

Effect of modified yam (*Dioscorea esculenta*) flour on some physicochemical and sensory properties of synbiotic yoghurt

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Abstract. The aim of the study were to know characteristics of yam modified flour; to know the effect of modified yam flour on some physicochemical and sensory properties of synbiotic yoghurt and to determine the concentration level of modified yam flour to produce symbiotic yoghurt preferred by panelists. The reasearch was conducted using one factor complete randomized design. Modified yam flour was added to yoghurt at concentration of 2%, 4%, 6%. The effect of physical modification were investigated. Proximate analysis showed modified yam flour consist of 7.66% moisture content, 1.42% ash content, 10.16%, dietary fiber, 7.49% inulin, and 71.78% total starch content. Result obtained that modified yam flour has yield of 10.54%. the modified yam flour showed solubility and water absopsion of 77,63% and 136,65 respectively. The addition of modified yam flour on yoghurt resulted significantly difference effect on texture, but did not have significantly difference on colour, flavour and aroma. Modified yam flour added yoghurt thickness because it was gelatinized when added to yoghurt at 40°C. Sensory analysis conducted with hedonic test showed synbiotic yoghurt added with 2% of modified yam flour most preferred by panellists. Synbiotic yoghurt with 2% of modified yam flour has pH number of 4,8 and total acid tirated of 1,7%.

1. Introduction

Currently yogurt promoted massively through various media as functional beverages, to promote healthy digestion. Yoghurt consumption has increased among consumers especially women since they believed that yoghurt could help them to maintain body slimness, improve skin beauty and prevent premature aging [1]. Increasing in yoghurt consumption is expected to continue along with the increasing of public awareness on functional food importance. Functional food not only fulfill the body basic needs of nutrients but also give benefit health effect. According to [2] Indonesia was one of the world's largest yoghurt consumers. Yoghurt is present in Indonesia in a variety of brand by offering a variety of health-related advantages. One of them is the latest variant of synbiotic yoghurt.

Synbiotic yoghurt contains probiotic bacteria and prebiotic component [3]. Probiotics and prebiotics may provide synergistic benefits to health to provide the balance of microflora in the digestive system. Prebiotics can stimulate the growth of good bacteria in the digestive tract as well as during the process of milk fermentation [4]. Thus, the presence of probiotics and prebiotics in the form yoghurt synbiotic can inhibit the growth of microbial pathogens and maintain the balance of intestinal micro flora. They improve absorption of minerals, prevent incidence of diarrhea, and optimize the assimilation of nutrients [5]. Prebiotic component can be obtained from several sources of agricultural products, one of them was inulin contained in yam (*Dioscorea esculenta*) tuber. Inulin from yam tubers can maintain the growth of



probiotic bacteria. Inulin prebiotic activity was affected by incubation time, where the longer incubation can enhance the value of yam tuber inulin prebiotic activity. Therefore, inulin from yam tuber can be used as a prebiotic source and added to food products [6].

Addition of yam flour in yoghurt were expected to provide a prebiotic effect because of its inulin content [7]. Yam flour can not be added directly to yoghurt since yoghurt has low pH and using heat in its processing. Thus, yam flour required modification so it would produce desired yoghurt characteristics. In addition, modification yam flour can increase the levels of resistant starch in the flour [8]. Resistant starch is resistant maltodextrin belonging to the oligosaccharides that can be fermented in the intestine often referred to as dietary fiber. In other words starch modification can increase fiber content of food. Dietary fiber needed by the body as a prebiotic. Therefore, research is needed on the addition of yam flour modified in yoghurt products. The aim of this study was to determine characteristics of modified yam flour, determine effect of modified yam flour addition on some physicochemical and sensory properties of synbiotic yoghurt and determine the concentration level of yam flour modified to produce symbiotic yoghurt most preferred by panelists.

