

7.9. Production of Maltodextrin from Cocoyams (*Xanthosoma Sagittifolium*) Starch Using α -Amylase Enzyme

by Dedin Finatsiyatull Rosida

Submission date: 05-Jan-2021 11:25AM (UTC+0700)

Submission ID: 1483165852

File name: 7.9._Production_of_Maltodextrin_from_Cocoyams.pdf (1.22M)

Word count: 3856

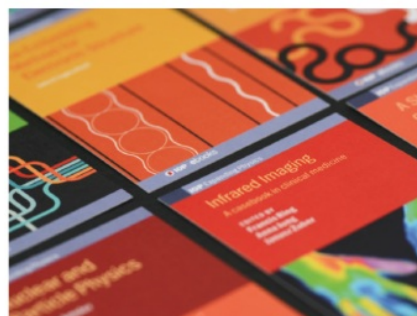
Character count: 20141

PAPER • OPEN ACCESS

Production of Maltodextrin from Cocoyams (*Xanthosoma Sagittifolium*) Starch Using A-Amylase Enzyme

6
To cite this article: D F Rosida *et al* 2020 *J. Phys.: Conf. Ser.* **1569** 042052

View the [article online](#) for updates and enhancements.



IOP ebooks™

Bringing together innovative digital publishing with leading authors from the global scientific community.

Start exploring the collection—download the first chapter of every title for free.

Production of Maltodextrin from Cocoyams (*Xanthosoma Sagittifolium*) Starch Using α -Amylase Enzyme

D F Rosida^{1*)}, S Djajati¹ and F S Susanti, ¹

⁴
¹)Department of Food Technology, Faculty of Engineering
Universitas Pembangunan Nasional Veteran Jawa Timur, Surabaya 60294, Indonesia
Email: *) dedin.tp@upnjatim.ac.id; *)rosy.upnsby@gmail.com

Abstract. Indonesia has many food crops that can be optimally developed. The developing of cocoyams tuber can be done to improve the economic value. The production of maltodextrin by modifying starch using the α -amylase enzyme. Maltodextrin is used in the food industry as a substitute for food, thickener, and fillers. So far, many starch-modified products was resulted from cassava tubers. The starch of cocoyams (*Xanthosoma sagittifolium* (L.) Schott) can be developed as maltodextrin. The cocoyams starch content 50.82% and amylose 18.18%. The aim of study was to produce maltodextrin from cocoyams tuber. In this study using the α -amylase enzyme by treating the volume of the α -amylase and incubation time to hydrolyze the cocoyams starch. This study used a completely randomized design with two factors. The first factor was volume of the α -amylase (0.10 mL, 0.12 mL and 0.14 mL) and the second factor was the incubation time (60, 90, and 120 minute). The best treatment were volume of α -amylase 0.14 ml and incubation time of 120 minutes. The best maltodextrin characteristic of cocoyams was moisture of 4.51%, DE 14.46, solubility 78.90%, reducing sugar 12.50%, starch 4.24%, amylose content 1.95%, swelling power 8.86 (g/g) and yield 96.85%.

Keywords: cocoyams, starch, modification, maltodextrin, α -amylase

Introduction

Cocoyams (*Xanthosoma sagittifolium*) is included in the type of taro plants. The largest component found in cocoyams is carbohydrates. Cocoyams flour contains starch of 50.82% [1] and amylose 20-25% [2]. The amylose content of starches from the six different tuber sources was investigated. *X. sagittifolium* had the highest amylose content ($26.2 \pm 0.34\%$), followed by *I. batatas*, *A. xanthorrhiza*, *C. esculenta* [3], while both, white and purple *D. trifida*, were almost amylose-free (1.44 ± 0.34 and 3.19 ± 0.34 , respectively), being reported as a new promising waxy yam starch [4]. The another tuber, taro (*Colocasia esculenta*) is a tropical tuber crop largely produced for its underground corms contain 70-80% starch [5].

