PROCEEDINGS

Starch Update 2011

The 6th International Conference on Starch Technology

13-14 February 2012

Centara Grand at Central Plaza Ladprao
Bangkok, Thailand

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Organized by

National Center for Genetic Engineering and Biotechnology (BIOTEC)
National Science and Technology Development Agency (NSTDA)
Ministry of Science and Technology (MOST)
Kasetsart Agricultural and Agro-Industrial Product Improvement Institute (KAPI)
Kasetsart University (KU)

Published by:
National Center for Genetic Engineering and Biotechology (BIOTEC)
113 Thailand Science Park, Phahonyothin Road, Klong 1,
Klong Luang, Pathumthani 12120 THAILAND
Tel. +662-564-6700, Fax. +662-564-6701-5
http://www.biotec.or.th

Starch Update 2011: The 6th International Conference on Starch Technology

Monday 13 - Tuesday 14 February 2012

Centara Grand at Central Plaza Ladprao Bangkok, Thailand

Monday 13 February 2012

Morning (08:30 – 12:00 hrs) at Ballroom B	
08:30 – 09:00	- Welcome remarks By **Assoc. Prof. Dr. Klanarong Sriroth** Chairman of organizing committee - Opening remarks By **Dr. Kanyawim Kirtikara** Executive Director of National Center for Genetic Engineering and Biotechnology (BIOTEC) **Ms. Yupa Pankaew** Director of Kasetsart Agricultural and Agro-Industrial Product Improvement Institute (KAPI)
09:00 – 09:30	**Plenary lecture 1:** "Insights into starch granule swelling and solubility" By **Prof. Sandra Hill** The University of Nottingham, UK
09:30 – 10:00	**Plenary lecture 2:** "Designed structure and digestibility of A- and B-type crystals through controlled assembly of short-chain amylose" By **Prof. Yong-Cheng Shi** Kansas State University, USA
10:00 – 10:30	***Coffee break***
10:30 – 11:00	**Plenary lecture 3:** "From blocklets to granule: exploring starch granular architecture" By **Prof. Dr. Koushik Seetharaman** University of Guelph, Canada
11:00 – 11:30	**Plenary lecture 4:** "How internal chain structure of amylopectin might drive function" By **Prof. Dr. Bruce Hamaker** Whistler Center for Carbohydrate Research, Purdue University, USA
11:30 – 12:00	**Plenary lecture 5:** "Starch business in China" By **Jin Shu Ren** Starch Association of China and Sugar-Alcohol Association of China, P.R. China
12:00 – 12:20	**Industrial presentation** : "Enzyme application for cassava starch extraction" By **Ying Qian** Genencor, P.R.China
12:20 – 13:30	***Lunch at Ladprao Suite***

Afternoon (13:30 – 20:00 hrs) at Ballroom A & B

	Concurrent session (25-mins oral presentation)	
	Session I (Ballroom A)	**Session II (Ballroom B)**
13:30 – 13:55	**Oral presentation 1** : "China starch industry development & modern processing technology" By **Wang Yanbo** Henan University of Technology, P.R. China	**Oral presentation 11** : "Acetylation of sago starch in densified CO_2" By **Henky Muljana** Parahyangan Catholic University, Indonesia
13:55 – 14:20	**Oral presentation 2** : "Effects of cassava crush size and variety on starch extraction efficiency" By **Ruenrom Lerdlattaporn** King Mongkut University of Technology Thonburi, Thailand	**Oral presentation 12** : "Silver particles prepared in chemical reduction of silver nitrate using hydroxypropyl starch" By **Kritapas Laohhasurayothin** National Science and Technology Development Agency, Thailand
14:20 – 14:45	**Oral presentation 3** : "Environmental impacts and benefits of cassava starch production using Life Cycle Assessment (LCA) thinking" By **Dr. Thierry Tran** CIRAD, France	**Oral presentation 13** : "Cassava starch nanocrystals with hydrophobically surface modification" By **Kittiwut Kasemwong** National Science and Technology Development Agency, Thailand
14:45 – 15:10	**Oral presentation 4** : "Atmospheric plasma: A non-chemical route for promoting cross-linking in starch" By **Somsak Dangtip** Mahidol University, Thailand	**Oral presentation 14** : "Effect of annealing treatments on the properties of flour from two different pre-germinated brown rice varieties" By **Onamon Jungsrimsirisakhul** Kasetsert University, Thailand
15:10 – 15:40	***Coffee break***	
15:40 – 16:05	**Oral presentation 5**: "The study of surface pores and channels of rice starch granules" By **Piyada Achayuthakan** Suan Sunandha Rajabhat Universiity, Thailand	**Oral presentation 15** : "Effect of annealing on thermal and pasting properties of acid-methanol hydrolysed rice starch" By **Junwadee Aryupong** Kasetsart University, Thailand
16:05 – 16:30	**Oral presentation 6** : "Functional properties of Thai lotus seed (*Nulumbo nucifera* Gertn.) flours" By **Urai Meesit** Ubon Ratchathani University, Thailand	**Oral presentation 16** : "Improving the texture of frozen cooked rice (*Oryza sativa* L.) cv. Khao Dawk Mali 105" By **Pornpisa Prasertthaijaroen** Kasetsart University, Thailand

