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CHEMICAL COMPOSITION OF MODIFIED COCOYAM FLOUR WITH SPONTANEOUS FERMENTATION AND AUTOCLAVING-COOLING CYCLES TO IMPROVED RESISTANT STARCH CONTENT

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ABSTRACT

This research was intended to identify chemical composition of cocoyam flour modified with spontaneous fermentation and autoclaving-cooling cycle in order to increase resistant starch content as functional food source. Increase of usage of modified cocoyam flour as product raw material and food ingredient is expected to improve physical characteristic and chemical characteristic of product resulted as well as to improve its potential as functional food source useful for health. The research did modification of caladium powder consisting of two factors. The first factor spontaneous fermentation method (without spontaneous fermentation F0; and with spontaneous fermentation, F1). The second factor is autoclaving-cooling cycle method consisting of three levels without autoclaving-cooling cycle (T0), one autoclaving-cooling cycle (T1) and two autoclaving-cooling cycles (T2). All treatments were repeated three times so there were 18 experiment units. Parameter observed in this research include water content, yield, amylase content, starch content and resistant starch. The best result of the research was spontaneous fermentation with following characteristic: yield 20.33%, water content 9.3%, starch content 75.16%, amylose content 25.95% and resistant starch content 13.89% and then was two autoclaving-cooling cycles with following characteristic: yield 18.48%, water content 8.87%, starch content 73.54%, amylose content 26.20% and resistant starch content 13.81%.

Keywords : *Cocoyam, flour modification, spontaneous fermentation, autoclaving-cooling, resistant starch*

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INTRODUCTION

Cocoyam (*Xanthosoma sagittifolium*) or known with local name as *keladi* is one of Balinese local tuber variants. Cocoyam is easy to grow in agricultural regions in Bali. Potential of cocoyam has not been used optimally to meet food needs or processed to be cocoyam based-product. Cocoyam tuber is only processed with steaming, boiling or frying with few variances as crispy chips. As a carbohydrate source, cocoyam may be used as industrial raw material in form of powder, starch, and starch hydrolysate and starch-based product.

Increase in people awareness toward foods and health have causes increase in demand for food. People do not only assess food from sensory component, but also consider effect of the food on health or functional food. Prebiotic is one of functional foods currently developed. One of candidate for prebiotic is resistant starch (RS). RS is all starch types and starch degraded product that cannot be absorbed in digestive tract, so RS is classified as fiber source [9]. Type III RS is physically modified starch that is a retrograded starch produced through food processing having advantages compared with other RS types that is very stable in heating.

Physical modification method with autoclaving-cooling method can improve physical, chemical and functional characteristic of cassava starch variety [7] and on banana powder [8]. According to [3]., physical modification with autoclaving-cooling method can increase dietary fiber, resistance starch level on arrowroot starch and banana starch [10] and rice starch [12]. Cocoyam starch modified with two-cycle autoclaving-cooling resulted in the best characteristic that can improve native cocoyam resistant starch from 1.25% to 4.38% [11]. [9] reported that banana powder modified with spontaneous fermentation and two-cycle autoclaving-cooling can increase resistant starch level to 42.68% compared with native banana powder (only 10.32%) [8]. Therefore, RS level of powder is assumed improvable when the chips was firstly fermented before autoclaving.

This research was intended to identify chemical composition of cocoyam powder modified physically with spontaneous fermentation and autoclaving-cooling method in order to increase resistant starch as functional food source. In addition, powder application in food product is easier than that with starch. Increase of usage of modified cocyam powder as product raw material or food ingredient is expected to improve physical and chemical characteristic of product resulted and to increase its potential as functional food source useful for health.

