CHAPTER II

LITERATURE REVIEW

2.1 Ingredients Review

2.1.1 Rice Washing Water

Rice washing water that knowns as Leri in Java is an organic liquid waste whose existence is very easy to find and very abundant since it is produced by most of Indonesian people because rice is a source of carbohydrates to fulfil daily energy needs and the staple food in Indonesia. The waste from washing rice is a liquid waste that contains a wealth of beneficial nutrients such as 0,015% nitrogen (N), 16,306% phosphorus (P), 0,02% potassium (K), 2,944% calcium (Ca), 14,252% magnesium (Mg), 0,027% sulfur (S), 0,0427% iron (Fe) and 0,043% thiamine (vitamin B1), 1.6 g carbohydrate, 1.52 g sugar and 13 mg sodium per 100 ml of rice washing water (Citra Wulandari *et al*., in Zaura et al., 2023 ; *Rice Water Calories, Carbs & Nutrition Facts*, 2023). (Rahmadsyah in Zaura et al., 2023) discovered that washing rice with water causes about 80% vitamin B1, 70% vitamin B3, 90% vitamin B6, 50% manganese (Mn), 50% phosphorus (P), 60% iron (Fe) and 100% fiber and essential fatty acids dissolved in rice washing water.

Rice washing water has similarities with coconut water since the nutrients contained in rice washing water can be a growth medium and support the nutritional needs of *Acetobacter xylinum* bacteria because the carbohydrate content as a source of carbon, the sufficient vitamins content plays a role in the metabolism of microbial cells and the nutrients contained in rice washing water can be converted into energy to support bacterial growth activities in the biosynthesis of nata formation (Fitriah in Laily & Palupi, 2019). Furthermore, rice washing water can be used

as an additional ingredient (fortifier) in the nata de coco fermentation process according to (Rachmat, in Laily & Palupi, 2019) research.

2.1.2 Pineapple Skin Juice & Pineapple Flesh Juice

Ananas comosus L. *Merr* or known as pineapple is a tropical plant that belongs to the Plantae division, this plant originates from South America and is widely cultivated in Indonesia (Jumu et al., 2023). 23% of the world's pineapple production comes from Indonesia (Center for Agricultural Data and Information Systems in Ramadani et al., 2019). Pineapple is an evergreen plant that lives throughout the year (perennial). Pineapple fruit has several parts such as skin, flesh and core or fruit hump. In 100 grams of pineapple flesh, it contains 40 kcal energy, 0.30 g total fat, 0.02 mg vitamin B1, 0.04 mg vitamin B2, 0.20 mg vitamin B3, 22 mg vitamin C, 9.90 g total carbohydrates, 0.60 g protein, 0.60 g dietary fiber, 22 mg calcium, 14 mg phosphorus, 18 mg sodium, 111 mg potassium, 0.90 mg iron, 0.10 mg zinc, 17 mcg Beta-Carotene, 88.90 g water, and 0.30 g ash (Risqi, 2018). Pineapple fruit contains natural digestive enzymes such as vitamins, minerals, fiber and bromelain (Rani et al., in Jumu et al., 2023). Consuming pineapple flesh offers various benefits, including controlling and reducing cholesterol levels due to its high fiber content, boosting the immune system, improving the digestion system, preventing cancer and promoting heart health.

In Indonesia, pineapples are a popularly consumed fruit and leading to a significant amount of food waste in the form of pineapple skins. Pineapple skin waste is the most abundant part and is often disposed of without being processed, which in turn causes an unpleasant odor. The cause of the unpleasant odor from pineapple skin waste is a lack of oxygen, as microorganisms need sufficient O_2 to support their growth and the release of methane and carbon dioxide gases occurs which increase emissions that cause the greenhouse effect which can cause

global warming (Kusuma et al., 2019). The underutilized pineapple skin actually contains various active compounds such as the protease enzyme known as Bromelain, flavonoids, vitamin C, and anthocyanins, which can be beneficial for human health and serve as traditional remedies due to the potential antibacterial properties of these active compounds (Zami et al., 2023). Moreover, there are 2.9 g carbohydrate, 2.2 g sugar, 0.11 g protein, 0.22 mg sodium, 24.22 mg potassium, 0.22% vitamin A, 17.5% vitamin C, 0.22% calcium, 0.22% iron, 19.49% crude fiber, 1,88% crude fat and 4,52% ash contained in 100 grams of pineapple skin (*Pineapple Skin Calories, Carbs & Nutrition Facts,* 2023 ; Ramadhan & Syarif in Noviandi et al., 2018). The carbohydrate and sugar content in the pineapple skin is sufficient as biomass for the formation substrate (Fadilah et al., 2021).