	Concurrent session (25 mins oral presentation)	
	Session I (Ballroom A)	**Session II (Ballroom B)**
16:30 – 16:55	**Oral presentation 7** : "Biobutanol production via Acetone-Butanol-Ethanol (ABE) fermentation of cassava chips by *Clostridium Saccharoperbutylacetonicum* DSM 14923" By **Son Chu-Ky** Hanoi University of Science and Technology, Vietnam	**Oral presentation 17** : "The effects of additives and white egg on composite cassava – wheat bread" By **Judy Witono** Parahyangan Catholic University, Indonesia
16:55 – 17:20	**Oral presentation 8** : "Potential of bioethanol production from inedible banana" By **Sutera Srichaiyos** Mahasarakham University, Thailand	**Oral presentation 18** : "Caramel sauces thickened with combinations of starch and xanthan gum" By **Magdalena Krystyjan** University of Agriculture in Krakow, Poland
17:20 – 17:45	**Oral presentation 9** : "Characteristics of enzymatic hydrolysates from butyrylated arrowroot starch" By **Hary Haryadi** Gadjah Mada, Indonesia	**Oral presentation 19** : "Resistant starch composition and physicochemical properties of four banana cultivars during ripening" By **Nednapis Vatanasuchart** Institute of Food Research and Product Development, Kasetsart University, Thailand
17:45 – 18:10	**Oral presentation 10** : "Effects of pullulanase and isoamylase and rice varieties on resistant starch type III formation" By **Ariya Lapkhoksung** Suranaree University of Technology, Thailand	**Oral presentation 20** : "Oxidation of cassava starch using H_2O_2 and UV-C irradiation to improve the baking properties" By **Niken Palupi** Jember University, Indonesia
18:10 – 20:00	***Reception cocktail and poster presentation at Ballroom B***	

Tuesday 14 February 2012

Morning (08:30 – 12:15 hrs.) @ Ballroom B	
8:30 – 9:00	**Plenary lecture 6:** "The building block structure of amylopectin" By **Dr. Eric Bertoft** University of Guelph, Canada
9:00 – 9:30	**Spectacular lecture:** "A Perspective on the Discoveries and Paradigm Shifts in Starch Research" By **Prof. Dr. Koushik Seetharaman and Dr. Eric Bertoft** University of Guelph, Canada
9:30 – 10:00	***Coffee break***
10:00 – 10:25	**Oral presentation 21:** "Effects of cultivars and starch preparation methods on Japanese potato starch properties" By **Takahiro Noda** National Agriculture Research Center for Hokkaido Region, Japan
10:25 – 10:50	**Oral presentation 22:** "Comparison of molecular structure and selected physicochemical properties of spelt wheat and common wheat starches illuminated with visible polarized light and UV radiation" By **Maciej Fiedorowicz** University of Agriculture, Poland
10:50 – 11:15	**Oral presentation 23:** "Sustainable bio-based green-composite with natural fiber" By **Kim Hyun-Joong** Seoul National University, South Korea
11:15 – 12:00	***Lunch at Ballroom A***
Afternoon (12:00 – 20:30 hrs.) – *Study Tour*	
12:00 – 14:00	- Bus departs from Centara Grand at Central Plaza Ladprao Bangkok - Arrival at **Chao Khun Agro Products Co., Ltd.**, Saraburi Province (http://www.ckapsweet.com)
14:00 – 14:20	- Welcome address By **Capt. Ekthai Chansue** Managing Director, Chao Khun Agro Products Co., Ltd. - Company and factory introduction By **Mr. Pipop Chancha** Assistant Plant Manager, Chao Khun Agro Products Co., Ltd. - Factory acknowledgement By **Assoc. Prof. Dr. Klanarong Sriroth** Chairman of organizing committee
14:20 – 16:00	Plant visit
16:00 – 18:30	Bus departs to **Montien Riverside Hotel**, Bangkok (http://www.montien.com/riverside)
18:30 – 20.30	***- Farewell Dinner*** **- Award announcement** **- Sponsorship acknowledgment**
20:30 – 21:30	Bus departs to Centara Grand at Central Plaza Ladprao Bangkok