RESEARCH METHODS

Material and Equipment

Main material used in this research was cocoyam obtained directly from plantation in Daup Bangli village, while chemical used were distilled water, NaCl, NaOH, H2SO4, HCl, Nelson solution, arsenomolybdate solution, BaSO4, pure amylose, acetate acid, phosphate buffer, α-amylase, glucoamylase, pure glucose, GOD, potassium sodium tartrate, buffer solution Na-phosphate, PP indicator, ethanol, NH4OH, CaCl2, KMnO4, iod solution.

Equipments used in this research were aluminum foil, label paper, filter cloth, knife, scrap, bucket, washbasin, baking pan, plastic container, HDPE plastic, tissue paper, small brush, spraying bottle, drop pipette, filer paper, mortar, oven, refrigerator, autoclave, 80 mesh sieve, meter glass, balance, analytic balance, mechanical or manual stirring, dyer cabinet, exicator, blender, Erlenmeyer, measure flask, petri dish, centrifuge, mechanic slicer, waterbath.

Research execution

This research was conducted in two steps. The first step is spontaneous fermentation on cocoyam tuber chips, while the second one is modification of cocayam starch with autoclaving-cooling method.

Spontaneous fermentation treatment

Cocoyam was peeled and sliced with ±3 mm thickness, then soaked within distilled water (1:2) and fermented for 24 hours at room temperature. The 24-hour fermented cocoyam was leaked through and given with pressure with autoclave.

Autoclaving-cooling treatment

The second step in this research was cocoyam starch with autoclaving-cooling. Cocoyam from step one was packed in HDPE plastic and stored in refrigerator at 4oC for 12 hours in order water distributed evenly on cocoyam. Then, autoclaving treatment using autoclave was done at 121oC for 15 minutes. Cocoyam was cooled directly at room temperature for one hour to prevent further gelatinization. Then, cocoyam was retrograded with cooling at 4oC for 24 hours. For 2-cycle autoclaving-cooling heating process with autoclave and cooling at 4oC was repeated once. Then, it was dried at 50oC for 15 hours. Dry cocoyam was grind and sieved using 80-mesh sieve. Then, the powder was packed and its physicochemical and functional characteristic was analyzed. Modification of cocoyam powder with autoclaving-cooling method is presented in Figure 1.

Research design

This research used completely randomized design with factorial pattern in which cocoyam starch was modified with spontaneous fermentation and autoclaving-cooling cycle.

First factor of spontaneous fermentation consist of 2 levels

F0: without spontaneous fermentation

F1: with spontaneous fermentation

The second factors was autoclaving-cooling cycle consisting of 3 levels

T0: without cycle

T1: 1 cycle

T2: 2 cycle

The two factors resulted in 6 treatment combinations. All treatments were repeated twice so there were 18 experimental units. Data obtained was analyzed with analysis of variance and if there is effect of treatment on observed parameter, it would be followed with Duncan test

Observation parameters

Parameters observed in modification include yield, water content, [1]., amylose content [1], starch content [1]. and resistant starch [4].

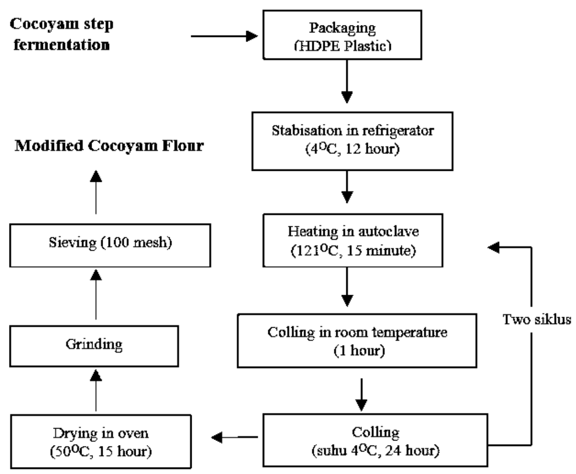

Fig.1.The diagram of starch modification by Autoclaving-cooling method [6], [8].