2.2 Product Review

2.2.1 Nata De Pinari

Nata de pinari is a kind of refreshing food or dessert that is rich in nutrition, this food product is an innovation from nata de coco. Most of nata de coco that sold in the market contains coconut water, but as time goes by some people create various innovations and alternatives that produce several kinds of nata de coco such as nata de coco which is made from tofu liquid waste, yam, aloe vera, tomato, cacao and others. This food product is made from food waste, namely rice washing water, pineapple skin juice and pineapple flesh juice which has been fermented with *Acetobacter xylinum* bacteria for 14 days. After a 14-day fermentation process, *Acetobacter xylinum* bacteria produce cellulose sheets, known as nata de pinari which has a bland taste, a solid yet chewy texture when bitten and a translucent white color like palm fruit. Nata de pinari has a slightly sour and refreshing aroma. The sour aroma in nata is caused by the activity of *Acetobacter xylinum* bacteria that converts the sugar content in the substrate during the fermentation process, which

produces by-products in the form of acetic acidic compounds (Natasya et al., 2022 ; Putri et al., 2021). Acetic acid is the primary metabolite resulting from the oxidation of alcohol by *Acetobacter xylinum* bacteria during the fermentation process, which triggers the emergence of the sour aroma in nata (Putriana in Natasya et al., 2022)

The main component of nata de pinari is cellulose, which makes this fermented product rich in fiber that is very beneficial for the human digestive system, also nata de pinari is a low-calorie food product that is suitable for consumption by individuals who are on a diet. Moreover, the benefits of consuming nata are believed to help stabilize cholesterol and high blood pressure because nata contains crude fiber as much as 2,5% and it is a very hydrating food because nata has a high water content up to 98% which can cure dehydration (Safitri et al., 2022).

The serving suggestion for Nata de pinari is it can be consumed directly or can be used as a mixture for desserts, such as Indonesian mixed ice or known as es teler. Moreover, nata de pinari can be used as a topping for drinks or packaged snacks, same as nata de coco that sold commercially which is used by many well-known beverage brands as well as large companies that produce products such as milk tea with nata topping, bottled drink with nata also fruit jelly in a cup with nata.

2.3 Process Review

2.3.1 Fermentation

Nata de pinari is a product resulting from the fermentation of rice washing water, pineapple skin extract and pineapple flesh extract. The fermentation process of nata de pinari occurs with the assistance of *Acetobacter xylinum* microbes. *Acetobacter xylinum* is a gram-negative bacterium that will grow and develop, producing a gelatinous membrane or pellicle identical to cellulose on the surface of the liquid culture and capable of synthesizing cellulose from glucose (Tri Nur Chasanah,

2021). The classification of *Acetobacter xylinum* bacteria falls under the genus *Acetobacter*, which exhibits characteristics such as obligate aerobicity, microaerophilic behavior, having a short rod shape (cocci) with approximately 2 microns in size, forming capsules, non-motile, arranging themselves in short chains of 6 to 8 cells, having a slimy surface on their cell walls, and cannot survive at temperatures of 65-70 degrees Celsius (Natasya et al., 2022; Salim in Natasya et al., 2022). The ideal growth of this cellulose-producing bacterium is ranges from 25^{o}C - 30^{o}C, and it can oxidize ethanol to acetic acid at a pH of 4.5 (Madigan et al. in Tri Nur Chasanah, 2021). There are 4 phases in microbial cellulose formation, namely the adaptation phase, stationary phase, exponential phase and death phase (Fadilah et al., 2021)

A source of minerals as well as nutrients including carbon (C), hydrogen (H), and nitrogen (N) is a requirement for bacteria to grow and develop (Tri Nur Chasanah, 2021). The sugar content found in the main ingredients of nata de pinari, namely rice water, pineapple peels, and pineapple fruit, serves as an energy source and carbon source for *Acetobacter xylinum* bacteria. These bacteria are responsible for forming metabolites, namely cellulose, to produce nata de pinari. Additionally, the mineral components in the nata de pinari substrate, such as phosphorus, potassium, calcium, magnesium, sulfur, iron, sodium, and zinc found in rice water, pineapple peels, and pineapple fruit, can enhance the activity of kinase enzymes in the metabolic processes of Acetobacter xylinum, aiding in cellulose production (Farida et al., 2021). The fermentation process of *Acetobacter xylinum* bacteria in the production of nata de pinari takes 14 days to produce thick cellulose with a smooth surface, chewy and soft texture.