Note: Casual dress is preferred during study tour on Tuesday 14 February 2012.

Content

Plenary lecture

Oxidation of cassava starch using H_2O_2 and UV-C irradiation to improve the baking properties

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Abstract
The aim of this study was to investigate the effect of oxidation using H_2O_2 and UV-C irradiation on the carboxyl content, pH as well as baking expansion and swelling solubility of the cassava starch. Commercial cassava starch was oxidized with 0.4% (v/v) H_2O_2 (30% solution) and irradiated with UV-C for 0.25 – 15 min. The treated starch was characterized for carboxyl content, baking expansion ability, swelling and solubility. The untreated commercial cassava starch was used as control. The result indicated that the cassava starch oxidized with H_2O_2 and UV-C irradiated for 3 min had the highest baking expansion (10.75 mL/g) and lower swelling and solubility compared to the native starch. The oxidized starch contained 0.36% carboxyl groups. The oxidized starch was then applied to substitute wheat flour to prepare bread. Bread made from 50% the oxidized cassava starch had a high volume, good texture, and great appearance compared with wheat bread and native cassava starch bread.

Keywords: Oxidized cassava starch, baking expansion, UV-C irradiated, swelling and solubility

1. Introduction

Sun dried, fermented cassava starch or cassava sour starch, known as *polvilho azedo* in Brazil and *almidon agrio* in Colombia (Mestres, Zakhia, & Rouau, 1997), is used for production of special kinds of gluten-free breads and biscuits that are very popular in some countries of South America. The traditional process needs long times to produce sour cassava. Therefore many research groups tried to find out more efficient process to produce starch that have baking expansion ability (Demiate, 2000; Mestres et al., 1997; Vatanasuchart et al., 2003 & 2005). Baking expansion related with starch depolymerization by oxidation. Previous studies have proposed a consecutive reaction path in which hydroxyl groups in starch molecules are first oxidized to carbonyl groups and then to carboxyl groups (Kuakpetoon & Wang, 2006). Lactic acid in sour cassava starch can oxidized starch and produced carboxyl groups. UV irradiation could increase carboxyl content of sour cassava starch (Dias et al., 2011). Bertolini et al. (2001) concluded that UV irradiation induced cassava starch depolymerization more effective at 254 nm (UV-C). A recent research also suggests that UV-C irradiation was more effective to enhance baking expansion of cassava starch (Vatanasuchart et al, 2003 & 2005).

Starch also oxidized using oxidizing agent (Kanth et al., 2006; Zhang et al., 2007; Wang & Wang, 2003; Paravuori et al., 1995). Hydrogen peroxide, an alternative oxidizing agent, has been used in a commercial practice to much lesser extent. Hydrogen peroxide creates no harmful byproduct. Hydrogen peroxide decomposes inevitably to oxygen and water (Isbell & Frush, 1987). Hydrogen peroxide was faster than hypochlorite for starch oxidation

(Sangseethong et al., 2010). In previous study, Harmon et al. (1971 & 1972) had reported the oxidation of starch with hydrogen peroxide that catalyzed by UV irradiation, but they were no relation with baking expansion.