Natural starches such as tapioca, corn starch, sago and other starches have several obstacles if used as raw materials in industries. The starch modification is needed so that starch has characteristics as needed by the food processing industry. Some methods that can be used to modify starch include hydrolysis enzymatically, oxidation, acid modification, and cross modification. Most enzymes work specifically, which means that each type of enzyme can only work on one type of compound or chemical reaction. This is due to differences in the chemical structure of each enzyme that is permanent. Each modification can produce modified starch with different properties, for example maltodextrin which is one of the derivative products of starch produced from an enzymatic modification process by an α -amylase enzyme which has a value of Dextrose Equivalent (DE) of less than 20 [6].

Various ways of starch hydrolysis have been developed including acid hydrolysis, enzyme hydrolysis, and acid and enzyme combinations. In enzymatic hydrolysis, starch bonds are cut according to the type of enzyme used. The mechanism of action of the α -amylase enzyme consists of two stages. The first stage of degradation of amylose to maltose and maltotriosa which occurs randomly. This degradation occurs very quickly and is followed by a decrease in viscosity quickly. The second stage is the formation of glucose and maltose as the final result and not random. Both the workings of the α -amylase enzyme in the amylose molecule. The amylopectin molecule lase will produce glucose, maltose and one series α -limit dextrin, and oligosaccharides consisting of four or more glucose containing α -1,6-glycosidic bonds [7]. Enzymatic modification of starch produces high starch concentrations, specific enzyme reactions to reduce amylose chains in starch, and guaranteed food safety. In addition, the

modified starch produced has the ability to be starch which is thermoreversible [8]. The products of enzymatic starch hydrolysis have characteristics that are not grosscopic, increase product viscosity, have adhesion, and are water soluble such as lactose. Amylase is an enzyme that catalyzes the hydrolysis of alpha-1,4-glycosidic polysaccharides to produce dextrin, oligosaccharides, maltose and D-glucose. The main function of the amylase enzyme is to break down starch in food so that they can be used by the body. Maltodextrin is defined as a partial starch hydrolysis product made by the addition of acids or enzymes, which contain α -D-glucose units which are mostly bound via glycosidic (1.4) bonds [9]. The production of Maltodextrin from Sago Flour Using the α -Amylase Enzyme found that the more enzyme addition, the higher DE maltodextrin value [10]. The higher the DE value of 20.63 in the addition of 0.14 ml enzyme. Furthermore, the temperature for making maltodextrin is 80 °C [11].

Methodology

A. Materials

The materials used in the research were cocoyam tuber, α -amylase enzyme, CaCl₂, aquadest, NaOH, HCL, anhydrous glucose, fehling A, fehling B

B. Procedure of Research

1. Production of cocoyam starch

The cocoyam was washing and stripping. Furthermore, reducing size and soaking with 7.5% salt solution for 1 hours. Then crushed with a blender and extracted with a ratio of 2: 1 (water: tuber). Then squeeze and pulp is extracted again in a ratio of 2: 1 (water: pulp). The next process is deposition for 8 hours and drying at 60 °C for 6 hours. The starch of cocoyams was grinding and sifting with 80 mesh sieves.

2. Production of Maltodextrin cocoyam tuber

20 gram of starch was dissolved in CaCl₂ 200 ppm. CaCl functions as a catalyst for the α -amylase enzyme which is added to the starch hydrolysis process. PH was adjusted with 0.1 N NaOH solution to pH 6-7 solution. After that the addition of enzymes according to the treatment was continued stirring at a temperature of 80 °C and incubation according to variables: 60 minutes, 90 minutes and 120 minutes. After that cool down and add 0.1 N HCL to rearrange pH to 3-4. The pH was reset with 0.1 N NaOH so that the pH becomes 4.5-6.5. Furthermore, maltodextrin was dried in a cabinet dryer at 60 °C. Then tuck with a blender and sift with an 80 mesh sieve.

