Physicochemical Properties of Modified Walur Starch Flour (*Amorphopallus campanullatus*) from Autoclaving-cooling Process

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Abstract. Walur had high starch content and was potentially used as an alternative food ingredient. Walur starch was not heat resistant, making it difficult to be used in the food industry which requires high temperatures during processing. These limitations could be overcome by a modification process so that starch utilization is more optimal. Starch modified by autoclaving-cooling has the advantage of increasing the stability of starch paste, resistant starch, and reducing starch digestibility. The aim of the research was to determine the effect of heating time and number of autoclaving-cooling cycles on the physicochemical characteristics of modified walur starch. This research used a completely randomized design (CRD) with a factorial pattern with 2 factors, namely factor I heating time (10; 20; and 30 minutes) and factor II number of autoclaving-cooling cycles (1; 2; and 3 cycles). The data was analyzed by Analysis of Variance (ANAVA) and further test using the DMRT test. The research results showed that the best treatment was heating time of 20 minutes and 3 autoclaving-cooling cycles which produced modified walur starch with yield value of 77.65%, starch digestibility 24.86%, resistant starch 4.22%, swelling power 11.82 g/g, solubility 8.44%, gelatinization temperature 75.33^{o}C, and gelatinization time 7.10.

Keywords: Autoclaving-cooling, Modified, Walur.

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1. Introduction

Walur is an Araceae tuber which has not been explored and considered as a nuisance plant [1]. However, walur has a high carbohydrate content and has the potential to be used as an alternative food. Natural starch has heat-resistant properties making it difficult to use in the food industry which requires high temperatures during processing [2]. These limitations can be overcome by the modification process so that the utilization of starch is more optimal. Modified starch is starch that is treated physically or chemically to change one or more physical or chemical properties. Modified starch with autoclaving-cooling has the advantage of being able to increase the stability of starch pasta, resistant starch, and reduce starch digestibility. Modification of starch by the autoclaving-cooling method causes amylose and amylopectin to reconnect with each other to form dense and stable structure by hydrogen bonds so that starch has heat resistance and changes its physico-chemical characteristics [3].

Walur starch tends not to be resistant to heat, making it difficult to use in the food industry which requires high temperatures during the processing of food products. Modifications are carried out to improve the profile of natural starch, both physicochemical and functional properties, so that the use of starch becomes more specific, for example by the autoclaving-cooling process.

The effects produced by the autoclaving-cooling starch modification technique include reducing starch digestibility and increasing levels of type III resistant starch [4], limiting swelling and reducing solubility, reducing gelatinization temperature and time, and reducing viscosity so that it can be used for instant food substitution [2]. The manufacture of modified walur flour is expected to facilitate its use in the food industry.

The flour modification process is carried out to improve the characteristics of the resulting flour. Modified flour also produces better flour properties than ordinary flour. In addition, the modification improves the physicochemical properties of flour so that it can be applied to substitute wheat flour [5].

Based on the facts above, it is necessary to carry out an assessment of the utilization of quality, competitive and high added value walur tubers so that they can be used as food ingredients. The objective of the research was to study the effect of heating time and number of autoclaving-cooling cycles on the physicochemical characteristics of modified walur starch flour.

2. Materials and Methods

The materials used were walur tubers obtained from farmers in Jember. This research used a completely randomized design (CRD) with a factorial pattern with 2 factors, namely factor I heating time (10; 20; and 30 minutes) and factor II number of autoclaving-cooling cycles (1; 2; and 3 cycles). The data was analyzed by Analysis of Variance (ANOVA) and further test using the DMRT test.

2.1 Modified Walur Starch Flour Production

Walur tuber was peeling, washing and soaking (using HCl 0,2 N for 30 min and followed by Sodium bicarbonate 1% for 5 min), and washing using tap water. Walur then crushed (using water 1:3), and shivered with filter cloth separate fiber, the process was repeated 3 times, the starch solution then precipitating and the starch deposit was drying (80ºC, 5 h) and grinding.
To make modified walur starch, the natural starch was dissolved with water (1:3) in beaker glass and boiling (80ºC, 20 min) and starch suspension was heating by autoclave (121ºC for 10, 20, or 30 min) and cooling using refrigerator (4ºC, 24 h) and repeated 1,2,3 times. The starch suspension then drying (80ºC, 5 h) and grinding before analyzing.

3. Result and discussion

Tabel 1. Chemical composition of natural walur flour

Chemical composition	Natural walur starch
Moisture (%)	8.63 ± 0.021
Starch content (%)	75.84 ± 0.14
Amylose content (%)	23.01 ± 0.04
Starch Digestibility (%)	60.21 ± 0.28
Resistant Starch content (%)	1.69 ± 0.02
Swelling power (g/g)	17.07 ± 0.11
Solubility (%)	12.71 ± 0.07
Gelatinization temperature (ºC)	82.33 ± 0.58
Gelatinization time (min)	8.08 ± 0.04

It was found that walur flour has a total starch of 75.84% with the amylose content of walur flour is 23.01%. Another component of the natural walur tuber is resistant starch content 1.69% and starch digestibility 60.21%. Swelling capacity and solubility of walur starch were 17.07 g/g and 12.71%, respectively. Initial gelatinization temperature and time of walur starch were 82.33°C and 8.08 min.

