to create innovative food items that attempt to preserve the nutritive value of pineapple fruit. Additionally, consumers expect natural, healthful products with great organoleptic properties. Cakes and other bakery goods are consumed widely over the world, therefore adding vitamins, minerals, polyphenols, and fiber from dietary sources is thought to be an efficient approach to creating meals with high nutritional value. Fruits and vegetables are also very perishable due to their high moisture content, thus different preservation techniques must be used to extend their shelf life and lower agricultural product waste, disposal costs, and environmental problems (Cassano et al., 2006; Salehi, 2019). As a result, another option for reducing these post-harvest losses is to produce a variety of fruits or vegetable-based food items (Salehi, 2017; Salehi et al., 2017). However, drying processes are employed to lessen the fresh ones' water activity as well as the production of new food items using fruit and vegetable powders (Salehi et al., 2016). It is well known that the powdered versions of dried fruits and vegetables are a wonderful source of nutrients for baked goods. The components used to prepare the batter, the batter's aeration, and the process conditions are only a few of the variables that affect the quality of cakes in the bakery sector. Wheat flour and other forms of flour have both been studied for making cakes with cheaper costs and more public acceptability since the components have a significant functional role in the product's structure and eating quality. A combination of wheat and chickpea flour, rice flour, and flour manufactured from wheat, rye, and barley were among the flours used to make the cakes used in the study (Gomez et al., 2008; Gomez et al., 2010; Turabi et al., 2008). According to the literature, there is no published information about pineapple powder-based cakes in Bangladesh. In order to diversify the manufacture of bread goods, pineapple powder might be converted into flour. Additionally, due to its appealing color, flavor, and texture, pineapple powder can be added to wheat flour when making bread, biscuits, cookies, noodles, and cakes, as well as utilized as a natural coloring agent in pasta and other mixtures (Ptitchkina et al., 1998). In order to reduce pineapple post-harvest losses, the study set out to create a value-added cake from pineapple powder.

However, creating a value-added cake using pineapple powder and wheat flour would be a fantastic opportunity to offer nutritional variety in the diet. The findings of the current study could be used in the production of commercially viable and quality cake and bread products in bakeries.

1.2 Objectives of study

i. To formulate a cake recipe with pineapple powder

ii. To determine how the addition of 10% pineapple powder to wheat flour will affect the cake's nutritional value.

iii. To compare the bioactive components and in vitro antioxidant activity of pineapple-based cake with an ordinary cake(control).

CHAPTER-II

REVIEW OF LITERATURE

2.1 Pineapple production, output, and area in Bangladesh

Rajshahi Division's least-productive and the lowest-cultivated area was 60 acres. Data on pineapple production in Bangladesh indicate an increase. In the years 2018 and 2019, a total of 36800 acres of land were used for pineapple farming, producing a total of 2174392 M. tons (BBS, 2020). In both years, the Rajshahi division had the lowest yield while the Dhaka division had the highest output. According to Table 1, the greatest cultivable land and production in the Dhaka division were 21341 acres and 138488 million tons in 2018–2019 and 120 million tons and 21341 acres in 2019–2020, respectively (Table 1). The Tangail district of the Dhaka division is the pioneer of pineapple production in terms of area, yield, and production. Tangail and Rangamati district's climate conditions and soil characteristics are better suited for growing pineapples. The higher yield, output, and quality of pineapple are most likely due to this. However, due to the temperature, terrain, soil fertility, and salinity, which are the main factors restricting the suitability of pineapple, production was lowest in the southern districtsthe of Barisal division (Hossain and Islam, 2017).

Table 1 Pineapple production and area by district from 2016–17 to 2018–19 (BBS,2020)

Division	2016-17		2017-18		2018-19	
	Area (acres)	Production (M. Ton)	Area (acres)	Production (M. Ton)	Area (acres)	Production (M. Ton)
Barisal	314	575	339	603	315	542
Chattogram	9883	51638	9991	51544	10040	52009
Dhaka	20281	133291	19778	129375	21341	138488
Khulna	216	651	241	731	228	675
Mymensingh	2633	15807	2641	16072	2673	15837
Rajshahi	59	189	54	179	60	120
Rangpur	134	365	164	504	158	470
Sylhet	1963	9317	2029	9393	1985	9298
Bangladesh	35483	211833	35237	208401	36800	217439

2.2 Pineapples' nutritional value and phytochemicals

It was proven in 1891 that pineapple juice contains proteolysis enzymes like bromelain (Lotz-Winter, 1990). The pulp and stems of ripe pineapples have the highest levels of bromelain. In the food and pharmaceutical industries as well as in diagnostic labs, bromelain is frequently employed. Cysteine proteases make up the majority of bromelain, with little amounts of peroxidase, acid phosphatase, amylase, and cellulose. While fruit bromelain is a cysteine protease found in pineapple fruit, ananain, comosain, and stem bromelain are cysteine proteases found in pineapple stems (Maurer, 2001). Bromelain is categorized globally as a single entity/enzyme despite variations in substrate specificity, molecular mass, isoelectric point, and pH optimum (Lotz-Winter, 1990). The biochemical, pharmacological, and medicinal uses of pineapple bromelain were reviewed by Lotz-Winter (1990) and Maurer (2001). It has been demonstrated that bromelain affects immunological responses by stimulating leukocyte populations, particularly an increase in T cell activation (Mynott et al., 1999; Hale et al., 2005; Secorjr et al., 2005). Bromelain, a non-toxic inhibitor of cell communication and cytokine synthesis that is present in pineapple fruit, helps to prevent the creation of IL-2 while having no impact on cell growth. These characteristics can be applied to the treatment of inflammatory, traumatic, and hypersensitive conditions (Mynott et al., 1999). Due to its analgesic and anti-inflammatory qualities, bromelain may be a safe alternative treatment for osteoarthritis (Brien et al., 2004).