Results and Discussion

Amylose content in cocoyam starch (24.26%) is different from the literature. Amylose content in cocoyam starch was 20.4% [12]. The difference in the results of the analysis can be due to the different types, age of harvest and the environment in which the growth growth and extraction factors of starch.

Table 1. Results of Analysis of Cocoyam Starch

Komponen	Content	Literature
Water (%)	8,07 ± 0,24	12,2 ± 1,2 [12]
Starch (%)	79,02 ± 0,15	89,12 ± 0,03 [13]
Solubility (%)	14,61 ± 0,02	14,60 ± 0,18 [14]
Amylosa (%)	24,26 ± 0,09	20,4 ± 1,6 [12]
Yield (%)	11,5 ± 0,42	17,44
Swelling power	22,29 ± 0,01	22,5 ± 0,11 [13]

Water content and yield

The average value of the water content of cocoyam maltodextrin ranged from 4.512% -6.326%. The highest water content was produced by enzymatic method of hydrolyzing starch with the treatment of the addition of α -amylase 0.10 ml and 60 minutes incubation time of 6.326%. The lowest water content was produced by enzymatic method of hydrolyzing starch with the treatment of the addition of α -amylase 0.14 ml and incubation time for 120 minutes, namely 4.512%.

The average value of the maltodextrin yield ranged from 83,30-96,85%. The highest yield was produced in maltodextrin with the treatment of the addition of α -amylase 0.14 ml and incubation time for 120

minutes at 96.85%. The lowest yield was produced on maltodextrin with the treatment of the addition of α -amylase 0.10 ml and incubation time for 60 minutes which was 83,30%.

The longer the hydrolysis time, the greater the yield of the product obtained, this is because the amylose in starch will have a longer contact (split) with enzymes and the more starch concentration used, the more many starches were converted to dextrin [15]. The greater the concentration of starch used and the longer the hydrolysis time, the greater the yield of the product obtained, and vice versa the smaller the concentration of starch used and the shorter the hydrolysis time, the smaller the yield of the product obtained. With a longer time the amylose in starch is longer contact (split) with the enzyme and the more starch concentration is used, the more starch converted to dextrin [16]. The characteristics of maltodextrin of jackfruit seeds are brownish yellow, have a yield of 64%, moisture content of 3.07%, dextrose equivalent (DE) 15.44 and solubility in water increase to 95.5% [17].

Amylose and reducing sugar content of cocoyam maltodextrin

The maltodextrin of Cocoyams produced content of water 4.51-6.33%. The volume of enzymes was increasing and the longer the incubation period produced the lower the water content of the maltodextrin. The longer incubation will increase the temperature which speeds up the work of the α -amylase enzyme as more and more volumes of the α -amylase enzyme are added which will cause starch to degrade more quickly and form simpler polysaccharide compounds. They have fewer hydroxyl groups than starch causing starch water content of maltodextrin decreasing. The starch hydrolysis by α -amylase enzyme will cause damage to starch granules so that the starch loses its ability to bind water so that the water content decreases [18].

Starch content of maltodextrine was 4.29% - 4.45% that was amylose content of 1.95% - 2.24%. The more α -amylase enzymes were added, the more starch that was hydrolyzed into simpler polysaccharides to become simple sugars such as glucose (Fig.1). Starch can be broken down into smaller units by cutting the glycosidic bonds. One of the enzymes that can break these bonds is the α -amylase enzyme. The action of amylase enzyme (α - 1.4 glukon hydrolase) is by cutting the α - amylase - 1.4 bond, but not cutting α - 1.6 [19].

The more amylose bonds that are cut into pieces by the α -amylase enzyme, which is supported by long incubation times, will give the opportunity for the enzyme to interact longer with amylose so that it degrades amylose to glucose so that the amylose content decreases. The enzymatic hydrolysis causes a decrease in amylose. The higher the enzymatic reaction that occurs in starch by α -amylase causes the higher the reduction in amylose content [20].

