A Review of the Potential of Beneng Taro as Material for Inulin Making and Its Application to Yogurt

Fitria Riany Eris[1,2(✉)], Dina Riziani[1], Vega Yoesepa Pamela[1,2], Muhammad Rizal Febriansah[1], Septariawulan Kusumasari[1,2], and Arni Komala Sari[1]

[1] Department of Food Technology, University of Sultan Ageng Tirtayasa, Serang, Indonesia
fitria.eris@untirta.ac.id

[2] Center of Excellence Local Food Innovation, University of Sultan Ageng Tirtayasa, Serang, Indonesia

Abstract. Inulin is a polymer of fructose units that are soluble in water and cannot be digested by enzymes but can be fermented by microflora in the colon. Inulin is commonly used as a food additive for synbiotic benefits. Inulin is generally produced from tubers or plant roots. Beneng taro is an indigenous tuber in Banten Province that contains 84.88% carbohydrates and 75.62% starch, so this taro has potential as an inulin source. Inulin can act as a bulking agent to improve the body, mouthfeel, texture, and taste of yogurt. Inulin has a functional quality that would make that yogurt can provide extra health benefits.

Keywords: inulin · beneng taro · yogurt · low caloric sweetener · bulking agent

1 Introduction

Inulin is a plant with high carbohydrate content which is a heterogeneous mixture of fructose polymers. One of the subgroups of inulin is oligofructose, where inulin and oligofructose cannot be digested in the digestive tract so they have low calorific value and can stimulate bifidobacteria growth in the intestine. The characterization of inulin is neutral, unscented and creates a mouthfeel in the mouth, creating stability and acceptability in low-fat foods. Inulin can usually be found in tubers or plant roots, such as gembili tubers, dahlia tubers, shallots, yam, chicory roots, and asparagus [1].

Beneng taro has the potential to be used as source for inulin making. Beneng taro has a starch content of 6.97% [2]. Beneng taro flour has a starch content of 56.29% [3]. Based on that, beneng taro can be used in the manufacture of inulin, besides that the use of taro beneng is to support the utilization of local food typical of Banten which can be increased in diversity. Inulin is commonly used in the food industry because it can be used as a substitute for sugar and fat or commonly referred to as a carbohydrate- based fat replacer in low-calorie foods [4].

Inulin is commonly added to foods and beverages as a prebiotic. Inulin is a water-soluble dietary fiber that can be fermented in the intestines and produces short-chain

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fatty acids. Inulin can act as a bulking agent to improve the body, mouthfeel, texture, and taste of yogurt. Inulin is able to increase the growth of *Bifidobacterium adolesentis, B. longum, Bifidobacterium breve, Bifidobacterium infantis, Lactobacillus plantarum, Lactobacillus delbruechii, Lactobacillus reuteri, Lactobacillus rhamnosus,* where these bacteria will ferment inulin into short chain fatty acids and decrease lactic acid, resulting in decreased colonic pH, and can inhibit the growth of *Escherischia coli* and *Clostridia* [5]. The addition of inulin to synbiotic yogurt can improve the organoleptic quality and the number of probiotic bacteria.

Inulin has not been mass-produced in Indonesia. Banten Province, especially the Pandeglang Regency, has a particular type of tuber which is currently very widely used, namely Beneng Taro. Some of research about making inulin from indigenous source already done. There are inulin from gembili [6], inulin from jombang [7], and inulin from jicama [8]. With high carbohydrate content, beneng taro has potential as a source for inulin making.

2 Inulin

Inulin is a natural polymer of carbohydrate groups. The monomer inulin is fructose whose amount in one polymer strand varies depending on the source. Between the fructose monomers in inulin are linked by bonds (2 → 1) - Dfructofuranosyl residues [9]. Each reducing end of the inulin polymer strand can contain glucose. Therefore, the inulin polymer can be written as GFn, which is a fructan with a glucose terminal end, or Fn, a fructan without a glucose terminal end. The symbol n in the formula is the degree of polymerization (DP) [10].

