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FUNCTIONAL PROPERTIES OF MODIFIED STARCH OF ARROWROOT, CASSAVA, AND KIMPUL STARCH BY AUTOCLAVING-FREEZE-DRYING AND CHEMICAL TREATMENTS

Betty Sri Laksmi Jenie[1)*)], Siti Nurjanah[1)], Antung Sima Firlieyanti[1)] and CC Nurwitri[1)]

[1)]Department of Food Science and Technology, Bogor Agricultural University, Indonesia

[*)]email address: betty_jenie@yahoo.com

Abstract

Studies on the functional properties of resistant starch (RS) receive much attention in recent years due to its promising beneficial effect for health known as prebiotic. Many local varieties of tubers contain high amylose and amylopectin which have the potential to be modified as resistant starch (RS). Many methods to modify the starch properties as RS have been developed. In this study starches of three varieties of tubers i.e. arrowroot (*Marantha arundinacea* L), cassava (*Manihot esculenta* Crantz), and kimpul (*Xahnthosoma violaceum* Schott) were modified to obtain two types of RS type III and IV. RS type III were prepared by autoclaving the starches at 121°C for 30 min and then freeze-dried, while RS IV were prepared using cross-linking method by addition of $POCl_3$. After physical and chemical treatments, modified starches were analyzed for RS type III and IV contents, amylose content, digestibility, and dietary fiber. Either physical or chemical treatments could significantly increase RS contents in all modified tuber starches. The formation of RS type III was higher than RS type IV ranging from 6.52 to 8.67%, and 4.3 to 5.2%, respectively. The highest content of RS type III (8.67%) was found in modified kimpul starch followed by arrowroot (6.65%) and cassava (6.52%). Digestibility of all modified tuber starch either containing RS III or RS IV were relatively low (15.96% - 29.31%), excluding cassava starch RS III (53.78%). No significant difference of amylose contents between native and modified starches were found which ranging from 26.54% to 31.76%. Prebiotic activity potential were also determined based on the viability of *Lactobacillus casei* subsp. rhamnosus, *Lactobacillus plantarum* sa28k, and *Bifidobacterium bifidum* in medium MRSB-minus glucose containing modified starch. All modified starches either containing RS type III or IV could be utilized by the three tested bacteria with the production of SCFA (short chain fatty acids) i.e. acetic acid, whilst formic, butyrate and propionate acids were not detected. Dietary fiber contents of all modified starches containing RS type IV were relatively high (7.5 – 8.7 g/100 g starch). Generally, the modified tuber starches resulted in this study produced higher RS and dietary fiber contents but low digestibility that will support the prebiotic properties.

Keywords: resistant starch, arrowroot, cassava, kimpul, prebiotic

Introduction

Indonesia is very rich in natural resources including tubers such as cassava (*Manihot esculenta* Crantz), arrowroot (*Marantha arundinacea* L) and kimpul

(*Xahnthosoma violaceum* Schott). Native RS content in tubers are usually low, but their high starch content make them possible to be modified either by physical or chemical treatments to form resistant starch (RS). Euresta (*European Flair Concerted Action on Resistant Starch*) defines RS as starch and degraded starch products that does not absorb by the intestinal of healthy individual (Euresta, 1992). There are four types of resistant starch i.e. type I, II, III and IV. RS type I is native starch that entrapped within food cell wall and can not be digested by the intestinal enzyme. RS type II is starch granules that naturally resistant to intestinal enzymes, RS type III are retrograded starches formed during physical (heating-cooling), while RS type IV are formed by chemical treatment (Sajilata *et al.*, 2006).

RS can be utilized as prebiotic which selectively stimulate the probiotic growth and reduce the concentration of pathogens. RS can be fermented by probiotic in the colon and produced SCFA (Shamai *et al.*, 2003). Either RS III or IV has the potential to serve as prebiotic (Topping *et al.*, 2001). RS also has other advantages, including does not cause constipation, reduces cholesterol and blood glucose level. The objectives of this study were to modify tuber starches of cassava, arrowroot and kimpul to improve their functional properties by producing RS III and IV as prebiotics.