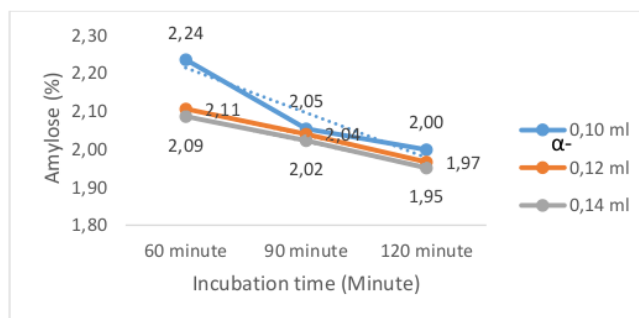


Figure 1. Relationship between the treatment of the volume of the α -amylase enzyme and the incubation period on the amylose of cocoyam maltodextrin

Reducing sugar content of maltodextrin was 11.46% - 12.74%. The addition of α -amylase enzymes increases, the more reducing sugar levels are produced. This is because more and more starch is bound to the enzyme and hydrolyzed into simpler sugars.

That starch can be broken down into smaller units by cutting the glycosidic bonds. One of the enzymes that can cut these bonds is the α -amylase enzyme [21]. The α - amylase is an endo enzyme that works to break the α - 1.4 bond randomly inside the molecule in both amylose and amylopectin. The nature and mechanism of action of the α -amylase enzyme depend on the source. Generally α - amylase cuts

the bond in the middle of the chain so that it decreases the ability of starch to bind iodine dyes. Hydrolysis with α -amylase causes amylose to break down into maltosa and maltotriosa. In the next stage maltotriosa decomposes again into maltose and glucose [22].

DE Value of Cocoyam Maltodextrin

The characteristics of the cocoyams maltodextrin, the DE value is 12 - 14. The volume of the enzyme α -amylase is increasing and incubation is longer, the DE value in maltodextrin tuber was increased (Fig 2). This was because of the larger the α -amylase enzyme is added, the more starch was converted to glucose. The more enzyme concentrations are added, the more starch broken down and hydrolyzed. The more simple sugar produced. Glycosidic bonds that can be broken down cause reducing sugar levels to increase and can increase DE value.

The effect of the hydrolysis time on the DE value of sago maltodextrin has research [23]. The increasing of DE value of sago maltodextrin as the hydrolysis time increases. The more enzymes bind to the substrate the more the product of reducing sugars produced, it follows the theory of hydrolysis, that the longer the hydrolysis time the more hydrolyzed the material. The time of hydrolysis used about 5-10% is 60-120 minutes.

That during the hydrolysis of the α -amylase enzyme breaks down been in the glycosidic bonds and shortens the chain. Modifications by the α -amylase enzyme consist of two stages of granule attack. In the initial stage, a rapid attack occurred on the amorphous region of starch containing an α -1.6 bond. The addition of a linear fraction to starch was found at this stage [24]. Hydrolysis runs slower in the crystal region during the second stage. Hydrolysis produces high free glucose which causes high DE values. has the property of reducing so that the value of DE increases.

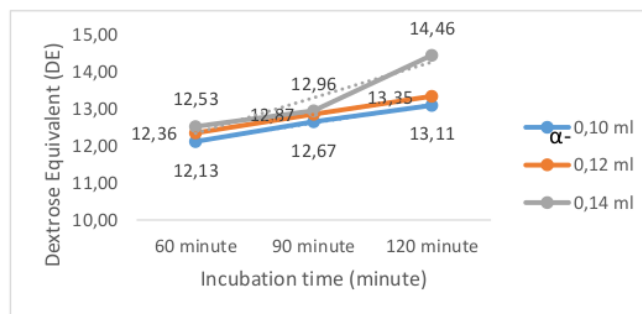


Figure 2. Relationship between the treatment of the volume of the α -amylase enzyme and the incubation period on the value of DE maltodextrin

Solubility and swelling power

The average value of maltodextrin starch ranged from 72.13% -78.90%. The volume of the enzyme α -amylase is increasing and the incubation is longer, the solubility of maltodextrine increased. This is due to the increasing number of α -amylase enzymes and the longer incubation time so that the starch which is hydrolyzed into simple sugars by reforming the α -amylase enzyme is catalyzed by incubation time which speeds up the performance of enzymes which causes the molecule to decrease in size and dissolve easily.