The present study was aim to find out the technique to produce cassava starch that having high baking expansion by oxidation use hydrogen peroxide and UV-C irradiation, in various length of time. The irradiated oxidized cassava starch will be characterized its pH, carboxyl content, baking expansion, swelling and solubility. Irradiated oxidized cassava starch with the highest baking expansion was applied in low gluten bread. Bread would be evaluated its volume and texture.

2. Materials and Methods

2.1 Materials

Commercial cassava starch was obtained from the near store, the chemicals and reagent were both locally.

2.2 Methods

Oxidation process

A slurry containing 42%cassava starchwas added with solution 30% H_2O_2 0.4% (v/v) and irradiated using UV-C lamp (39 watt, 220-240 V, dimension 83 mm x 900 mm (Alinco product)) in continuous system for 0.25 - 15 min. For the safety reason, this lamp use chamber stainless steel.

Level of pH

Acidity expressed as pH values were measured after suspension of 10% (w/v) starch in distilled water for 30 min under agitation at room temperature. After a further 30 min, starch was decanted and the pH of the soluble fraction was measured (Demiate, 2000).

Carboxyl Content

The carboxyl content of the samples was determined as described by Smith (1967) and employed by Parovuori et al. (1995). Amount of 500 mg of sample (DW) were suspended on 300 ml de-ionized water and boiled for 10 min with constant agitation. These solutions were titrated with NaOH 0.025 M employing phenolphthalein as indicator. Carboxyl content was calculated as shown :

COOH% = ml NaOH x 0.025 x 0.045 * x 100 / 0.5 g(* COOH molecular weight/1000)

Baking expansion

The measurement of baking expansion uses the method of Demiate et al (2000) with a little modification. The baking property was measured by weighing 24 g of sample and partially cooking by addition of 30 ml of boiling de-ionized water over this starch mass. This partially cooked starch was homogenized to produce dough thatwas molded to three small balls and baked on an electric oven at 200°C for 25 min. After baking, the dough was weighed, and made impermeable by using paraffin and their volumes determined on graduated cylinders as the volume of water displaced. The expansion was obtained by dividing volume by weight and was expressed as specific volume (ml/g).

Swelling and Solubility

Swelling power and solubility were determined following method of Lorlowhakarn (2005) with slight modification. Starch sample (0.5 g) in 15 ml of distilled water was heated to the desired temperature (65, 75,85, and 95°C) for 30 min in shaking water bath, then centrifuged at 4000 rpm for 15 min. The supernatant was carefully removed and the swollen flour sediment was weighted. The aliquot of supernatant was evaporated at 100°C until its weight constant.

Bread preparation

The preparation started by weighing all ingredients. The following step was the mixture and kneading, according to a specified sequence, adding first the dry ingredients, followed by the egg, yeast, water, and margarine, according to times and speed experimentally determined. After homogenization, 520 g of bread dough were transferred to a greased baking pan and incubated at room temperature in 2 hours. The baking process was carried out in electric oven at 180°C for 30 min. The baked bread were cooled down at room temperature and then wrapped up in plastic bags.

Bread volume and texture

The volume of the thin loaf was evaluated by measurement of length x width x height of bread (cm^3). Specific volume was determined using the formula: specific volume (cm^3/g) = volume (cm^3) / dough (g). Bread texture was measured as the resistance to an applied shear force using Universal Testing Machine (UTM). Force required to attain a given deformation was measured as F max (in Newton).

3. Results and Discussion

3.1 Level of pH and carboxyl content

Carboxyl content is parameter of starch oxidation level. The higher carboxyl content means the higher level of starch oxidation. The presence of carboxyl groups would influence the pH value of starch. Figure 1 exhibited that oxidation and UV-C irradiation decrease pH value of cassava starch after 4 min irradiation (6.19-5.22). In contrary, UV-C irradiation for 0.25-3 min caused increase pH value (6.60 – 6.81). Oxidized cassava starch after irradiated by UV-C for 15 min has the lowest pH value (5.22) and the highest carboxyl content (0.428%). The relationship between the formation of carboxyl groups during starch oxidation and pH value is not yet completely understood. Previous studies have proposed a consecutive reaction path in which hydroxyl groups in starch molecules are first oxidized to carbonyl groups and then to carboxyl groups (Kuakpetoon & Wang, 2006). It can be assumed that in earlier stage of starch oxidation, many of carbonyl groups wasproduced, so the pH value getting higher than native (6.38).