2. Materials and Methods

Yam (*Dioscorea esculenta*) tubers were obtained from farmers, whole milk, yoghurt cultures consist of *Lactobacillus bulgaricus*, *Streptococcus thermophilus* and *Lactobacillus acidophilus*. Yam flour was modified physically according to [9]. Proximate value were determined including moisture content, ash, dietary fiber and inulin.

The research was conducted by several stages: (1) Making of modified yam flour; (2) Analysis of characteristics of modified yam flour; (3) producing synbiotic yoghurt with modified yam flour addition; (4) Analysis of physicochemical and sensory properties of symbiotic yoghurt.

The research method was using complete randomized experimental design. The treatment factor was concentration of modified yam flour with three concentration levels namely 2%, 4%, 6%. Each treatment was repeated 2 times to minimize experimental error. The analysis was performed using Analysis of variance (ANOVA). The effect of modified yam flour addition to yoghurt characteristic were investigated. Analysis were carried out on chemical characteristics included pH and total acid titrated. Sensory analysis conducted using hedonic test for texture, colour, aroma and flavour. The flowchart of diagram of modified yam flour processing can be seen in Figure 1.

Manufacture of synbiotic yoghurt with the addition of yam flour modified, consists of several stages, i.e. the main raw material preparation of fresh whole milk and then pasteurized at a temperature of 65 C for 15 minutes. Then, yam flour modified is added to the various treatments which is 2%, 4% and 6% then stirred until homogeneous. Subsequently cooled to a temperature of 40 C for inoculation with the starter yogurt as much as 3% consisting of *Lactobacillus bulgaricus*, *Streptococcus thermophilus* and *Lactobacillus acidophyllus* as probiotic bacteria. Anaerobic incubation yoghurt conducted at a temperature of 37C for 12 hours. Here is a diagram of processingsynbiotic yoghurt with the addition of yam flour modified (figure 2).