That hydrolysis will cause cutting of starch molecules into shorter polymers, namely maltose, oligosaccharides, dextrin and glucose. These molecules have a smaller molecular weight than starch [25]. Molecular weight is one of the factors that determines the solubility of the polysaccharide [24]. The greater the molecular weight it will reduce its solubility in water. In addition, solubility will increase with decreasing particle size. Hydrolysis of starch with enzymes causes the size of molecules to decrease so that solubility increases [26]. Starch hydrolysis using enzymes causes the size of the starch molecule to drop dramatically because the starch chain is cut into pieces by enzymes. The decrease in molecular size causes the physical properties of starch to change, including solubility, white degree, brightness, acid level and viscosity [27].

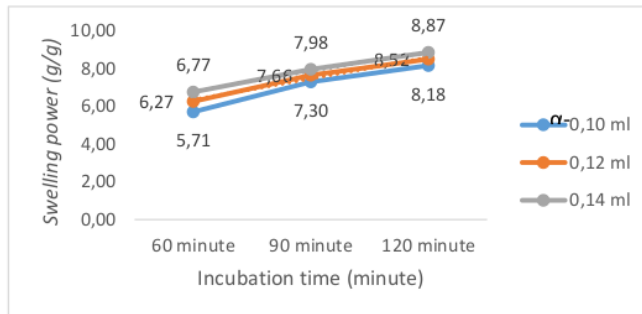


Figure 3. Relationship between treatment of volume treatment of α -amylase enzymes and incubation time on swelling power of cocoyam maltodextrin

The increase in solubility value was accompanied by an increase in swelling power value of 5.71% - 8.85% (Fig.3). The volume of the enzyme α -amylase is increasing and the incubation progresses causing the swelling power of cocoyams dextrine to increase. This is due to the large volume of the α -amylase enzyme added and the incubation time resulting in the weakening of the hydrogen bonds in the starch due to degradation by the α -amylase enzyme, so that the water easily enters the starch granule. The process can make the starch granule bigger and expand. Starch granules will absorb water so that the longer the starch granules expand (swelling the power increases).

That starch hydrolysis with enzymes causes the size of the molecule to shrink, with the smaller the size of the molecule, the greater the molecular weight distribution, this will result in greater swelling power when heated[28]. Swelling power is also strongly influenced by the presence of amylose groups as one of the constituent components of starch. The longer the process results in more amylose being reduced, so that the decrease in the amount of amylose causes swelling power increases.[29]

Conclusion

Modified starch with a volume of 0.14 ml α -amylase enzyme and 120 minutes incubation time is the best treatment with a moisture content of 4.512%, DE14,460, solubility 78,900%, reducing sugar content 12,500%, starch content 4,245%, amylose content 1,952%, swelling power 8,865 (g / g) and yield 96,850.

18

Acknowledgment

This research was funded by the Directorate of research and community service at directorate general of higher education (RISTEKDIKTI) on competency-based research programme (2018-2020).