RESULT AND DISCUSSION

Yield

Analysis of observation result native cocoyam powder and modified cocoyam powder was presented in Table 1. Based on analysis of variance indicated that autoclaving-cooling cycle treatment has effect on yield, while fermentation treatment and interaction of both treatments did not affect yield of modified cocoyam powder.

Table 1 reveals that the highest average yield was obtained on without autoclaving-cooling cycle (T0) of 23.09%. The lowest yield was obtained on two cycle autoclaving-cooling (T2) of 18.48%. Decrease in yield on cocoyam powder modified with two-cycle was caused by repeated autoclaving with high temperature resulting in water in foodstuff evaporated.

Table 1. Yield of Modified Cocoyam Flour (%)

Fermentation	Cycle T0	Cycle T1	Cycle T2	Average
F0	23.33	21.83	19.21	21.46 a
F1	22.85	20.38	17.75	20.33 a
Average	23.09 a	21.10 b	18.48 c	

Note: Values in the same column and line followed by the same letter is not significant statistically based on conviction level at 95%. F0: without spontaneous fermentationn; F1: with spontaneous fermentation; T0: without cycle; T1:1 cycle; T2: 2 cycle

Water content

Result of analysis on water content of native cocoyam powder and modified cocoyam powder is presented in table 2. Analysis of variance indicated that fermentation treatment affect water content, while autoclaving-cooling cycle treatment and interaction of two treatments did not affect water content of modified cocoyam powder.

Table 2. Water Content of Modified Cocoyam Flour (%)

Fermentation	Cycle T0	Cycle T1	Cycle T2	Average
F0	8.35	8.45	8.37	8.39 b
F1	9.10	9.42	9.38	9.30 a
Average	8.72 a	8.94 a	8.87 a	

Note: Values in the same column and line followed by the same letter is not significant statistically based on conviction level at 95%. F0: without spontaneous fermentationn; F1: with spontaneous fermentation; T0: without cycle; T1:1 cycle; T2: 2 cycle

Table 2 shows that the highest water content was obtained from fermentation treatment (F1) (9.30%). The lowest water content was obtained on treatment of without fermentation (8.39%). Increase in water content of cocoyam powder modified with spontaneous fermentation was due to spontaneous fermentation followed with soaking cocoyam tuber into water for 24 hours so water will enter and penetrated into tuber granule that will increase water content. Increase in water content on cocoyam powder modified with fermentation also occurred on research on modified banana powder, where water content of banana powder without fermentation was 6.32% and increase to 8.51% after spontaneous fermentation for 24 hours [8].

Starch Content

Result of observation on starch content of native cocoyam powder and modified cocoyam powder was presented in table 3. Based on analysis of variance, autoclaving-cooling cycle treatment has effect on starch content, while fermentation treatment and interaction of both treatments did not affect starch content of modified cocoyam powder.

Table 3. Strach Content of Modified Cocoyam Flour (%)

Fermentation	Cycle T0	Cycle T1	Cycle T2	Average
F0	77.66	75.95	73.81	75.81 a
F1	77.50	74.72	73.26	75.16 a
Average	77.58 a	75.34 a	73.54 b	

Note: Values in the same column and line followed by the same letter is not significant statistically based on conviction level at 95%. F0: without spontaneous fermentationn; F1: with spontaneous fermentation; T0: without cycle; T1:1 cycle; T2: 2 cycle

Table 3 shows that highest average starch content(77.58%) was obtained from treatment of without autoclaving-cooling cycle (T0) that was not significantly different from treatment of one cycle autoclaving-cooling (T1) (75.34%). The lowest starch content was obtained from two-cycle autoclaving-cooling (T2) of 73.54%.

Spontaneous fermentation on cocoyam powder for 24 hours did not affect starch content of cocoyam powder, but cocoyam powder modified with two-cycle autoclaving-cooling cause decrease in starch content. Treatment with autoclaving cause starch broken and gelatinized, in which amylose will move out from starch granule that will under go retrogradation in cooling process.