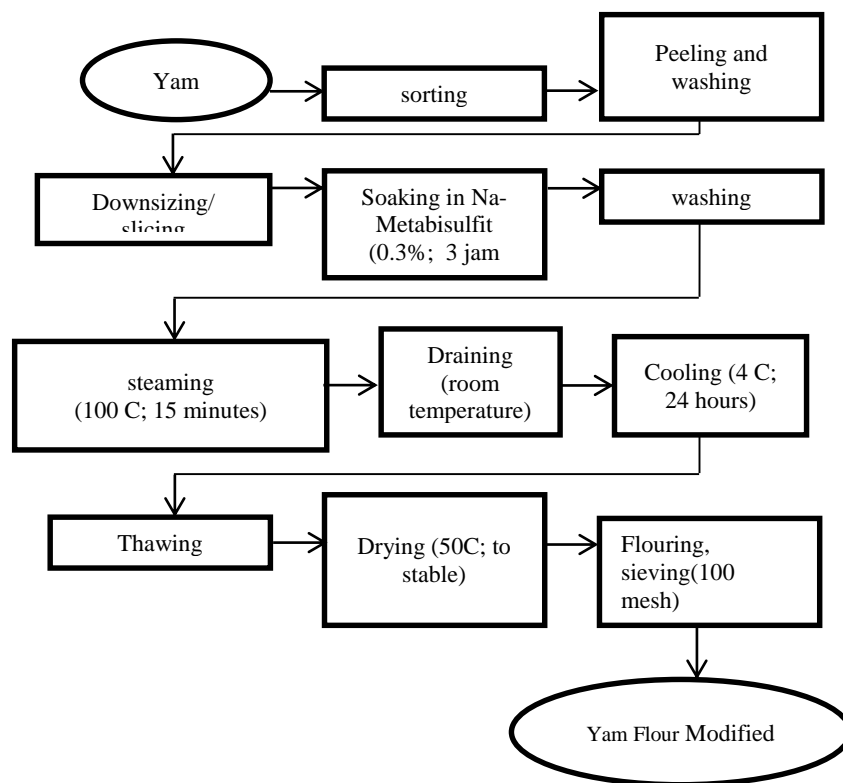


Figure 1. Diagram processing of yam flour modified

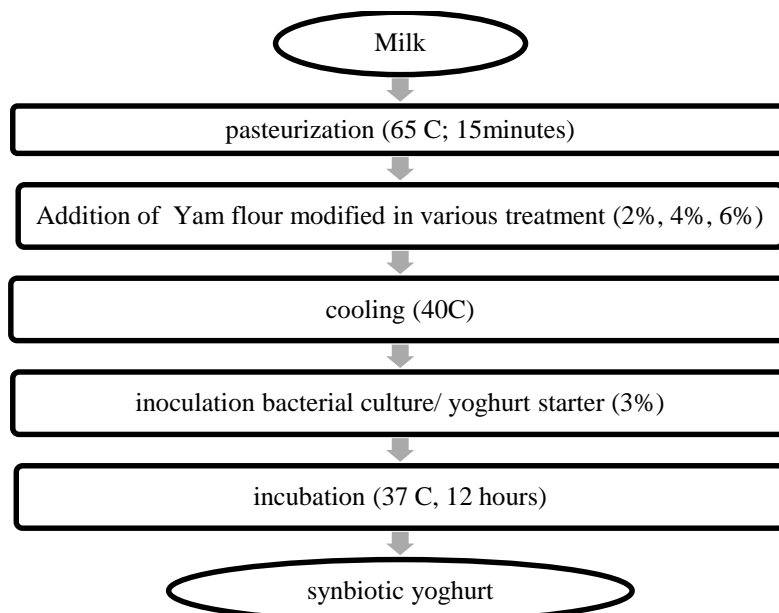


Figure 2. Diagram processing of synbiotic yoghurt with addition of yam flour modified

3. Results and Discussion

3.1. The Characteristics of Modified Yam Flour

Modification of starch and flour can be chemically or physically modified. In this research, flou modification using physical treatment which was steaming. Research conducted by [8] shows the process of pre-cooking (combined heating and cooling) can increase the levels of resistant starch in bananas. Yam has white tuber flesh color so that it produce white color flour. Shortly after peeled, yam tubers were immersed in 0.3% sodium meta-bisulfite solution. The maximum limit use of sulfites in dried foods by the FDA (food drug administration) is 2000-3000 ppm. Immersing is intended to prevent browning reactions that may occur during the process of peeling and drying. Yam flour modification produced a white, powdery substance with a degree of fineness of 100 mesh, has a normal aroma and taste. Sensory characteristics of yam flour is influenced by raw material used (yam tuber) and various treatments during the flour making.

The yield of yam starch modification obtained in this study is 10.54%. Yield is the percentage of flour weight compared to yam tubers intact, meaning that 100 grams of yam tubers can be obtained 10.54 grams of yam flour modified. Physicochemical characteristics of modified yam flour are presented in Table 1.

Table 1. Characteristics of yam flour modified

Characteristics	Yam (<i>Dioscorea esculenta</i>) flour modified
Yield	10.54 %
Solubility	77.63 %
Water absorption	136.66 %
Swelling power	618.87 %
Moisture	7.66 %
Ash content	1.42 %
Total starch content	71.78 %
Total dietary fiber content	10.16 %
Inulin Content	7.49 %

Water absorption test was conducted to determine how much flour to absorb water which would affect the treatment process when the flour applied to food processing. Physical modification yam flour has a high water absorption 136.66%. This value is influenced by heat treatment in the process of making physical modifications flour. Yam starch in the flour has undergone gelatinization, so it is no longer in amylose starch granules; it diffuses out with amylopectin. Amylose which is no longer in granules, it will be easier to form hydrogen bonds and more easily absorb water.