Additionally, it has been demonstrated to lessen inflammatory bowel disease's colonic anti-clinical inflammatories and histologic severity (Hale et al., 2005). AAD's progression was slowed down by bromelain, which also changed the lymphocyte population. Based on the improvement in AAD outcomes, bromelain may have similar effects in the treatment of human asthma and hypersensitivity diseases (Mynott et al., 1999; Secorjr et al., 2005). The pineapple fruit's edible component, which accounts for 60% of the fresh fruit, has a composition of 85% water, 0.4 % protein, 14% sugar, 0.1 % fat, and 0.5 % fiber (Purseglove, 1972). Significant variations in sugar concentration occur throughout ripening and are cultivar-dependent.Vitamins A, B1, B6, and C, copper, manganese, and dietary fiber are all abundant in pineapple fruit (Purseglove, 1972; Morton, 1987; Mateljan, 2007).

Table 2 Morton (1987) and Mateljan's(2007) sources for the nutritional data on pineapple

Nutrients	Amount milligrams(mg)
Manganese	2.56
Vitamin C	23.87
Vitamin B1 (Thiamine)	0.14
Copper	0.17
Dietary Fiber	1860.0
Vitamin B6 (Pyridoxine)	0.13
Calcium	6.2-37.2
Nitrogen	38.0-98.0
Phosphorous	6.6-11.9
Iron	0.27-1.05
Ascorbic Acid	27.0-165.2
Carotene	0.003-0.055
Thiamine	0.048-0.138
Riboflavin	0.011-0.04
Niacin	0.013-0.267

2.3 The advantages of dried pineapple for health

Improvements in digestion, immunity, and post-surgery recuperation are just a few of the health advantages of pineapple and its components. A few of advantages are described below:

Bacterial resistance: In addition to having a lot of vitamin C, dried pineapple also has a lot of bromelains. This strong anti-bacterial enzyme removes poisons from the body and kills germs. Additionally, eating dried pineapple can help to reduce inflammation. This chemical works well to combat dangerous germs and fungi. By preventing platelet aggregation, bromelain and vitamin C work together to prevent blood clots (L'Orenta, 2022).

Anti-inflammatory: In addition to having a lot of vitamin C, dried pineapple also has a lot of bromelains. This strong anti-bacterial enzyme removes poisons from the body and kills germs. Additionally, eating dried pineapple can help to reduce inflammation. This chemical works well to combat dangerous germs and fungi. By preventing platelet aggregation, bromelain and vitamin C work together to prevent blood clots (L'Orenta, 2022).

Weight management: Because it helps break down proteins in food, dried pineapple (which includes bromelain) is a great weight-loss snack. Due to its ability to speed up digestion, pineapple may help people lose weight. Weight loss is aided by food digestion, which lowers fat storage (L'Orenta, 2022).

Effective against acne: Pineapples include vitamin C, which helps with acne and other inflammatory skin conditions both inside and externally. This fruit encourages the body to produce more collagen, which leads to healthier skin (L'Orenta, 2022).

Prevent hair loss: A good way to stop hair loss is to incorporate dried pineapples into your diet. A necessary nutrient that aids in preventing hair loss is vitamin C. This vitamin protects the body from free radical damage and is a powerful antioxidant. Additionally, by giving vital nutrients, pineapple enzymes support the growth of stronger hair follicles. As a result, the hair thickens and softens (L'Orenta, 2022).

2.4 Foods made with pineapple

2.4.1 Pineapple juice

Jori et al. created and researched pineapple fruit juice (2013). A few other factors were also looked into, including time, sensory evaluation of pineapple juice concentration (10%, 12%, and 15% of juice with 100 psi of carbonation), and pineapple juice shelf life. Investigations into chemical elements including acidity, pH, and sugars led to the observation of variations in these elements through time. The obtained data showed that a lower pH value extended the shelf life of prepared carbonated pineapple juice (Jori et al., 2013). The preservation of pineapple juice, however, depends on processing. The quality of pineapple juice is influenced by the processing method employed, the impacts of pasteurization and other preservation techniques, and other factors (Islam et al., 2014).

2.4.2 Pineapple jam

Fruit pulp, pectin, sugar, and acid are the main ingredients in jam, a wet intermediate food. Anuradha et al. created value-added pineapple jams (2017). The jam was also produced by Awolu et al. (2018) using mixtures of pulp from watermelon, pineapple, and banana. Fruit jams were also made using beetroot powder, de-oiled soya meal powder, milk powder, and watermelon powder, all in variable proportions. Before combining, each fruit was cleaned, dried, peeled, and cut into smaller pieces. After blending, they were immediately placed in the refrigerator till usage. To soften the fruit pieces and pasteurize the fruit pulp combination, it was cooked for ten minutes. The boiling pulp was mixed for ten minutes before sugar and pectin solution were added to thicken the mixture. The mixture was then supplemented with preservatives (citric acid and sodium benzoate). After combining, colorant was added and again combined to achieve the desired color and gelation. After cooling in cold water, the mixture was placed immediately into a sterile jar with a lid.