The DP of inulin depends on the origin of the inulin. Plant-derived inulin is a linear molecule with a DP varying from a few fructose units to about 70 [10]. The DP of inulin from chicory is between 2 and 60, with a mean DP of 12 [11]. This means that inulin is a mixture of oligomers and polymers. Inulin DP in Jerusalem artichoke tubers changed during storage after harvest. The DP fraction increased from 3–10, the DP > 10 fraction decreased after 4–6 weeks of storage of tubers of the Jerusalem artichoke (Helianthus tuberosus L) plant [12]. This symptom is caused by the presence of inulinase in Jerusalem artichoke tubers. This has also been proven in dahlia tubers [13] (Fig. 1).

Inulin is a white powder. Inulin is difficult to dissolve in cold water and organic solvents such as ethanol, on the other hand, inulin is easily soluble in hot water. Therefore, the principle of extracting inulin from natural ingredients is to utilize the solubility of inulin in water and ethanol. An important property of inulin to study is the solubility of inulin in water because this property is very important for the enzymatic hydrolysis of inulin [13].

The solubility of inulin in water depends on how the inulin is recrystallized. The solubility of inulin recrystallized with ethanol was greater than the solubility of inulin recrystallized with water. It looks very prominent starting at a temperature of 60 °C. At 60 °C, the solubility of inulin recrystallized with ethanol was 47.0 g/100 g, while the solubility of inulin recrystallized with water was 1.57 g/100 g (Phelps, 1965). Inulin solubility is also affected by inulin DP. Inulin with a DP range of less than 30 is more soluble in water and has a lower viscosity than inulin with a DP range of 2 to 60. In

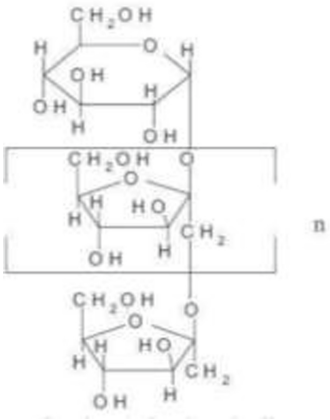

Fig. 1. Inulin Structure [Source: 10]

addition, inulin DP is also affected by heating. Water-free inulin can be degraded by heating at temperatures above 135 °C [12].

Inulin can be as an emulsifier, stabilizer, and texturizer at a concentration of 2–5% in meat-containing foods. Because of these properties, inulin is used as a stabilizer in low-fat foods. Inulin qualifies as a stabilizer because inulin is tasteless, well dispersed in water, and very well combined with low-fat foods such as skim milk. The addition of inulin to low-fat foods in addition to functioning as a stabilizer can also function as dietary fiber. Dietary fiber is a group of carbohydrates that cannot be hydrolyzed by the enzymes of the human body but is fermented by the intestinal microflora so that it affects intestinal function and blood lipid parameters. Inulin is a soluble dietary fiber that is rapidly fermented by *Bifidobacteria* and *Lactobacilllus*. Therefore, inulin is classified as a food ingredient that is classified as a prebiotic. Inulin provides the best prebiotic effect compared to other prebiotics [11].

The functional property of inulin is that it can increase calcium absorption and possibly magnesium absorption. Inulin is indigestible by human enzymes (as fibers). It can help lowering blood cholesterol and glucose levels. Inulin can also promote intestinal bacteria, which help regulate the activity of disease-causing bacteria. Fibers cannot be split by the enzymes of the upper digestive tract and pass through the intestine undigested, therefore they have no significant calorie value, increase bulk of fecal mass (undigestible material), insoluble fibers normalize intestinal transit time, and soluble fibers hold water to form a gel in GIT.

Some of research about making inulin from indigenous source already done. There are inulin from gembili [6], inulin from jombang [7], and inulin from jicama [8].Yield of inulin are 14%, 5%, and 12% respectively. Inulin from beneng taro has yield 12% if extracted with ethanol 30%.