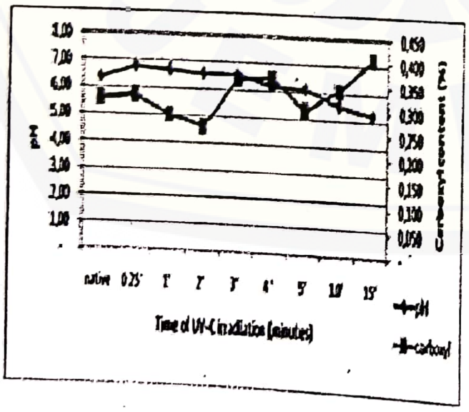

Figure 1 pH and carboxyl content of native and irradiated oxidized cassava starches

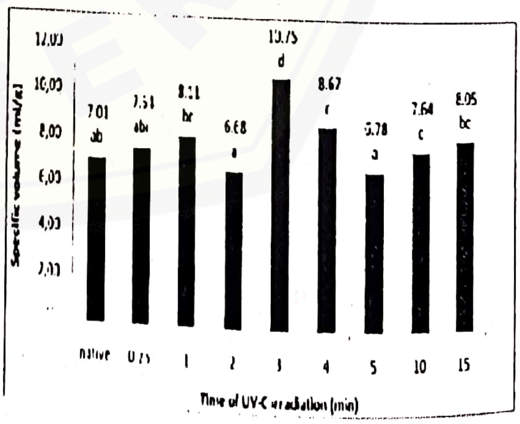

Figure 2 Baking expansion of native and irradiated oxidized cassava starches

3.2 Baking Expansion

Starch oxidation and depolymerization could enhance baking expansion of cassava starch. Baking expansion expressed as specific volume of baked product of cassava starch. **Figure 2** shows the specific volumes of cassava starch that oxidized with H_2O_2 0.4% (v/v) and irradiated by UV-C in different time. The highest specific volumes (10.75 mL/g) were observed within an optimum irradiation range (at 3 min). Our results are consistent with those from Vatanasuchart et al. (2003 & 2005) who obtained the highest specific volumes of irradiated cassava starch on the optimum time of UV irradiation. Interestingly, the highest specific volume was not obtained on irradiated oxidized cassava starch with the highest value of carboxyl groups.

This result relevance with Dias et al work (2011) that conclude that baking expansion ability of oxidized cassava starch was influenced by optimum ratio carbonyl and carboxyl. This behaviour is likely due to not only required carboxyl groups to obtain maximum baking expansion. Demiate et al. (2000) observed that there is a great contribution of the carboxylate group associated with some others difference in starch at around 1060cm-1 on spectral region. After 5 min UV-C irradiated, oxidized cassava starch had lower specific volume (6.78 mL/g) than nativee (7.01 mL/g).

It is possible that this negative effect on the expansion capacity is due to excessive oxidation and increased starch degradation (from breaking glycosidic linkages and increased depolymerisation), which affects the ability of the starch to form internal alveolar structures responsible for expansion. When degradation was too extensive the bubble walls lost their integrity earlier, they ruptured at lower strain causing no expansion of the starches.

3.3 Swelling and Solubility

Table 1 Swelling and solubility of native and irradiated oxidized cassava starches

Samples	Swelling (g/g)			
	65°C	75°C	85°C	95°C
Native	2.630	5.322	6.652	4.827
0.4% H_2O_2 UV-C 0.25 min	2.450	4.632	4,974	4.308
0.4% H_2O_2 UV-C 1 min	2.311	4.182	4.989	3.513
0.4% H_2O_2 UV-C 2 min	2.354	4.562	4.418	4.133
0.4% H_2O_2 UV-C 3 min	2.098	4.257	4.899	4.461
0.4% H_2O_2 UV-C 4 min	1.853	4.450	5.411	6.472
0.4% H_2O_2 UV-C 5 min	2.900	4,722	3.473	3.510
0.4% H_2O_2 UV-C 10 min	2.892	5.326	4.157	3.655
0.4% H_2O_2 UV-C 15 min	2.344	5.834	4.689	3.708

Table 1 Swelling and solubility of native and irradiated oxidized cassava starches (Cont.)