2.4.3 Pineapple candy

A confectionery product is considered candy if it combines chocolate, fruits, nuts, or other components or flavorings with sugar, honey, or other natural or artificial sweeteners (Hamid, 2007). The bar is defined as a mix of elements that gives the food power and low water content, acting as a source of nutrients, as opposed to candies, which are ingested as sweetened items. According to Achumi et al. (2018), pineapple juice and carrot juice can be successfully combined with agar-agar, sugar, and other ingredients to create gummy candies. Khanom et al. (2015) processed fresh pineapple into pineapple candy by soaking it in solutions containing 40, 50, and 60 percent sugar before drying it in a solar dryer. To test its marketability and shelf life, Jothi et al. (2014) also created and researched pineapple (*Ananas comosus*) candies and preserves.

2.4.4 Pineapple leather

Preparing the fruit puree, whether other ingredients are used, followed by mixing and drying is the typical method for creating fruit leather (Chaudhary et al., 2019). Depending on the fruit type, the extra ingredients, the drying methodology, and other factors, these steps may vary. Investigations were done on the physicochemical composition and sensory enhancement of pineapple leather (Phimpharian et al., 2011). After removing the stalk and thoroughly washing the pineapple, they proceeded to remove the skin, divots, and leafy crown. They then thoroughly rinsed the treated pineapple flesh with tap water before slicing and chopping it. Before usage, the puree was stored for up to two weeks in plastic bags. The pineapple puree was stored in the refrigerator overnight and used the following day. Then, pectin, glucose syrup, sugar, and maltodextrin were combined with the heated pineapple puree in an automated pot while it was being stirred. The puree was cooked and mixed one more to create pineapple paste. In order to create a flat, rectangular paste, pineapple paste was extruded through a die after being forced into the extruder zone by a pneumatically powered ram at a pressure of two bars through the top of the leather forming machine. The polypropylene plastic sheet-lined conveyor belt was covered with flat pineapple paste, which was then sliced and dried to create pineapple leather (Phimpharian et al., 2011).

2.4.5 Pineapple vinegar

Making pineapple vinegar from overripe, imperfect, or surplus fruit is a great method to turn wasteful cores, peels, and trimmings into cash. Although less well-known than coconut vinegar, pineapple vinegar is already exported in limited amounts. Alcohol and acetic acid can be fermented to create pineapple vinegar. (2012) Raji et al. Using baker's yeast (Saccharomyces cerevisae) and other ingredients, the fermentation was carried out in two stages. To turn sugar into ethanol, pineapple peel was fermented for 48 hours. Then, using continuous aeration, acetic acid bacteria employed a chance method to convert ethanol to vinegar (Acetobacteraceti). The findings demonstrated that as acidity increased, vinegar output increased.

2.4.6 Pineapple wine

An alcoholic beverage made from fermented fruit juice is called wine (Okafor, 1978). Wine can be produced from any fruit with a high sugar content, and the resulting product is typically named after the fruit. Fruit and yeast strain selection is based on the type of wine being made (Amerine and Kunkee, 2005). Pineapple wine was produced using a combination of its own microbes, granulated sugar, and baker's yeast. Fermentation of malo-lactic acid was found. However, more investigation is necessary to establish the wines' shelf life (Emmanuel, 2012).

2.5 Food diversification

There are numerous methods to define food diversity. Ni (2008) defined diversification as a decision-making process when a person has a variety of options (alternatives) for a variety of foods rather than being entirely dependent on one sort of food. Food diversity, according to Verma et al. (2007), includes three interconnected areas of understanding: food availability, food production, and food consumption diversification. Modified versions of currently available food items may be crucial in guaranteeing food security and stabilizing food output.

2.6 History of cake

Making cakes hasn't undergone much change throughout history. The nun's cake from the 18th century, the spice cake from the 16th, and even the rich pound cake from colonial times needed several hours of labor. Even though later recipes required smaller amounts, the mixing technique remained largely the same (Mills, 1998). Numerous cake goods come in a wide range of compositions. Cakes today contain more shortening, sugar, eggs, and milk due to advances in the processing of ingredients like flour. The current cake is short and soft, with a sweet flavor and pleasant scents (Pyler, 1988). The two primary forms of cakes—foam and shortened—are prepared very differently and have very different issues. A fat-liquid emulsion created during batter preparation is what gives shortened-style cakes (such as pound cake, yellow cake, chocolate cake, etc.) their distinctive crumb structure. Foam-style cakes (angel food, sponge, and chiffon) rely on the aerating and foaming abilities of eggs to provide structure and volume. There are several variables that affect a cake's quality. The choice of ingredients and knowledge of their functions are the initial steps in producing a high-quality product. Making a quality product involves a lot more, though. The cake recipe is a precise formula with a good balance. The best mixing and baking techniques should be used as the last step.

2.7 Ingredients for cake formulation

A critical phase in the creation of food products is the choice of acceptable ingredients. A detailed understanding of substances, their roles, and uses is essential. Cake ingredients can be categorized as either binding or tenderizing elements depending on their anticipated impact on the result. The ingredients include flour, water, milk solids, egg white, cocoa powder, sugar, shortenings, leavenings, emulsifier, starch, and salt (Patel et al., 2003).

2.7.1 Wheat flour

Wheat flour is a type of flour or fine powder made from wheat that is used as a cake's foundation. The purpose of wheat flour is to create a sturdy cake structure, bind the other components, and provide a satisfying texture. The amount of carbohydrates and proteins in wheat flour affects how stretchy the gluten is in dishes produced from wheat. The three varieties of wheat flour identified by Ranzanet al. (2014) are high-protein flour (hard flour), medium flour, and low-protein flour (soft flour).

2.7.1.1 High protein flour (hard flour)

Wheat flour with a high protein level, between 11 and 13 percent, is known as high protein flour and is used as a component in bread, noodles, spaghetti, and donuts.