3 Indonesian Local Tuber

Tubers are materials that come from the soil, such as cassava, sweet potatoes, potatoes, arrowroot, gadung, kimpul, taro, gembili, canna, and so on, which generally are a source of carbohydrates, especially starch [14]. Local tubers that are still not widely used, for example, are gembili (Dioscorea esculenta L.), gadung (Dioscorea hispida), coconut yam (Dioscorea alata), arrowroot (Maranta arundinacea L) and kimpul (Xanthosoma sagittifolium schott). Currently, gembili tubers are only used in the form of flour and starch as substitutes in various processed products such as cakes, instant noodles, crackers, and others. Garut is a tuber that has many benefits both as food and medicine. Arrowroot tubers can treat dysentery, as a remedy for eczema and can also help increase breast milk. The starch content in arrowroot tubers is more than 85% [15] and because of its ease of digestion, arrowroot starch is usually used as baby food and for sick people. Currently, the main yield of arrowroot tubers is arrowroot flour. Coconut yam has antidiabetic activity in alloxan-induced rats [16]. Because their utilization has not been maximized, these tubers can be developed more widely for the manufacture of products that are beneficial to health.

Apart from not being fully utilized, local tubers also have bioactive compounds that can be beneficial for health, including water-soluble polysaccharides, dietary fiber, and diosgenin. Gembili flour contains 5.05% soluble dietary fiber; 8.21% insoluble dietary fiber; 29.53% water-soluble polysaccharides; and 150.44 mg/100 g diosgenin. Gadung flour contains 1.55% water-soluble dietary fiber; 7.08% insoluble dietary fiber; 31.99% water-soluble polysaccharides and 28.80 mg/100 g diosgenin. Coconut yam flour contains 1.67% water-soluble dietary fiber; 10.18% insoluble dietary fiber; 3.27% water-soluble polysaccharide; 3.34% dioscin and 82.39 mg/100 g diosgenin. Arrowroot flour contains 1.12% water-soluble dietary fiber; 1.49% insoluble dietary fiber; 3.98% water-soluble polysaccharides and 2.16 mg/100g diosgenin. Kimpul flour contains 1.94% water-soluble dietary fiber; 4.97% insoluble dietary fiber; 4.33% water-soluble polysaccharides and 0.02 mg/100g diosgenin [17].

4 Beneng Taro

Beneng taro (Xanthosoma undipes K. Koch) is one of the local food sources typical of Banten and is often found in the Pandeglang Regency area around Mount Karang. Beneng taro is a potential source of local food, because of its easy and fast maintenance. Beneng taro grows wild and is not used as food, but because beneng taro has high potential and selling value, people have finally started to cultivate beneng taro and use it as a local food source indigenous of Banten. Beneng taro has the advantage of having a large tuber of about 832 g [3].

Beneng taro tubers are usually used by the local community in Juhut Village (Pandeglang, Banten) as an alternative food when there is a shortage of staple food. Beneng taro has many benefits, besides the tuber which can be used as an alternative food, the stalk of taro beneng can also be used as a vegetable [2]. The creation of processing beneng taro has now begun to develop, at first, it was only processed like steamed or fried. To increase the shelf life and high selling value as well as facilitate the processing

process, beneng taro is processed into semi-finished products (flour) which can then be created into many processed foods, such as chips, wet noodles, and local superior products for the food industry [3].

The protein content of beneng taro was higher than other types of taro, with a protein content of 8.53%. In beneng taro tubers there was a protein content of 8.77%; 6.97% starch content; ash content 8.53%; 0.46% fat and 84.65% water content. In addition, it is known that taro beneng contains quite high oxalate, the oxalate content in taro beneng is quite large, which is 60.56 ppm. Efforts to reduce the oxalate content in taro beneng can be done by soaking in 10% saltwater for 120 min, oxalic acid will be reduced by 51.5% [2].

5 Yogurt with Inulin

Yogurt is one of the processed foods resulting from milk fermentation with the help of c such as *Lactobacillus bulgaricus* and *Streptococcus thermophilus* or other lactic acid bacteria. Making yogurt consists of 4 stages, namely pasteurization, heating milk, adding lactic acid bacteria starter culture, the incubation (fermentation), and cooling. Heating functions to inactivate and eliminate pathogenic bacteria such as *Salmonella sp* and *Escherichia coli.* The heating process will affect the milk protein which will obtain uniform protein clumps and cause the process of releasing oxygen so that anaerobic conditions will be created during the fermentation process. The main principle in making yogurt is the occurrence of milk fermentation using yogurt bacteria. The bacteria commonly used in making yogurt are *Lactobacillus bulgaricus, Streptococcus thermophillus* and *Bifidobacterium* [18].