Samples	Solubility (%)			
	65°C	75°C	85°C	95°C
Native	0.000	0.265	0.349	0.604
0.4% H_2O_2 UV-C 0.25 min	0.035	0.273	0.304	0.479
0.4% H_2O_2 UV-C 1 min	0.000	0.086	0.282	0.417
0.4% H_2O_2 UV-C 2 min	0.107	0.247	0.351	0.429
0.4% H_2O_2 UV-C 3 min	0.035	0.249	0.290	0.348
0.4% H_2O_2 UV-C 4 min	0.105	0.084	0.305	0.632
0.4% H_2O_2 UV-C 5 min	0.113	0.162	0.357	0.301
0.4% H_2O_2 UV-C 10 min	0.220	0.164	0.407	0.265
0.4% H_2O_2 UV-C 15 min	0.144	0.454	0.555	0.423

Oxidized cassava starch that irradiated UV-C in 3 min has the highest baking expansion (10.75 mL/g) and swelling value was lower (4.899 g/g) than native (6.652 g/g) (Table 1). It has been suggested that expansion related to starch swelling (Mestres et al., 2000) attributable of amylopectin. At the beginning of baking, the starch gelatinization induces its partial solubilization and swelling and leads the formation of viscoelastic material. This latter can trap the gas being produced during baking, mainly before the formation of a rigid crust due to the progressive dehydration and which impede the dough expansion. When degradation was too extensive, disturbance in amorphous phase of starch granules was more, so starch swelling getting lower cause of too many water in starch granule. However, the bubble walls lost their integrity earlier causing no expansion of the starches. The high solubilization of irradiated, oxidized cassava starchwas attributed to higher amylopectin solubilization (Mestres, Zakhia, Dufour, 1997). Oxidation by H_2O_2 and UV-C irradiation leads the degradation in amylopectin molecules (Bertolini et al, 2001) which could impacton the decreasing swelling and solubility.

3.4 Bread properties and texture

Irradiated oxidized cassava starch (oxidized cassava starch that irradiated by UV-C at 3 min) which highest baking expansion was applied to produce low gluten bread. As a control is bread prepared with wheat flour which exhibited the best volume (3.437cm3/g) and appearance. It was interesting that bread was made from 50% irradiated oxidized cassava starch has a slight volume difference (3.268 cm3/g), only 5% lower than wheat bread volume. Texture can be considered a manifestation of the rheological properties of a food and constitutes an important quality attribute, since it has great influence on the judgment of bread acceptability (Clerici et al., 2009). The resistance of bread crumb to deformation is the textural attribute referred to as firmness and is an important factor in bakery products since it is strongly correlated with consumers' perception of bread freshness (Ahlborn et al., 2005). In contrast, baked product with a higher baking expansion usually needed a lower force to break it (Saputro, 2010). In this work, compared with wheat bread, irradiated oxidized cassava starch bread with a lower volume in contrary need a lower force to break its bread. It means, irradiated oxidized cassava starch bread had more crispy texture. This result was relevance with earlier statement, that cassava bread and wheat bread had difference mechanism for making expansion during baking (Bertolini, et al., 2001). The difference mechanism could influence difference crumb bread properties and texture.

4. Conclusion

The longer time of UV-C irradiation increase baking expansion ability of oxidized cassava starch until initial time. Treatment of cassava starch by adding H_2O_2 0.4% (v/v) and UV-C irradiation for 3 min resulted in oxidized starch having characteristics: pH 6.59, carboxyl content 0.360%, highest baking expansion ability (specific volume 10.75 ml/g), highest swelling power at 85°C (4.899 g/g), highest solubility at 95°C (0.348%). Thismethod was more efficient than that of previous study because require short time to produce cassava starch that has high baking expansion. Bread prepared with irradiated oxidized cassava starch (50%) not only produce a high volume bread and need a low force to break it, but also had a good appearance. It can be accepted that irradiated oxidized cassava starch can be substituted wheat to produce low gluten bread.