2.7.1.2 Medium protein flour

Medium flour is defined as flour with a 10–11% protein level. typically employed for domestic tasks like cooking noodles.

2.7.1.3 Low protein flour (soft flour)

Wheat flour is a low-protein flour since it only contains 8 to 9 percent protein. This flour is perfect for producing cakes, biscuits, and cookies because it has less gluten than both.

2.7.2 Water

During combination, water hydrates the gluten protein. During baking, water gelatinizes starch and acts as a dispersant for the other components. Water is a key ingredient in baking because it provides the essential medium for the physical, chemical, biological, and biochemical reactions that turn raw ingredients into baked goods. Additionally, it has a significant impact on the final baked goods' overall quality and flavor. During baking, it transforms into vapor and leavens the goods. Additionally, it aids in regulating dough temperature (Patel et al., 2003).

2.7.3 Fats

Fat maintains the cake's resilience, boosts the cake's nutritional value, and gives it flavor. Fat also acts as an emulsifier, enhancing crispiness. You can use butter or margarine. Butter should be used when making cakes to provide savory flavors and a mouthwatering scent.

2.7.4 Sugar

Providing sweetness, coloring the cake, softening the cake, moistening the cake, and relaxing the dough are just a few of sugar's duties, according to Conforti (2006). The quantity and quality of the sugar will have an impact on the finished product's texture, look, and flavor. Usually, refined and powdered sugar are used to make cakes. It caramelizes when heated, turning the product a dark brown color (Patel et al., 2003).

2.7.5 Egg

Cakes' structure and toughness are established by eggs, which also give cakes their savory flavor and serve as a natural emulsifier. If you use too many eggs, the cakes will become fragile. The eggs are fresh (pH 7–7.5), haven't been exposed to extreme cold, and weren't fractured or damaged before use. The egg yolks provide the dough structure, taste, and a crisp finish after baking.

2.7.6 Milk powder

Because it has a longer shelf life and more uniform quality than fresh milk and other types of milk, whole milk powder is used in the production of cakes. The most significant moistening agents are they. The milk sugar, or lactose, enhances the color of the cake's crust and its capacity to retain moisture. Casein is the primary protein found in milk powder, and it also contains all the essential amino acids, which enhances the nutritional value of the cakes (Patel et al., 2003).

2.7.7 Salt

Salt is mostly used in cakes to impart flavor. Additionally, salt prevents the development of gluten during the mixing process. Salt gives food flavor and enhances its attractiveness and palatability. Conforti (2006) asserts that salt can inspire flavor or aroma and affect the color of the crust. The type of flour used is one of many variables that affect the amount of salt utilized.

2.7.8 Baking Powder

Sodium bicarbonate, sodium aluminum phosphate, and monocalcium phosphate are the three ingredients that make up baking powder, which is used as a developer (leavening agent). Baking powder is used to leaven the cake.

2.8 Commercial cake production procedures

To guarantee that finished products are homogeneous in size, shape, and appearance, the commercial baking industries use highly automated procedures. To produce a greater quantity of finished goods in the most reliable manner, commercial mixers, filling devices, bake ovens, etc the batter is combined with a professional mixer. To trap air within the protein matrix and enable the cake to rise properly, the mixer beats the mixture after combining all of the ingredients for an additional 10 minutes. The cake expands in size during baking as a result of the trapped air and the additional leavening agent.The batter is well combined before being placed into a shape and cooked (Delcour and Hoseney, 2010). An automated mold is coated with a thin layer of oil emulsion to prevent batter from sticking when baking takes place. Using an automated dosing system that simultaneously checks the batter's weight, shape, and level before baking, emulsified molds are further filled with batter. Conveyor belts are used to move batter-filled molds to automatic ovens the temperature and relative humidity of the oven should be precisely regulated to make cakes of the highest quality. To prevent case hardening during the initial baking stage, a very small amount of water is sprayed over the crust. The crust is then given time to acquire a pointy texture. On the other hand, the strength of this structure is impacted by the creation of a large protein network during baking, which ultimately influences the final product's quality (Wilderjans et al., 2013). The cakes must be properly cooled off after baking in order to avoid the crust collapsing. As the chilling process continues, moisture is released, which is quickly removed from the cooling station using strong suction pumps to avoid moisture condensation. The cakes are taken out of the mold once cooling is complete and brought to the packaging area. If the finished products are not totally cooled, moisture would condense and harm them. Commercial cakes, however, are often secondary packaged with cardboard tray covers over plastic bag wraps.

CHAPTER-III

MATERIALS AND METHODS

3.1 Location and time of research

The study was carried out at Chattogram Veterinary and Animal Sciences University (CVASU), Chattogram, Bangladesh, in the Department of Food Processing and Engineering and Department of Applied Food Science and Nutrition, Faculty of Food Science and Technology, and Department of Animal Science and Nutrition, Faculty of Veterinary Medicine. Between January 2021 and December 2021, the study was conducted.

3.2 The process of making pineapple powder

From a neighborhood market called "Jhawtola" in Chattogram, mature pineapples were bought. They were then cleaned by being further rinsed in tap water after being peeled and deseeded to remove the inedible portion. After trimming the pineapple, it was cut into small pieces and blanched for two to three minutes at 70 to 80 degrees Celsius. Following the drying process developed by Pongjanta et al., treated pineapple slices were then subjected to a cabinet dryer's 60°C for 12 hours of drying (2006). The dried pineapple was sliced then, crushed into powder, then sieved, and stored in plastic bags at room temperature.