Research by [8] indicate decrease in starch content of native banana powderfrom 70.16% to 67.40% on banana powder modified with two cycle autoclaving-cooling. Pyrodextrin component of carbohydrate will be formed due to high temperature during heating and ovening [2].

Amylose Content

Result of observation on amylose content of native cocoyam powder and modified cocoyam powder is presented in table 4. Analysis of variance indicated that treatment of autoclaving-cooling cycle and fermentation had effect on amylose content, while interaction of two treatments did not affect amylose content of modified cocoyam powder.

Table 4 shows that the highest average amylose content was obtained from treatment of fermentation (F1) and two cycle autoclaving-cooling (T2) (25.95% and 26.20%, respectively). The lowest amylose content was obtained from treatment of without fermentation (F0) (23.88%) and without cycle autoclaving-cooling (T0) and not significantly different with one cycle autoclaving-cooling (T1) (23.91% and 24.64%, respectively).

Increase in amylose content on powder modification with spontaneous fermentation and with autoclaving-cooling cycle occur due to at fermentation there is debranching that result in straight chain oligomer such as amylose. Retrogradation will occur on amylose given with heating treatment followed with cooling. When heating-cooling was done repeatedly it will increase amylose content [8]. Increase in RS content is due to role of retrograded amylose [10]. Increase of amylose also agrees to research by [3] on arrowroot starch where amylose increased from 24.64% to 28.12%.

Table 4. Amylose Content of Modified Cocoyam Flour (%)

Fermentation	**Cycle**			**Average**
	T0	**T1**	**T2**	
F0	22.53	23.50	25.63	23.88 b
F1	25.29	25.78	26.78	25.95 a
Average	23.91 b	24.64 b	26.20 a	

Note: Values in the same column and line followed by the same letter is not significant statistically based on conviction level at 95%. F0: without spontaneous fermentationn; F1: with spontaneous fermentation; T0: without cycle; T1:1 cycle; T2: 2 cycle

Resistant starch

Result of analysis on resistant starch of native cocoyam powder and cocoyam powder modified is presented in table 5. Analysis of variance indicated that autoclaving-cooling cycle treatment and fermentation treatment had significanteffect on resistant starch while interaction of both treatments did not have effect on resistant starch content of modified cocoyam powder.

Table 5. Resistant Starch of Modified Cocoyam Flour (%)

Fermentation	Cycle T0	Cycle T1	Cycle T2	Average
F0	8.83	11.29	12.01	10.71 b
F1	11.94	14.12	15.62	13.89 a
Average	10.39 c	12.71 b	13.81 a	

Note: Values in the same column and line followed by the same letter is not significant statistically based on conviction level at 95%. F0: without spontaneous fermentationn; F1: with spontaneous fermentation; T0: without cycle; T1:1 cycle; T2: 2 cycle

Table 5 above shows that the highest average resistant starch was obtained from treatment of fermentation (F1) and treatment of two cycle autoclaving-cooling (T2) (13.89% and 13.81%, respectively. The lowest resistant starch content was obtained from treatment of non fermentation (F0) (10.71%) and treatment of non autoclaving-cooling (T0) (10.39%).

Two-cycle autoclaving-cooling resulted in higher resistant starch content of cocoyam powder than one cycleand fermented cocoyam. Meanwhile, resistant starch content of control cocoyam powder was 8.83%. Retrogradation process will result in resistant starch that is type III resistant starch (RS3) that is result of retrograded amylose [9]. It agrees to data of amylose content of cocoyam powder that increase due to spontaneous fermentation or due to two cycle autoclaving-cooling where retrograded amylose play important role in forming resistant starch as candidate of prebiotic that will increase its function as functional food. Modification at powder level is easier and may be applied directly on processed foods product as substituting powder and as functional food source