3.1 Physical Characteristics of Modified Walur Flour (MWF)

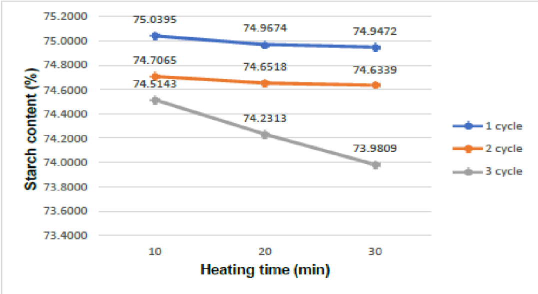

Fig 1. Starch content of MWF

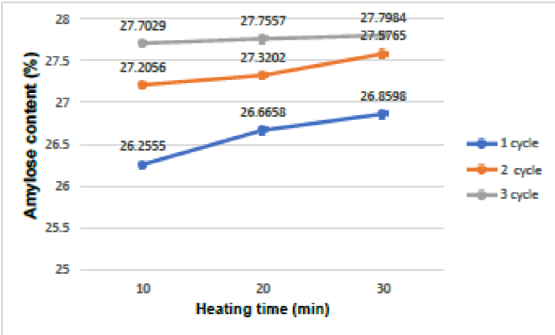

Fig 2. Amylose content of MWF

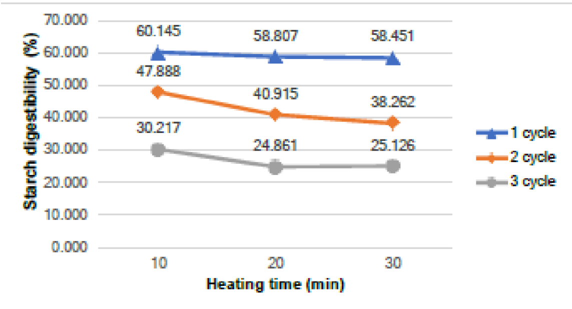

Fig 3. Starch digestibility of MWF

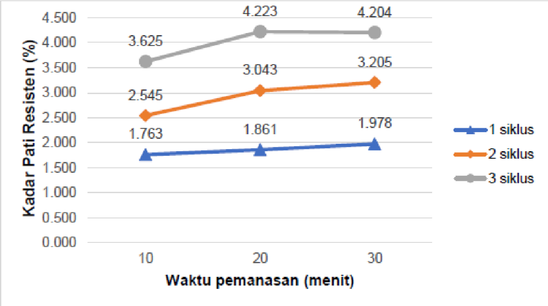

Fig 4. Resistant starch content of MWF

The results showed that the more cycles of autoclaving-cooling and the longer heating time, starch content reduces but the resistant starch content increases. The starch content reduces because it experienced texture changing because of the autoclaving-cooling process into resistant starch, namely gelatinization and retrogradation process. Those processes modify the properties of starch, so it can not be digested by human, and it has effect as dietary fiber. From the figure 1-4 shows that the more autoclaving-cooling cycles, the more amylose content of the starch. Because this process can break the branch chain of amylopectin into a straight chain, and it increases amylose and resistant starch content, furthermore it will lower starch digestibility.

According to Mandei [6], high amylose content is something that is expected in making dry noodles because it has a stronger binding force so that cooking loss is low. High levels of amylose cause the formation of more and more crystallized amylose fractions which are formed through hydrogen bonds to form double helix structure which, when combined with other double helix structures, will form crystallite structure which is heat stable, very complex and resistant to the amylase enzyme. According to Yuliwardi et al. [7], the formation of the recrystallized amylose fraction causes starch resistance to increase because it is difficult for digestive enzymes to digest, resulting in low starch digestibility. The higher the amylose content, the more RS3 is formed so that the digestible starch composition decreases.

Starch that has low digestibility is defined as resistant starch. Starch that is difficult to digest will take longer to be absorbed by the body so that metabolism will be slower. So the lower the digestibility of starch, the lower the ability of starch to be converted into glucose, so the lower the ability of starch to increase blood glucose. So starch which has low digestibility can be applied as a source of prebiotics and functional food ingredients for diabetes sufferers so that it takes longer to be absorbed by the body. According to Setiarto et al. [8], starch digestibility analysis is one of the parameters used to determine the effect of starch modification treatment, because starch digestibility can correlate with the levels of resistant starch produced. The lower starch digestibility occurs due to the higher resistant starch content in food.