3.3 Formulation of cake

We bought common ingredients from the grocery store, such as wheat flour, eggs, sugar, baking powder, milk powder, and oil. Below are the proportions for the cake preparation formulas (Table 3).

Table :3 Cake recipe formulations

Ingredients	Control biscuit	Pineapple-based cake (10%)
Wheat Flour (g)	200	180
Pineapple powder (g)	0	20
Powdered sugar (g)	80	80
Milk powder (g)	30	30
Butter (g)	6.25	6.25

Egg (no.)	2	2
Salt (g)	1.50	1.50
Baking powder (g)	2.5	2.5
Vanilla essence (ml)	2	2

3.4 Preparation of cake

10% pineapple powder was substituted with wheat flour in the preparation of pineapple powder blended cake. The total procedure is given in Figure 1.

Ingredients were weighed properly

⇓

Wheat flour was mixed with pineapple powder, powdered sugar, egg, milk, and oil

⇓

Baking powder and vanilla essence were also added and kneaded

⇓

Butter was smeared on prepared pan

⇓

Dough was subjected to bake at 140 ºC for 30 minutes

⇓

Cooled

⇓

Packed into moisture-proof packets

Figure 1: Flow chart for the preparation of cake

3.5 Analyzing the approximate composition

Cake samples made with pineapple had their moisture, protein, fat, fiber, and ash levels tested using AOAC standards (AOAC, 2016). By drying to a constant weight in an oven set at 105°C, the moisture was determined. The Kjeldahl technique (6.25 N) was used to calculate the crude protein content. The Soxhlet system was used to extract total lipid according to the usual procedure. Ash was also gravimetrically measured in a furnace by heating it to a constant weight at 550^oC.

3.5.1 Moisture

A 5-gram sample of the cake was placed on an empty crucible that had been dried for an hour at 100^oC. The crucible was then put in a thermostatically controlled air oven to dry at a temperature between 100 and 105^oC. The crucible was taken out of the oven after drying and chilled in the desiccator. After that, it was weighed using covered glass. Once more, the crucible was put in the oven to dry for 30 minutes before being removed, cooled in a desiccator, and weighed. These were continued until the weights of the two succeeding repetitions were equal. Following the calculation of these weights, the percentage of moisture in cake samples was determined to be:

$$\% \text{ Moisture} = \frac{Loss\ of\ weight}{Weight\ of\ sample} \times 100$$

3.5.2 Crude protein

Reagents used: Boric acid solution, Alkali solution, Mixed indicator solution, Standard HCl, concentrated H_2SO4, Digestion mixture (Potassium sulphate 100gm + Copper sulphate 10gm + Selenium dioxide 2.5gm) (0.1N) for estimation of protein, the following steps were followed:

Digestion: 2gm sample, 3gm digestion mixture and 25ml H_2SO_4 was taken in a kjeldahl digestion flask and heated for 4 hours. The digestion was completed when the colour of the substance was pale yellow.

Distillation: Following digestion, kjeldahl flask containing about 10ml 2 percent boric acid and 2-3 drops mixed indicator was filled with 100ml water, 100ml 40 percent NaOH, and glass blitz. Just before the distillation was terminated, around 100ml of distillate was collected. The receiving flask was positioned such that the distillate was exposed at the distillation tube's tip. To make sure there were no ammonia residues in the condenser tube, some distillate was collected.

Titration: Titer values were recorded when the ammonia collected was titrated with 0.1N HCl solution.

Using the protein factor 6.25, the percentage of protein in the sample was calculated.

$$\%\ \text{Nitrogen} = \frac{(T_s - T_b) \times Normality of\ acid \times meq.N_2}{Weight\ of\ sample\ (gm)} \times 100$$

Where,

T_s= Titer value of sample (ml)

T_b = Titer value of Blank (ml)

meq. of N_2= 0.014

% Protein = % Nitrogen × 6.25

3.5.3 Crude fat

After the moisture content was determined, the dried sample was put into a thimble and the top of the thimble was sealed with a wad of fat-free cotton. The thimble was inserted into the Soxhlet flask's associated fat extraction tubing. A flask was filled with at least 75ml of anhydrous ether. The condenser was connected to the tube's top. The sample was extracted on a water bath for at least 16 hours at 70 to 80 degrees Celsius. The thimble was taken out of the device after the extraction phase and used to collect the ether in a Soxhlet tube or evaporate most of it off. When the tube was almost filled, the ether was scraped off. A tiny funnel with a cotton plug in it was used to funnel the ether into a tiny, dry beaker once it had diluted to a little amount. The flask was carefully washed once again and filtered using ether. The ether was dried at 100°C for an hour, cooled, and weighed after being evaporated on a steam bath at low heat. The amount of ether-soluble material in the sample was determined by the difference in weights, which was then used to determine the sample's fat content.

The presence of fat was shown in the following ways:

$$\%\ \text{fat} = \frac{Loss\ of\ ether\ soluble\ materials}{Weight\ of\ sample} \times 100$$

3.5.4 Crude fiber

The AOAC technique was used to calculate crude fiber (AOAC, 2005). The water-insoluble portion of carbohydrates known as "crude fiber" is composed mostly of cellulose, hemicellulose, and lignin. By boiling a known amount of fat-free food sample in weak acid solution (1.25 percent H_2SO4) for 30 minutes, followed by weak alkali solution (1.25 percent NaOH) for 30 minutes at constant volume, and then subtracting ash from the residue produced, it may be approximated by digestion.