Swelling power value characterizes the strength of the flour to inflate derived from the ratio of the weight of sediment pasta starch (supernatant) with a dry weight of wheat flour to form a paste. Yam flour modified has swelling power high value i.e. 618.87 %. This happens because of heat treatment which causes the starch in the flour gelatinization previous experience or a so-called pre-cooked so that the flour has a greater force expands.

Solubility is the ability of the material to dissolve in water. This solubility is a trait that is quite important for the usefulness of starch in food processing. Yam flour modified has high solubility values 77.63%. This is possible because the starch in the flour so that the experience gelatinization constituent molecules such as amylose and amylopectin starch diffuses out of the starch granules, the solubility will increase.

Yam flour modified obtained in this study is a dry material that has moisture content 7.66% so including foodstuffs non-perishable and this value meets the standards of quality flour in general which, according to the Indonesian National Standard (SNI) the maximum moisture content of flour about 14%. Yam flour modified has ash content 1.42%. Ash content indicates mineral content in a food [10]. Mineral

contained in a food can be in the form of salts of organic and inorganic salts. According [11] all commercial starch derived from cereals and tubers contain small amounts of inorganic salts can be derived from the material itself or from the water during treatment.

Starch contained in yam flour modified based on this research is 71.78%, This shows that the starch content owned still high enough that can be utilized in further food processing applications. As well as total dietary fiber content in the yam flour modified is quite high at 10.16 % derived from the formation of resistant starch as a result of heating-cooling treatment when modifications yam flour. This makes the value of yam flour physical modifications can be categorized as a source of dietary fiber because the food can be claimed as a source of dietary fiber if it contains dietary fiber of 3-6 g / 100 g[12]. In addition, high fiber food in the yam flour modified can be used as a prebiotic. This is similar to the one proposed by [13] that ingredient food can not be digested will provide beneficial effects for the body because it supports the activities of microflora of the digestive tract, so it can provide healthful effects on the body.

Yam flour modified in this study had higher inulin content at 7.49% where the value is in line with the statement Winarti, et al [14] regarding the content of inulin contained in tubers group *Discorea* spp. which ranged from 2.8 to 14.7%. Inulin is not digested by the human digestive enzymes, which can stimulate the growth of good bacteria in the large intestine (*Lactobacillus* sp and *Bifidobacterium* sp). Inulin is fermented by microflora present in the colon making is prebiotic inulin.

3.2. Characteristics of synbiotic yoghurt with yam flour modified addition

3.2.1. pH of synbiotic yoghurt

World nutrition standards of yoghurt containing a maximum pH of 4.5. The low pH of yoghurt is caused by activity of lactic acid bacteria are *L.bulgaricus* and *S.thermophilus*. *Streptococcus thermophilus* had first role in yoghurt fermentation to decrease pH to about 5.0 and then *Lactobacillus bulgaricus* decrease again until it reaches a pH of 4.0. In this study, the pH of yoghurt sinbiotik with the addition of yam flour modified ranged from 4,38 to 4,56.

Table 2. pH of synbiotic yoghurt with the addition of yam flour modified	
Concentration level yam flour modified	pH synbiotic yoghurt
Without added yam flour modified	4.68
Added yam flour modified 2 %	4.48
Added yam flour modified 4 %	4.38
Added yam flour modified 6 %	4.56

Based on these data (table 2), it can be seen that the addition of yam flour modified 4% as a source of prebiotic effect on a decrease in pH 4.38. Whereas when the addition of flour to 6% an increase in the pH to 4.56. As revealed in previous studies conducted [15] by using tubers of arrowroot, more concentration of flour is added, lower the pH value. Yam flour modified addition 4% to 3% starter alleged to provide optimum results for microbes to ferment for a comparison of flour and yoghurt working culture that is not too different. Inulin and oligosaccharides as nutrients more bacteria present in the flour will be faster to lower pH than starch which is only slightly contains inulin and oligosaccharides [15].