Materials and Methods

Materials

Cassava and kimpul were purchased from Bogor traditional market, and arrowroot was obtained from Research Center of Biotechnology and Genetics, Bogor. Lactic acid bacteria cultures are probiotic candidates (*Lactobacillus casei* subsp. rhamnosus (FNCC) and *Bifidobacterium bifidum (FNCC)* and *Lactobacillus plantarum BSL-sa28k* (Food Microbiology Laboratory, Bogor Agricultural University).

Extraction and Modification of tuber starch (Lehmann, 2002; Haynes et al., 2000)

Cassava, arrowroot and kimpul were peeled, sliced, washed, crushed, and extracted with water. RS III were prepared by suspending tuber starch in water (20% w/w), autoclaved for 30 min at 121°C, cooled and stored at 4°C for 24 h, and then freeze-dried. RS IV were prepared by dissolving 100 g of starch in 150 ml aquadest, adjusting the pH to 10.5. $POCl_3$ (0.2%) was added into starch solution, incubated on *environmental orbital shaker* (T = 40°C, 200 rpm, for 2 h), adjusted the pH to 5.5 and then vacuum filtered. The starch residue was washed five times with aquadest followed by drying in oven vacuum (50°C, for 24 h), and then ground and sieved (100 mesh).

Prebiotic activity (in vitro)

Probiotics were grown in MRSB at 37°C for 48 h. Specifically for *Bifidobacterium bifidum* incubation was performed in *anaerobic jar*. Media (50 ml) were prepared i.e. (A) steriled water + 2.5% RS, (B) MRSB without glucose (mMRSB), and (C) mMRSB + 2.5% RS. Each media was inoculated with 2.5 ml of one day old suspension of the three strains, respectively and then incubated at 37°C for 24 h in similar conditions as stated above. After incubation, the viability of the three strains were enumerated (pour plate method).

Results and Discussion

Autoclaving all tuber starches at 121°C followed by freeze-drying, and crosslinking by $POCl_3$ significantly generate the RS III and IV, respectively, except for cassava RS IV (Table). Physical treatments resulted in higher resistant starch content than chemical treatments. Modified kimpul starch resulted in the highest increase of RS III contents (6.89%) as well as RS IV (3.37%), followed by modified arrowroot starch for RS III (4.58%) and RS IV (2.57%).

Modification of tuber starches resulted in low digestibility i.e. 19.57% (arrowroot), 21.25% (cassava), and 29.31% (kimpul), except for RS III of cassava starch (53.78%). All modified starches either containing RS III or RS IV could be utilized by the three tested bacteria with the highest number (8 log CFU/ml) shown by *L. plantarum* BSL-sa28k and produced acetic acid. The highest dietary fiber contents (8.7 g/100 g) of RS IV were found in cassava starch.

Table. Chemical and biochemical analysis of modified tuber starches

No	Modified starch	RS (%)	Amylose (%)	Diges-tibility (%)	Dietary fiber (g/100 g)	SCFA (% w/v)			
						Formic acid	Acetic acid	Propionic acid	Butyric acid
1	**Kimpul**								
	Native	1.78	30.86	-	-	-	-	-	-
	RS III	8.67	31.76	15.96	-	-	-	-	-
	RS IV	5.15	31.44	29.31	7.53	n.d	0.04	n.d	n.d
2	**Arrowroot**								
	Native starch	1.85	30.27	-	-	-	-	-	-
	RS III	6.65	30.32	26.95	-	-	-	-	-
	RS IV	4.42	26.82	19.57	8.11	n.d	0.04	n.d	n.d
3	**Cassava**								
	Native starch	4.33	27.32	-	-	-	-	-	-
	RS III	6.52	26.54	53.78	-	-	-	-	-
	RS IV	4.28	29.42	21.20	8.72	n.d	0.04	n.d	n.d