Reagent used: Potassium sulfate, 0.25 N sulfuric acid (10 percent)

Calculation: Crude fiber makes up the weight loss.

$$\%\ \text{Crude fiber} = \frac{Weight\ of\ residue\ with\ crucible - weight\ of\ ash\ with\ crucible}{Weight\ of\ sample} \times 100$$

3.5.5 Ash

After charging over an electric heater for four hours, the oven dried sample was collected. The ash was indicated as a percentage of the difference between oven dried matter and final weight. The following formula was used to compute it:

$$\%\ \text{Ash content} = \frac{Weight\ of\ ash}{Initial\ Weight\ of\ dry\ matter} \times 100$$

3.5.6 Carbohydrate

Rahman et al calculation of total carbs used the difference method. (2020)

% carbohydrate = 100% − % (moisture + ash + crude protein + crude fat + crude fiber)

3.6 Biological component analysis and in vitro antioxidant activity

For 72 hours at 30°C, 2gm of each cake sample was refluxed with 20ml of ethanol containing 1 percent HCl (Hithamani and Srinivasan, 2014). The supernatants were filtered and then centrifuged at 5000 rpm for 20 minutes to assess the amount of total phenolic and total flavonoid compounds as well as the antioxidant activity.

3.6.1 Total phenolic content determination (TPC)

The procedure given by Singleton et al. (1999) was slightly modified in order to measure the total phenol content (TPC). In a 50ml volumetric flask, 0.1ml of each acidified methanolic extract and 5ml of distilled water were added. After that, 7.5ml of a 15 percent sodium carbonate solution and 2.5ml of 10 percent Folin-reagent Ciocalteu's (v/v) were also added and carefully mixed. A 50ml total volume was created, and the reaction was allowed to occur for 30 minutes. Finally, using a UV-visible spectrophotometer, the samples' absorbance was measured at 765 nm (UV-1800, Shimadzu Corporation, Japan). The samples' absorbance was contrasted with the gallic acid reference curve. For each 100 grams of the sample, TPC was computed and reported as mg of gallic acid equivalent (GAE)every.

3.6.2 Calculating the content of all flavonoids (TFC)

With a few minor adjustments, the technique described by Meda et al. (2005) was used to quantify the total flavonoid content (TFC) of the cake sample extracts. In a nutshell, each sample was diluted properly before being combined with 0.5 ml of methanol, 50 l of 10% aluminum chloride, 50 l of 1M potassium acetate, and 1.4 ml of water. The mixture was then let to sit at room temperature for 30 minutes. After that, a UV-visible spectrophotometer was used to detect the reaction mixture's absorbance at 415 nm (UV-1800, Shimadzu Corporation, Japan). Quercetin was used as the standard in the calculation of TFC, which is reported as mg of quercetin equivalent (QE) per 100 grams of the sample.

3.6.3 Measurement of antioxidant or DPPH radical scavenging activity

The 2, 2-diphenyl-2-picrylhydrazyl (DPPH) scavenging activity or antioxidant activity of produced cakes was assessed using the technique established by Ancos et al., 2002. In a nutshell, 4 mL of methanolic 0.1M DPPH solution and 10 l of the acidified methanolic extract were combined with 90 l of distilled water. The combination was properly blended using vortex machinery, and it was then stored in shadowy areas for 30 minutes. A UV-visible spectrophotometer was then used to detect the absorbance at 515 nm (UV-1800, Shimadzu Corporation, Japan). The percentage (%) suppression of the DPPH radical as a result of antioxidant activity.

3.7 Statistic evaluation

To find statistical differences between the data and assess the level of significance ($p \leq 0.05$), one-way analysis of variance (ANOVA) was performed on the data using Minitab Statistical Software (Version 19.0.1, United Kingdom).

CHAPTER-IV

RESULTS

4.1 Proximate composition of pineapple-based cake

Table 4 shows the findings of the approximate composition of the fortified pineapple-based cake. The results showed that adding pineapple powder (10%) to wheat flour boosted the fortified cake's moisture content (16.547–17.673%) and fiber content (0.273–3.833%). As the substitute increased, however, the number of carbohydrates (72.253 - 67.723%) and protein (7.787 - 7.710%) decreased. In terms of proximate composition, regardless of cake samples, there were no appreciable changes in ash and crude fat content ($p \leq 0.05$)

Table 4 Approximate make-up of the pineapple-based cake and the control (10 percent)

Variables	Wheat flour-based cake (Control)	Pineapple-based cake (10%)
Moisture (%)	16.547 ± 0.031^{b}	17.673 ± 0.025^{a}
Crude Fiber (%)	0.273 ± 0.006^{b}	3.833 ± 0.012^{a}
Ash (%)	0.940 ± 0.010^{a}	0.960 ± 0.010^{a}
Crude Fat (%)	2.200 ± 0.100^{a}	2.100 ± 0.100^{a}
Crude Protein (%)	7.787 ± 0.015^{a}	7.710 ± 0.010^{b}
Carbohydrate (%)	72.253 ± 0.080^{a}	67.723 ± 0.130^{b}

Results are presented as three replicates' means and standard deviations. Significant variations between mean values are shown by different superscripted lower-case letters (a, b) in the same row within each fraction (one-way ANOVA followed by Fisher's LSD, ($p \leq 0.05$).