References

Ahlborn, G.J., Pike, O.A., Hendrix, S.B., Hess, W.M., Hubber, C.S., (2005) Sensory, mechanical, and microscopic evaluation of staling in low- protein and gluten-free breads. Cereal Chemistry. 82, 328-335

Bertolini, A. C.; Mestres, C.; Lourdin, C.; Della Valle, G.; Colonna, P. (2001) Relationship between thermomechanical properties and baking expansion of sour cassava starch. *J. Sci. Food Agric.*, in press.

Clerici, M.T.P.S., Airoldiu, C., El-Dash, A.A.,(2009) Production of acidic extruded rice flour and its influence on the quality of gluten-free bread. LWT – Food Science and Technology. 42, 618-623

Demiate, I.M., N. Dupuyb, J.P. Huvenneb, M.P. Ceredac, G. Wosiackia (2000) Relationship between baking behavior of irradiated oxidized cassava starches and starch chemical structure determined by FTIR spectroscopy. Carbohydrate Polymers 42 ,149–158

Dias, A.R.G., Zavareze, E.d.R., Elias, M.C., Helbig, E., Silva, D.B.d, & Ciacco, C.F. (2011) Pasting, expansion and textural properties of fermented casaava starch oxidized with sodium hypochlorite.*Carbohydrate Polymers*.84 : 268-275

Harmon, R.E, S.K.Gupta, and J. Johnson (1971) Oxidation of Starch by Hydrogen Peroxide in the Presence of UV Light Part I. Starch/Starke. 23. No 10. 347-349

Harmon, R.E, S.K.Gupta, and J. Johnson (1972) Oxidation of Starch by Hydrogen Peroxide in the Presence of UV Light · Part II.Starch/Starke. 24. No 1. 8-11

Kanth, S. V., Madhan, B., Rao, J. R., Nair, B. U., Sadulla, S., & Ramasami, T. (2006). Studies on the stabilization of collagen using dialdehyde starch. Part I. Effect of autoclaving on dialdehyde starch.Journal of the American Leather Chemists Association, 101, 444.

Kuakpetoon, D., &Wang, Y. J. (2006) Structural characteristics and physicochemical properties of oxidized corn starches varying in amylose content. Carbohydrate Research, 341, 1896–1915.

Mestres, C., Boungou, O., Akissoc, N., dan Zakhia, N. (2000) Comparison of The Expansion Ability of Fermented Maize Flour and Cassava Starch during Baking . Journal of the Science of Food and Agriculture 80 : 665 – 672.

Mestres, C., Zakhia, N., & Dufour, D. (1997). Functional and physicochemical properties of sour cassava starch. In P. J. Frazier & P. Richmond & A. M. Donald (Eds.), *Starch—*

structure and functionality, (pp. 43–50). Cambridge: The Royal Society of Chemistry Special publication no. 205.

Parovuori, P., Hamunen, A., Forssell, P., Autio, K., & Poutanen, K. (1995).Oxidation of potato starch by hydrogen peroxide. Starch/Starke, 47, 19-23.

Sangseethong, K., Termvejsayanon, N., Sriroth, K. (2010) Characterization of physicochemical properties of hypochlorite and peroxide oxidized cassava starches. *Carbohydrate Polymers*.82 : 446-453

Saputro, A.D. (2010) Iradiasi UV-A pada pati kasava dalam asam laktat untuk meningkatkan baking expansion.Tesis.Program pasca sarjana Universitas Gadjah Mada. Yogyakarta

Vatanasuchart, N. O. Naivikul, S. Charoenrein, K. Sriroth (2003) Influence of different UV irradiation on properties of cassava starch and biscuit expansion. In the 2nd Conference on starch technology, 71-78

Vatanasuchart, N., O. Naivikul, S. Charoenrein, K. Sriroth (2005) Molecular properties of cassava starch irradiated oxidized with different UV irradiations to enhance baking expansion. Carbohydrate Polymer 61, 80-87

Wang, Y & L. Wang. (2003) Physicochemical properties of common and waxy corn starches oxidized by different levels of sodium hypochlorite. Carbohydrate Polymers 52. 207–217

Zhang, S. D., Zhang, Y. R., Zhu, J., Wang, X. L., Yang, K. K., & Wang, Y. Z. (2007) Irradiated oxidized corn starches with improved comprehensive properties for preparing thermoplastics. Starch/Stärke, 59, 598.