3.2.2. Lactic acid levels of synbiotic yoghurt

Lactic acid is the result of bacterial activity *L.bulgaricus* and *S.thermophilus* that breaks lactose during yoghurt fermentation so that both bacteria called lactic acid bacteria. The content of lactic acid in yogurt is one indicator of the quality of yoghurt. Yogurt lactic acid levels that meet the quality standards according to national standards of Indonesia [16] ranged between 0.5% - 2% (w / w). Yogurt lactic acid

levels according to international standards (codex) fermented milk product that is at least 0.6% (w / w) and a minimum of 0.9% (w / w) according to the USDA.

Table 3. Lactic acid levels of synbiotic yoghurt with the addition of yam flour modified

Concentration level yam flour modified	Lactic acid levels of synbiotic yoghurt
Without added yam flour modified	1.2 %
Added yam flour modified 2 %	1.7 %
Added yam flour modified 4 %	2.02%
Added yam flour modified 6 %	1.59%

In this study, sinbiotik yogurt contains lactic acid that meet the standards (table 3), whether ISO, the international standards (Codex) and the USDA. Lactic acid levels are highest are owned by yoghurt sinbiotik yam flour modified with the addition of as much as 4%. The lactic acid produced from the fermentation of milk into yoghurt will lower the pH value of the growth environment and cause a sour taste [17]. Aside from the influence of the number of microorganisms, the yoghurt sinbiotik also influenced by the composition of prebiotics in the flour.

3.2.3. Sensory properties of Synbiotic Yoghurt: color attributes

The color of yoghurt is influenced by raw materials and components that are added also during the fermentation process. At sinbiotik yogurt, milk as a raw material has a yellowish white color. Milk white color on the effect of the spread of colloidal droplets of fat, calcium caseinate (a colloidal dispersion opaque) while the yellowish color influenced the content of carotenoids and riboflavin [18]. Yam flour modified added in the manufacture of yoghurt sinbiotik has a white color so resulting white yoghurt. The results showed (table 4) that the differences in the addition of yam flour modified did not show significant color differences according to panelists at the organoleptic assessment.

Table 4. Color attributes of synbiotic yoghurt with the addition of yam flour modified

Concentration level yam flour modified	Color attribute scores of synbiotic yoghurt
Without added yam flour modified	2.30 ^a
Added yam flour modified 2 %	2.35 ^a
Added yam flour modified 4 %	2.05 ^a
Added yam flour modified 6 %	1.75 ^a

Description: treatment that is characterized by the same small letter are not significantly different at 5%

3.2.4. Sensory properties of Synbiotic Yoghurt: Aroma attributes

Yoghurt has a distinctive aroma that is affected by bacterial activity *L.bulgaricus* and *S.thermophilus* during the fermentation process. Starter cultures bacteria that is used is the main responsible in the formation of flavor compounds in the aroma of yoghurt [19]. In addition, the aroma of the yoghurt is also influenced by the other components are added.

Table 5. Aroma attributes of synbiotic yoghurt with the addition of yam flour modified

Concentration level yam flour modified	Aroma attribute scores of synbiotic yoghurt
Without added yam flour modified	2.25 ^a
Added yam flour modified 2 %	2.90 ^a
Added yam flour modified 4 %	2.35 ^a
Added yam flour modified 6 %	2.65 ^a

Description: treatment that is characterized by the same small letter are not significantly different at 5%

The results showed (table 5) the addition of yam flour modified at various concentration levels contributed to the increase panelist evaluation to yoghurt aroma. It is suspected that the addition of yam flour modified become prebiotic source for the bacteria that make the bacteria more active and produce more flavor compounds in yogurt.

3.2.5. Sensory properties of Synbiotic Yoghurt: Flavour attributes

Yoghurt has a distinctive flavor that is product of lactic acid bacteria fermentation. *L. bulgaricus* had bigger role in the formation of aroma, whereas *S. thermophilus* had bigger role in the formation of yoghurt flavor. Results of both bacteria fermentation which produces the characteristic flavor of yogurt is lactic acid, acetaldehyde, acetic acid and diacetyl. A sense of sensory attributes that determine the final decision of consumers to accept or reject a food product [20].