CONCLUSION

1. Spontaneous fermentation treatment on modified cocoyam powder has effect on water content, amylose content and resistant starch but has no effect on yield and starch content
2. Autoclaving-cooling treatment on modified cocoyam powder has effect on yield, starch content, amylose content and resistant starch, but not on water content
3. There is no interaction between spontaneous fermentation treatment with autoclaving-cooling cycle on yield, water content, starch content, amylose content and resistant starch
4. The best result of the research was spontaneous fermentation treatment with following characteristic yield 20.33%, water content 9.30, starch content 75.16%, amylose content 25.95% and resistant starch content 13.89%. in addition two cycle autoclaving-cooling resulted in following characteristic: yield 18.48%, water content 8.87%, starch content 73.54%, amylose content 26.20% and resistant starch 13.81%.

REFERENCES

AOAC. 1995. Official Methods of Analysis of AOAC International. Sixteenth Edition, 5th Revision, 1999. Vol. 2. USA : AOAC Inc.

Carrera, E.C., Cruz, A.C., Guerrero, L.C.danAncona, D.B. (2007). Effect of pyrodextrinization on available starch content of Lima bean (Phaseoluslunatus) and Cowpea (Vignaunguiculata) starches. Food Hydrocolloids 21: 472-479

Faridah DN, Rahayu WP, Apriyadi MS. 2013. Modifikasi Pati Garut dengan Perlakuan Hidrolisis Asam dan Siklus Pemanasan-Pendinginan untuk Menghasilkn Pti Resisten Tipe 3

Giacometti DC dan Leon J. 1994. Tannia, Yautia (Xanthosoma sagittifolium),p 253-258. In J.E. Hernando Bermejo and J. Leon (eds), Neglected Crops: 1492 from Different Perspective. FAO, Rome.

Jenie BSL, Widowati S, dan Nurjanah, S. 2009. Pengembangan Produk Tepung Pisangdengan IGRendah dan Sifat Prebiotik sebagai Bahan PanganFungsional Laporan Akhir Hibah Kompetitif Penelitian Sesuai Prioritas Nasional Batch II. Lembaga Penelitian dan Pengabdian kepada Masyarakat, Institut Pertanian Bogor, Bogor.

Lehman U, jacabasch G, Schmiedi D. 2003. Characterization of Resistant Starch Type III from Banana (Musa acuminate). J of Agricultural and Food Chemistry 50: 5236-5240

Nazrah, Julianti E, Masniary L. 2014. Pengaruh Proses Modifikasi Fisik terhadap Karakteristik Pati dan Produksi Pati Resisten dari Empat Varietas Ubi Kayu (Manihot esculenta). J Rekayasa Pertanian dan Pert. 2(2): 1-9.

Nurhayati, Lkasmi BS, Widowati S dan Kusumaninggrum HD. 2014. Komposisi Kimia dan Kristalinitas Tepung Pisang termodifikasi secara FermentasiSpontan dan Siklus Autoclving-cooling. J Agritech 34(2): 146-150.

Okoniewska M, Witwer RS. 2007. Natural resistant starch : an overview of health properties a useful replacement for flour, resistant starch may also boost insulin sensitivity and satiety. Nutritional Outlook.

Soto dkk. 2004. Resistant Starch Made from Banana Starch by Autoclaving and Debranching. J Starch 56: 495-499.

Wiadnyani AAIS, Peramna IDGM, Widarta IWR. 2015. Ekstraksi dan Modifikasi Pati keladi dengan Pemanasan-Pendinginan (Autoclaving-Cooling) dalam Upaya Meningkatkan Nilai Tambah Umbi-umbian Lokal. Laporan Penelitian HUPS Unversitas Udayana. Tidak dipublikasikan

Yuliwardi F, Syamsira E, Hariyadi P Widowati S. 2014. Pengaruh Sikliu Autoclaving-Cooling terhadap Kadar Pati Resisten Tepung Beras dan Bihun yang Dihasilkan. Artikel Pangan 23(1): 43-52.