3.2 Physical Characteristics of Modified Walur Flour (MWF)

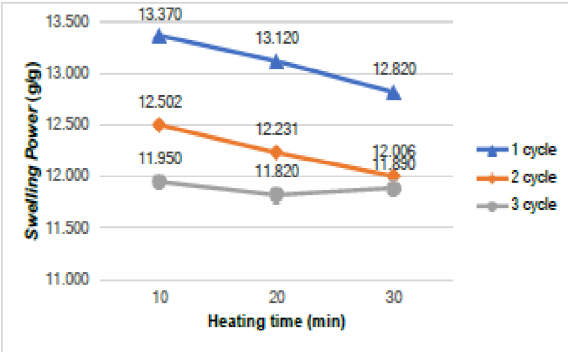

Fig 5. Swelling power of MWF

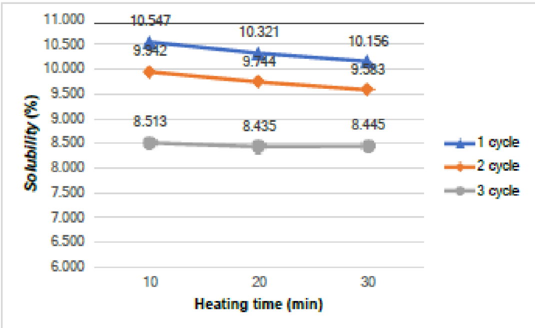

Fig 6. Solubility of MWF

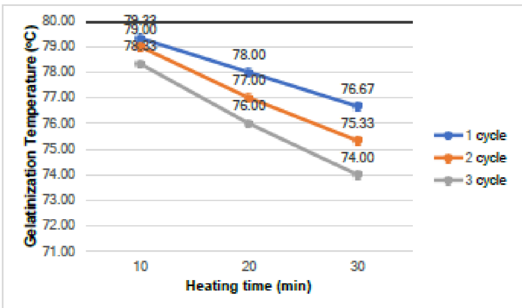

Fig 7. Gelatinization temperature of MWF

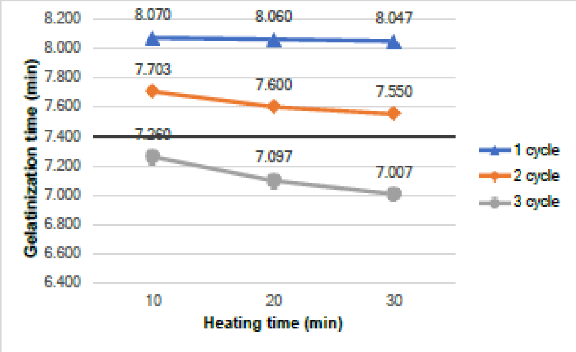

Fig 8. Gelatinization time of MWF

Figure 5-8 showed that there was a decline in swelling power, solubility, gelatinization temperature and gelatinization time of modified walur flour along with increasing autoclaving-cooling cycles and heating time. This is due to an increase in amylose content and resistant starch. Amylose has a rigid structure and it makes it difficult to swell and dissolve.

The smaller the swelling power value, the lower the expansion ability and volume. A large volume with a small amount of mass will provide little energy and nutritional intake, so it is more effective if it has a low swelling power value so that the swelling ability is also reduced and nutrition is also sufficient. A low solubility value indicates that the ability to dissolve in water is also low. This is in accordance with Santosa et al. [9] that materials that have low swelling power and solubility values will also have low swelling power and solubility in water, low swelling power values will increase the consumption mass of the material so that nutrition is met, while low solubility values will cause it to be digested longer, thus providing an effect. full longer.

The greater the number of autoclaving-cooling cycles, the gelatinization temperature and time of modified wheat starch decrease. This is because the increasing number of autoclaving-cooling cycles causes a decrease in viscosity because the formation of a complex between amylose or amylopectin with hydrogen bonds can reduce the swelling capacity so that the viscosity decreases and this causes the time taken to reach the gelatinization temperature to be faster. According to Amin [10], the less viscous the solution, the faster it will reach this temperature. The decrease in gelatinization time also occurred in Asbar [11], the gelatinization time for modified mocaf with 3 cycles was 3.07 minutes, lower than the gelatinization time for natural mocaf, which was 5.8 minutes.

According to Rahman et al [12], a decrease in gelatinization time shows that the starch gelatinization process is shorter, which will reduce costs, while a low gelatinization temperature shortens the processing process. This characteristic of starch paste is desired by industry because processing time can be reduced and the process can take place at lower temperatures, thereby reducing production costs.

4. Conclusion

It can be concluded that the best treatment was heating time of 20 minutes and 3 autoclaving-cooling cycles which produced modified walur starch with yield value of 77.65%, starch digestibility 24.86%, resistant starch 4.22%, swelling power 11.82 g/g, solubility 8.44%, gelatinization temperature 75.33ºC, and gelatinization time 7.10 minutes.

Disclosure of Interests. There is no conflict of interest between the authors

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