Flavor is a combination of the overall perception of the sense of smell, feelings and visions play an important role in determining consumer food as desired [21]. The results showed that yogurt without addition yam flour modified has the highest score in the organoleptic evaluation by panelists. However, with the addition of yogurt synbiotik yam flour modified is acceptable panelists with scores did not differ much, and did not differ significantly based on analysis of variance (table 6).

Table 6. Flavour attributes of synbiotic yoghurt with the addition of yam flour modified

Concentration level yam flour modified	Flavor attribute scores of synbiotic yoghurt
Without added yam flour modified	3.20 ^a
Added yam flour modified 2 %	2.70 ^a
Added yam flour modified 4 %	2.70 ^a
Added yam flour modified 6 %	2.75 ^a

Description: treatment that is characterized by the same small letter are not significantly different at 5%

3.2.6. Sensory properties of Synbiotic Yoghurt: Texture attributes

Yogurt texture is different with milk as raw material. Yoghurt has a somewhat viscous texture with a viscosity greater than milk. According to the Indonesian National Standard (SNI yoghurt) the consistency of yogurt is viscous/semi-solid. Creamy texture of yogurt that is influenced by both the fermentation of lactic acid bacteria. During fermentation, the bacteria *L. bulgaricus* and *S. thermophilus* produce acids that lower the pH, so that coagulates milk proteins and make the consistency of yogurt thickens.

In this study, yoghurt synbiotik with yam flour modified addition have significant effect on the texture of yogurt organoleptic test (table 7). The addition of yam flour modified as much as 6% have the highest score, which means that most panelists liked the yogurt synbiotik with the addition of yam flour modified.

Table 7. Texture attributes of synbiotic yoghurt with the addition of yam flour modified

Concentration level yam flour modified	Texture attribute scores of synbiotic yoghurt
Without added yam flour modified	2.80 ^b
Added yam flour modified 2 %	1.70 ^a
Added yam flour modified 4 %	3.35 ^c
Added yam flour modified 6 %	3.75 ^d

Description: treatment that is characterized by the same small letter are not significantly different at 5%

The texture and taste of yoghurt is influenced by the concentration of prebiotics. The higher concentration of addition flour to yogurt will be more viscous [15]. Yam also contains starch that is high enough that when heated in water to give a viscous texture through gelatinization process. Gelatinization of starch is starch granule swelling of the starch granules due to the increase in volume

that occur in water at temperatures between 55°C to 65°C. If the starch granules are heated in water, the thermal energy will cause hydrogen bonding is interrupted, and water into the starch granule. Water entering subsequently form hydrogen bonds with amylose and amylopectin. Water seep into granules cause swelling of the starch granules. Granule size will increase to a certain extent before the starch granules burst [22]. Rupture granules cause parts of amylose and amylopectin diffuse out. The process of entry of water into the starch granules swell and eventually cause rupture called gelatinization. It is why the higher the concentration the addition of arrowroot, yoghurt more viscous texture and taste will be more acidic [15].

4. Conclusion

The results showed that yam (*Dioscorea esculenta*) flour modified characteristics are follows 7.66% moisture content, ash content of 1.42%, total dietary fiber content of 10.16%, 7.49% inulin content, total starch content of 71.78%, solubility is 77.63%, water absorption 136.65%, 618.86% swelling power, and yield of 10.54%. The addition of yam flour modified in produce synbiotic yoghurt provide a significantly different effect on hedonic quality test (texture), but does not give a significantly different effect on the color, flavour and aroma. Based on the analysis of hedonic quality, synbiotic yoghurt with the addition of yam flour modified 2% is the most preferred characteristics of panelists from the aspect of color, aroma, flavor, texture. It has a pH value of 4.48, lactic acid levels is 1.7%.

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