The main ingredients for making yogurt are fresh milk and skim milk. The more milk used, the higher the lactic acid formed so that the acidity increases. The addition of skim milk serves as a substitute for lactose and can improve the texture of yogurt. The protein content of skim milk is quite high. During the fermentation process, the protein will coagulate so that the yogurt will thicken. Generally, the addition of 10% skim milk will form good protein clumps, if 5–7% skim milk is added then the yogurt will be watery and vice versa if the addition of skim milk is too much (20%) then the protein clumps produced are dense and thick, broken [19]. Yogurt is rich in calcium, phosphorus, iodine, vitamins B2 and B12, it contains ascorbic acid, choline, retinol, vitamin e, vitamins B1, B3, B6, D, organic and fatty acids, and potassium in it as much as in bananas. Other minerals that are present in yogurt: magnesium, sodium, sulfur, iron, manganese, chromium, zinc, fluorine.

Yogurt is a fermented food product made from milk that uses a starter in the form of lactic acid bacteria (LAB). Yogurt has a sour and fresh taste resulting from the fermentation process of lactic acid bacteria. Yogurt is one of the functional drinks because it contains probiotics that are good for the health of the human digestive system [18]. Generally, the yogurt available in the market is probiotic yogurt. Probiotics are live microorganisms that will have a good effect on body health if consumed in sufficient quantities [20]. Improving the quality of yogurt can be done by adding prebiotics. This formulation is known as synbiotic yogurt. Synbiotic yogurt is a combination of probiotics and prebiotics. The addition of prebiotic sources serves as a substrate that helps

increase the growth and viability of one or more probiotic bacteria [10]. Making symbiotic yogurt can add inulin as a prebiotic. It is known that inulin cannot be digested by digestive enzymes, but is fermented by the colonic microflora in the large intestine, therefore inulin functions as a prebiotic [19].

The addition of inulin to synbiotic yogurt can improve the organoleptic quality and the number of probiotic bacteria. The higher the concentration of inulin, the thicker the yogurt will be. This is because prebiotics will be used by LAB in the fermentation process, causing a decrease in the pH of yogurt to an isoelectric pH (4–4.5). When the pH reaches an isoelectric pH, the solubility of the protein will decrease so that the protein will coagulate [21].

The addition of inulin and several nutritional components that are fermented by lactic acid bacteria will produce components that give yogurt a distinctive flavor such as lactic acid, carbonyl components, acetaldehyde, acetone, diacetyl, and other volatile substances. As the levels of inulin in yogurt increase, the total LAB is accompanied by an increase in lactic acid production, so that the aroma of the yogurt produced will be more acidic. The formation of a distinctive flavor of yogurt is due to the activity of the bacteria *Lactobacillus bulgaricus* and *Streptococcus thermophillus* where both types of bacteria can decompose lactose (milk sugar) into lactic acid and various components of aroma and taste [22]. Inulin can be acts as a fat substitute, sugar substitute (low-caloric sweetener), bulking agent, emulsifier, and thickener. In the manufacture of low-fat yoghurt, inulin is needed as a bulking agent to improve the body, mouthfeel, texture and taste of yogurt.

6 Conclusion

Inulin has not been mass-produced in Indonesia, to reduce import of inulin, research inulin making from indigenous tuber has been carried out. Beneng taro has high carbohydrate content, so this tuber has potential as source for inulin making. Inulin can be applied in foods for increase functional value. In the manufacture of low-fat yoghurt, inulin is needed as a bulking agent to improve the body, mouthfeel, texture, and taste of yogurt. Yoghurt synbiotic can be made with inulin beneng taro as prebiotic. Inulin from beneng taro has yield 12% if extracted with ethanol 30% and can improve Lactic Acid Bacteria (LAB) number in yogurt.

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