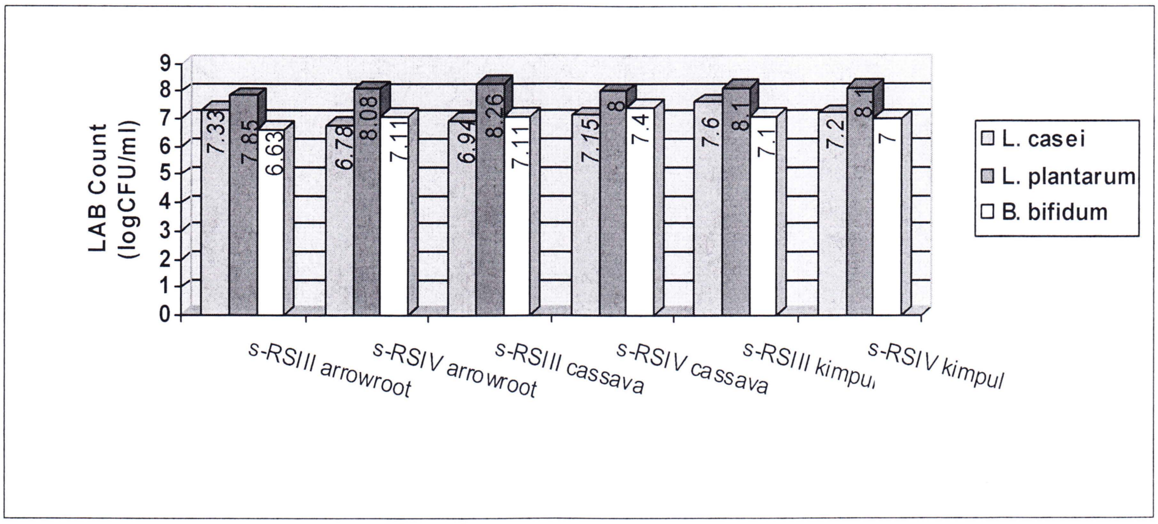

Figure 1. Viability of tested bacteria in RS media

Conclusion

Kimpul was a potential source for resistant starch mainly with autoclaving followed by freeze-drying process. The RS III formed in the modified starches were higher than RS IV. All modified tuber starches had promising functional properties as prebiotic due to their support on the growth of probiotics and had relatively low digestibility. Prebiotic properties of the tubers RS need to be confirmed further by using pure RS-digestible starch free.

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References

EURESTA (European Flair Action Concerted on Resistant Starch). Newsletter III. (1992). Department of Human Nutrition. Wageningen Agricultural University

Haynes LN, JP Gimmler, JP Locke, Mae-Ra-Kweon, L Slade, and H Levine. 2000. Process for Making Enzyme-Resistant Starch for Reduced-Calorie Flour Replacer. US Patent 6,013,299. Jan 11, 2000. Wilmington, Del: Nabisco Technology Co.

Lehmann U, G Jacobasch and D Schmiedl. 2002. Characterization of Resistant Starch Type III from Banana (*Musa Acuminata*). *Journal of Agricultural and Food Chemistry*.

Sajilata M, G Rekha, S Singhai and PR Kulkarni. 2006. Resistant Starch-A Review. Comprehensive Reviews in *Food Science and Food Safety*. Vol 5, 2006.

Shamai K, HB Peled and E Shimoni. 2003. Polymorphism of Resistant Starch Type III. Carbohydrate Polymers. www.elsevier.com/locate/carpbpol.[6 Juni 2006]

Topping DL and PM Clifton. 2001. Short-chain fatty acids and human colonic function: roles of resistant starch and nonstarch polysaccharides. *Physiological Reviews*, Vol. 81 No.3, pp.1031-64.