4.2 Bioactive contents and in vitro antioxidant activity of pineapple- based cake

There were significant differences ($p \leq 0.05$) between the control and pineapple-based cakes in terms of their total phenolic content (TPC), which varied from 4.331 to 4.563 mg GAE/100 g. (Table 5). The pineapple-based cake was found to have the greatest phenolic content, whereas the control cake had the lowest. Table 5 also showed that the inclusion of pineapple powder was a factor in the pineapple-based cake's higher flavonoid content (TFC) when compared to the control ($p \leq 0.05$). Cake made with pineapple had the greatest total flavonoid content (72.987 mg QE/100 g), whereas control had the lowest (61.221 mg QE/100 g). Cake samples' ability to inhibit 2, 2-diphenyl-2-picrylhydrazyl (DPPH) ranged from 2.103 to 2.379 percent, with significant differences ($p \leq 0.05$) seen between the control and pineapple-based cake samples (Table 5). The TPC, TFC, and DPPH radical scavenging activities of the control and pineapple-based cake samples showed a favorable correlation with the findings.

Table 5 Bioactive contents and in vitro antioxidant activity of pineapple- based cake

Variables	Wheat flour-based cake (Control)	Pineapple-based cake (10%)
TPC (mg GAE/100 g)	4.331 ± 0.002^b	4.563 ± 0.001^a
TFC (mg QE/100 g)	61.221 ± 0.027^b	72.987 ± 0.005^a
DPPH (%)	2.103 ± 0.006^b	2.379 ± 0.003^a

Results are presented as three replicates' means and standard deviations. Significant variations between mean values are shown by different superscripted lower-case letters (a, b) in the same row within each fraction (one-way ANOVA followed by Fisher's LSD, ($p \leq 0.05$). TPC is for total phenolic content, TFC for total flavonoid content, and DPPH stands for percent DPPH radical inhibition or antioxidant activity.

4.3 Sensory Evaluation

Sensory analysis (or sensory evaluation) is a scientific discipline that applies principles of experimental design and statistical analysis to the use of human senses (sight, smell, taste, touch, and hearing) for the purposes of evaluating consumer products. The discipline requires panels of human assessors, on whom the products are tested, and record the responses made by them. By applying statistical techniques to the results, it is possible to make inferences and insights about the products under test. Most large consumer goods companies have departments dedicated to sensory analysis. Sensory analysis can mainly be broken down into three sub-sections:

- Analytical testing (dealing with objective facts about products)
- Affective testing (dealing with subjective facts such as preferences)
- Perception (the biochemical and psychological aspects of sensation)

Sensory evaluation was carried out using Seven-point Hedonic scale.

Qualitative parameters – Appearance, Odor, Taste, Saltiness, Crispiness, Hardness and Overall acceptability.

Rank	Score
Like extremely	7
Like moderately	6
Like slightly	5
Neither like nor dislike	4
Dislike slightly	3
Dislike moderately	2
Dislike extremely	1

Fig: 2 Observation of Sensory evaluation

CHAPTER-V

DISCUSSION

5.1 Effects of adding pineapple powder (10%) as a substitute on the created cake's primary ingredients

Regarding the quality, acceptability, and shelf-life of baked goods, moisture is essential (Adebayo Oyetoro et al., 2016; Ergun et al., 2010). Cake made with pineapple had the greatest reported moisture level, followed by the control cake. It's possible that adding pineapple powder during cake preparation improved the cake's moisture level. However, comparable results about the enhanced moisture content of baked items by the addition of Desert Truffle Powder were also reported by Gadallah and Ashoush (2016).

Compared to wheat-based cake, the protein level of the pineapple cake was observed to be the lowest (control). The outcome likewise showed a modest drop in protein concentration when pineapple powder replacement increased ($p \leq 0.05$). However, this development is related to pineapples' substantially lower protein content (Kader et al., 2010) Kenawi et al. showed a similar pattern of declining protein (10.09 to 9.98%) in cookies made with wheat-date powder (2016).

To improve the texture, rheology, and general quality of the food product, fat is a crucial component that acts as a lubricant (Ahmed et al., 2022). Table 4 shows that the cakes' fat content varied between 2.10 and 2.20 percent. Since the same amount of oil was used to prepare each cake, there were no significant changes in the study's results. Ikuomola et al. (2017) stated that the fat level of the cakes was within the usual range (25 percent) that is advised for food goods, which may lessen oxidative rancidity and offensive aromas.

The cakes ash percentage varied from 0.94 to 0.96 percent (Table 4). While substituting the amount up to 10%, the ash content of the pineapple-based cake samples marginally rose, statistically speaking there were no significant variations. But the slightly increased ash concentration in pineapple-based cakes could be caused by the fruit's higher mineral content (Hossain et al., 2015). However, Kenawi et al. (2016) observed a modest rise (0.58 to 0.88 percent) in ash content when replacing date powder with wheat flour while making biscuits.

The addition of fruit and vegetable residual flour to baked goods boosts their dietary fiber content and functional qualities (Ajila et al., 2008). The pineapple-based cake's fiber content increased to 3.383 percent when pineapple powder was added, compared to the control cake's 0.273 percent fiber level. This outcome is consistent with Ktenioudaki et alfindings (2012). Earlier research by Vergara-Valencia et al. (2007) showed that adding whole-fruit mango dietary fiber to cookies and biscuits enhances their nutritious value.

For 10% pineapple was substituted for wheat flour when creating the cake, the carbohydrate level dropped from 72.25 to 67.72 percent (Table 4). The amount of carbohydrates in the cakes decreased as the amount of pineapple powder increased. In a similar vein, Alam et al. (2014) discovered that biscuit samples created with plant components had lower carbohydrate amounts (56.6 to 54.6 percent). Low-carbohydrate meals are connected to health benefits, nevertheless.