Reference

- [1] Jatmiko, G. P. 2013. Characteristics of Physicochemicals, Bioactive, and Organoleptic Noodles from Kimpul Bulbs (*Xanthosoma sagittifolium*). Unpublished thesis. Malang: UB Faculty of Agricultural Technology
- [2] Koswara, S. 2013. Processing Technique of Tubers: Processing of Taro Tubes. Module IPB: 23 gor.
- [3] Tapia M S, Perez E, Rodriguez P E, Guzman R, Noelle M. 2012. Some properties of starch and starch edible films from under-utilized roots and tubers from the Venezuelan Amazons. *Journal of Cellular Plastics* 48(6) 526-544
- [4] Pe´ rez E, Gibert O, Rolland-Sabate´ A, et al. Evaluation of the functional properties of promising *Dioscorea trifida* L waxy starches for 1 food innovation. *J Agric Food Chem* 2011; 16: 263–273.
- [5] Kaushal P, Kumar V, Sharma H K. 2013. Utilization of taro (*Colocasia esculenta*): a review. *J Food Sci Tech*.

- [6] Effionora Anwar, Joshita D., Arry Yanuar, and Anton Bahtiar. 2004. Utilization of Wheat Flour Maltodextrin as Excipients in Tablet and Niosom Preparation Formulas, *Pharmaceutical Science Magazine*, ISSN: 1693-9883, 2004, vol. I, no. 1, pp. 34-46.
- [7] Winarno, F.G. 1995. *Food Enzymes*. PT. Publisher Gramedia Main Library. Jakarta. 113 p
- [8] Hansen, Michael Riis. 2008. *Food Uses of Enzyme Modified Starches*. Samfundslitteratur Chart, 22; deriksberg C. Denmark
- [9] Lloyd, N.E and Nelseon, W.J. 1984. Glucose and Fructose containing sweeteners from starch chapter 21 in *starch: chemistry and Technology*, R.L. Whistler, J.N. Berniller and E.F Paschall (eds.) Second edition. Academic Press. Orlando, FL.
- [10] Sunari, Syaiful Bahri, Hardi Ys. 2016. The Production of Maltodextrin of Sagoo Flour using α -amylase]. *KOVALEN*, 2 (3): 33-38, December 2016. Page 1-6.
- [11] Kunarto, B and Sani, Y.E. 2017. Manufacture of maltodextrin from durian seed starch (*Durio zibethinus* Murr.) Using α -amylase enzyme. *Proceeding SNST Faculty of Engineering*. Vol.1. 11 mber 1. ISBN 978-602-99334-7-5
- [12] Saikia, J.P and B.K. Konwar. 2012. *Physicochemical properties of starch from Aroids of North East India*. *International Journal of Food Properties*. ISSN: 1094-2912.
- [13] Gudjónsdóttira, M., Abena, A.B., Faustina, D.W.M, Ibok, O. 2016. *Characterization of red and white cocoyam (Xanthosoma sagittifolium) roots, flours and starches during heating by low field NMR*. *Magnetic Resonance in Food Science 2016 Proceedings*
- [14] Zahruniyah, Z. 2014. *Optimization of Making Type III Resisitent Starch from Cassava Starch (Manihot esculenta Crantz)*. Essay. Bogor Agricultural Institute. Bogor.
- [15] Chen, Z., Schols, H.A. and Voragen, A.G.J. 2012. *Physicochemical properties of starches obtained from three different varieties of Chinese sweet potatoes*. *Journal of Food Science* 68: 9 1-437.
- [16] Zhang, T. and Oates, C.G. 2009. *Relationship between α -amylase degradation and physicochemical properties of sweet potato starches*. *Food Chemistry* 65: 157-163.
- [17] Kurniawati i. 2015. characteristics of jackfruit seed maltodextrine obtained by hydrolysis using 3 amylase. *J. Profesi*. Volume 13. P 47-51
- [18] Uthumporna, I.S.M. Zaidul, A.A. Karima, 2010. Hydrolysis of granular starch at sub-gelatinization temperature using a mixture of amyolytic enzymes. *food and bioproducts processing* 8 8 (2010) 47-54. Elsevier.
- [19] Fogarty, W.M and Kelly, C.T. 1983. In *Enzyme Technology*, ed. R.M. Lafferty. Springer-Verlag. 3 idelberg. p.149
- [20] Rocha, T.S., Carneiro, A. P., Franco, C.M. 2010. Effect of enzymatic hydrolysis on some physicochemical properties of root and tuber granular starches. *Ciênc. Tecnol. Aliment., Campinas*, 30 (2): 544-551, abr.-jun. 2010
- [21] 7 pswara. 2009. *Pati Modification Technology*. Ebookpangan.com
- [22] Walker, G.J., Whelan, W.J. 1960. The mechanism of carbohydrate action. 8. Structures of the muscle-phosphorylase limit dextrins of glycogen and amylopectin, *Biochem. J.*, 1960, 76, 264-268 8
- [23] Arfah R A, Ahmad A, Dali S, Djide M N, Mahdalia and Arif A R. 2018. Utilization of α -amylase enzyme from *Bacillus stearothermophilus* RSAII_{1B} for maltodextrin production from sago starch. *Journal of Physics*. 979(2018)012018
- [24] Cui, S.W. 2005. *Food Carbohydrates*. Taylor & Francis Group, New York.
- [25] De Man, 20 J. 1997. *Food Chemistry*. Translator: K. Padmawinata. ITB Publisher, Bandung.
- [26] Jane and Chen. 1992. Effect of Amylose Molucular Size and Amylopectin Brain Chain Length on Paste Properties of Starch. By The American Association of Cereal Chemist. Inc.
- [27] Pentury, M.H., Happy, N., Nuddin, H., Soemarmo. 2013. Characterization of Maltodextrin from Mangocotyl Mangrove Starch (*Bruguiera gymnorrhiza*) Using Several Enzymes Hydrolysis 17 thods. E-ISSN.2338-1787.
- [28] Yan, H., and Zhengbiao, G.U. 2010. Morphology of modified starches prepared by different 14 thods. *Food Research International*, 3, 767-722
- [29] Sasaki, T. and Matsuki, J. 1998. *Effect of Wheat Starch Structure on Swelling power*. *Cereal Chemistry*, 75, 525-529.

7.9. Production of Maltodextrin from Cocoyams (*Xanthosoma Sagittifolium*) Starch Using A-Amylase Enzyme

ORIGINALITY REPORT

18%	%	%	18%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Universitas Negeri Surabaya The State University of Surabaya Student Paper	5%
2	Submitted to Kookmin University Student Paper	1%
3	Submitted to Universiti Sains Malaysia Student Paper	1%
4	Submitted to Universitas Brawijaya Student Paper	1%
5	Submitted to Padjadjaran University Student Paper	1%
6	Submitted to Universitas Trunojoyo Student Paper	1%
7	Submitted to Chulalongkorn University Student Paper	1%
8	Submitted to Monash University Student Paper	1%

9	Submitted to Higher Education Commission Pakistan Student Paper	1%
10	Submitted to University of North Florida Student Paper	1%
11	Submitted to Amity University Student Paper	<1%
12	Submitted to Bramalea Secondary School Student Paper	<1%
13	Submitted to Universiti Tunku Abdul Rahman Student Paper	<1%
14	Submitted to Universitas Sebelas Maret Student Paper	<1%
15	Submitted to University of Reading Student Paper	<1%
16	Submitted to University of Hawaii - West Oahu Student Paper	<1%
17	Submitted to Lincoln University Student Paper	<1%
18	Submitted to Universitas Diponegoro Student Paper	<1%
19	Submitted to The University of the South Pacific Student Paper	<1%

20

Submitted to The University of Manchester

Student Paper

<1%

21

Submitted to Colorado State University Fort Collins

Student Paper

<1%

22

Submitted to Bournemouth University

Student Paper

<1%

23

Submitted to Universiti Teknologi Malaysia

Student Paper

<1%

Exclude quotes Off

Exclude matches Off

Exclude bibliography Off