5.2 Effects of adding pineapple powder (10%) to developed cake on its bioactive components and antioxidant activity

Since pineapples are known to be a rich source of polyphenols, which are frequently employed to enhance the functional qualities of certain food products, the increasing trend of TPC and TFC in this study is consistent with the prior literature (Ali et al., 2020). Elhassaneen et al. (2016) found similar results, indicating that adding prickly pear and potato peel powders (5%) increased the bakery goods' total phenolic content (TPC) compared to the control (from 110.23 to 192.79 mg/100 g of sample). In contrast, Pasqualone et al. (2015) observed a similar outcome for TFC, finding that adding plant by-products to semolina flour boosted the flavonoid content of biscuits. The presence of any maillard reaction during baking, however, might be the cause of the reduced TFC in the control cake (Manzocco et al., 2000). However, an important processing step known as baking may have had an impact on the rising trend of bread items' antioxidant activity (Baba et al., 2015). The present study's findings, however, are consistent with those of Ajibola et al. (2015), who found that the antioxidant qualities of baked goods rose as the amount of Moringa oleifera leaves and cocoa powder increased. According to Jan et al. (2015), combining buckwheat and wheat flour increased DPPH inhibition by 55.53 to 61.65 percent.

CHAPTER-VI

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

However, the lower TFC in the control cake might be due to the existence of any maillard reactions during baking (Manzocco et al., 2000). The growing trend of bread items' antioxidant activity, however, may have been influenced by a crucial processing step known as baking (Baba et al., 2015). However, the results of the current study are in line with those of Ajibola et al. (2015), who discovered that the antioxidant properties of baked products improved as the proportion of Moringa oleifera leaves and cocoa powder increased. Buckwheat and wheat flour combined boosted DPPH inhibition by 55.53 to 61.65 percent, according to Jan et al. (2015). A unique cake product with additional value that was strengthened with pineapple powder was made with success. The freshly created cakes' crude fiber levels were boosted by the inclusion of pineapple powder. The pineapple-based cake's approximate composition and bioactive components demonstrated improved crude fiber, total phenolic content, and total flavonoids properties, suggesting that pineapple powder is a promising ingredient for use in composite formulations with wheat flour for the development of bakery products. This overwhelmingly shows that adding more pineapple powder to cakes raised their total antioxidant activity and, thus, their therapeutic potential. As a result, the substitutability of pineapple powder for wheat flour and the sensory qualities' consumer acceptance offers fresh information for further study on the utilization of waste products as a value-added food ingredient for baked goods or other chosen functional meals.

6.2 Recommendations

This method may be used by several food companies to produce pineapple cake on a big and medium scale. Additionally, the creation of a small-scale processing facility at the farmer level might use pineapples for the processing of bakery goods, which would be useful to reduce the fruit's post-harvest losses and to provide producers with revenue during the off-season. The following advice is suggested when pineapple powder (10%) is used for wheat flour:

1. The effect of different preservatives on the nutritive value of pineapple cakes should be evaluated prior to packaging and transportation.
2. Changes in bioactive compounds should be studied during prolonged storage.
3. Drying losses should be measured and drying should be occupied in the appropriate dryer to retain the keeping quality.
4. Attention should be given while preparing dough in order to get a smooth texture in the finished product.
5. Promotion of scientific means of postharvest handling, primary processing, and preservation of pineapples is essential to improve awareness to consumers and entrepreneurs aiming to minimize wastage.

6.3 Limitations of the study

The manufacture of pineapple cake and the evaluation of its nearby and bioactive chemicals at the level of 10% replacement are the only topics covered in this study. To assess the in-vivo antioxidant activity of this dietary product based on pineapple, additional research should be done. In order to find additional unique functional meals with noteworthy health advantages, particularly from pineapples, future research should also concentrate more on merging sophisticated food technology technologies.

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Appendix - I

Fig 3: Peeling of Pineapple

Fig 4: Slicing of Pineapple

Fig 5: Drying the sliced Pineapple

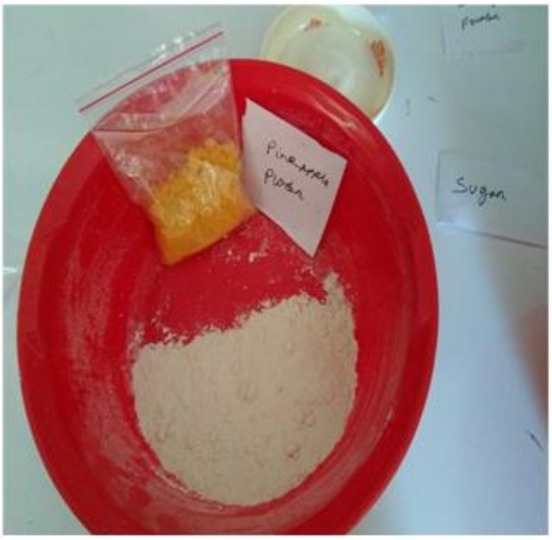

Fig 6: Ingredients for Pineapple

Fig 7: Mixing the

Fig 8: Baked Pineapple cake

Fig 9: Sliced pineapple cake

Brief Biography of the Student

This is Sumon Ahmed son of Khurshid Uddin Ahmed and Hosne Ara Begum. He has passed the Secondary School Certificate Examinations in 2011 followed by Higher Secondary Certificate Examination in 2013. He obtained his Food Science and Technology Degree in 2017 (held in 2018) from Chattagram Veterinary and Animal Sciences University (CVASU), Bangladesh. Now, he is a candidate for the degree of MS in Applied Human Nutrition and Dietetics under the Department of Applied Food Science and Nutrition, Faculty of Food Science and Technology, CVASU.