



## BAB V

### KESIMPULAN DAN SARAN

#### 5.1 Kesimpulan

1. Peningkatan jumlah asetat anhidrida dan natrium hidroksida yang digunakan dapat meningkatkan nilai derajat substitusi (DS).
2. Sintesis pati sagu asetat menggunakan konsentrasi asetat anhidrida 0,05 ; 0,08 ; 0,11 mol/mol AHG pati serta konsentrasi natrium hidroksida pada 0,75 ; 1 ; 1,25 M menghasilkan pati sagu asetat yang memiliki nilai DS pada rentang 0,035-0,054.
3. Pati sagu asetat yang dihasilkan memiliki nilai DS yang termasuk dalam kategori DS rendah sehingga aman bila digunakan sebagai bahan aditif pada makanan.
4. Modifikasi dengan metode asetilasi menunjukkan pati yang dihasilkan semakin jernih, memiliki daya serap terhadap air dan minyak yang lebih baik, kelarutan meningkat, dan kemampuan mengembang juga meningkat dibandingkan dengan pati sagu yang belum dimodifikasi.
5. Hasil analisis kimia dan sifat fungsional terhadap pati sagu asetat menunjukkan bahwa pati sagu asetat yang dihasilkan dari penelitian ini dapat digunakan sebagai bahan pengental (*food thickener*) pada makanan.

#### 5.2 Saran

1. Pada penelitian selanjutnya dapat dilakukan pengamatan terhadap parameter lain yang dapat mempengaruhi nilai DS yaitu pengaruh temperatur.



## DAFTAR PUSTAKA

- Abbas, K. A., Khalil, S. K. & Hussin , A. S. M., 2010. *Modified Starches and Their Usages in Selected Food Products: A Review Study.* *Journal of Agricultural Science*, June, 2(2), pp. 90-100.
- Adebawale, K. O. A. T. & Lawal, O. S., 2002. Chemical Modification and Physicochemical Characterisation of Bambarra Groundnut (*Voandzeia subterranea*) Starch and Flour. *Food Chemistry*, Volume 78, pp. 305-311.
- Ahmad, F. dkk., 1999. Physico-chemical Characterisation of Sago Starch. *Carbohydrate Polymers*, Volume 38, pp. 361-70.
- Aini, N. & Purwiyatno, H., 2010. Gelatinization Properties of White Maize Starch From Three Varieties of Corn Subject to Oxidized and Acetylated-Oxidized Modification.
- Albert, T. W., Ayucitra, A. & Setiawan, L. E., 2008. Karakteristik Pati Sagu Dengan Metode Cross-Linking. *Jurnal Teknik Kimia Indonesia*, 7(3), pp. 836-843.
- Ayucitra, A., 2012. Preparation and Characterization of Acetylated Corn Starch. *International Journal of Chemical Engineering and Applications*, June, Volume 3, p. 156.
- Azudin, M. & Lim, E.-T., 1991. An Evaluation of The Quality of Sago Starch Produced in Sarawak. In: T. Ng, Y. Tie & H. Kueh, eds. *Proceedings of the Fourth International Sago Symposium*. Sarawak: Ministry of Agriculture & Community Development and Department of Agriculture, pp. 149-152.
- Bao, J. & Bergman, C. J., 2004. The Functionality of Rice Starch. In: A. Eliasson, ed. *Starch in food : Structure, Function and Applications*. Cambridge: Woodhead Publishing Limited, p. 282.
- Bayazeed, A., Farag, S., Shaarawy, S. & Hebeish, A., 1998. Chemical Modification of Starch via Etherification with Methyl Methacrylate. In: C. Meyer, ed. *Starch*. s.l.:Wiley, pp. 89-93.
- Beadle, G., 1978. In: D. Walden, ed. *Maize Breeding and Genetics*. New York: Wiley, pp. 93-112.
- Bello-Pérez, dkk, 2010. Effect of Low and High Acetylation Degree in The Morphological, Physicochemical and Structural Characteristics of Barley Starch. *LWT - Food Science and Technology*, 6 April, pp. 1434-1440.

- Bertolini, A. C., 2010. Trend in Starch Applications. In: A. C. Bertolini, ed. *Starches : Characterization, Properties, and Applications*. USA: Taylor and Francis Group, pp. 1-20.
- Betancur , A. D., Chel , G. L. & Canizares , H. E., 1997. Acetylation and Characterization of *Canavalia ensiformis* Starch. *Journal of Agricultural Food Chemical*, Issue 45, pp. 378-382.
- Blakemore, W. R. & Harpell , A. R., 2010. Carrageenan. In: *Food Stabilisers, Thickeners and Gelling Agents*. Singapore: John Wiley & Sons, Ltd.
- Bujang, K. & Ahmad, F., 2000. *Country report of Malaysia : production and utilization sago starch in Malaysia*. Bogor, UPT Pelatihan Bahasa-IPB, pp. 1-8.
- Cecil, J., 2002. The development of technology for the extraction of sago. In: K. Kainuma, Y. Toyoda & J. Cecil, eds. *Proceedings of the International Symposium on Sago (Sago 2001)*. Tokyo: Universal Academy Press Inc, pp. 83-91.
- Chafid, A. & Kusumawardhani, G., 2010. Modifikasi Tepung Sagu Menjadi Maltodekstrin Menggunakan Enzim Alpha-Amylase.
- Colonna, P., Buléon, A., Planchot, V. & Ball, S., 1998. Starch granules : structure and biosynthesis. *International Journal of Biological Macromolecules*, 19 February.p. 94.
- Cousidine, D., 1982. *Foods and Food Production Encyclopedia*. New York: John Wiley Inc.
- Craig, S. A. S., 1989. Starch Paste Clarity. In: *Cereal Chemistry*. s.l.:American Association of Cereal Chemistry, pp. 173-182.
- de Graaf, R. A., Broekroelofs , A. & Janssen , L. P. B. M., 1998. The Acetylation of Starch by Reactive Extrusion. *Starch*, Volume 50, pp. 198-205.
- de Paula, J. & Atkins, P., 2001. *Atkins' Physical Chemistry*, 7th Ed.. s.l.:Oxford.
- Djafar, T., Rahayu, S. & Mudijisihono, R., 2000. *Teknologi Pengolahan Sagu*. Yogyakarta: Kanisius.
- Eliasson, A. C., 2000. *Starch in Food : Structure, Function and Applications*. Cambridge: CRC Press.
- Fannon, J., Hauber, R. & BeMiller, J., 2009. Cereal Chemistry. In: J. BeMiller & R. Whistler, eds. *Starch : Chemistry and Technology*. 3rd ed. s.l.:Macmillan Publishing Solutions, p. 198.
- FAO/WHO, 1998. Carbohydrates in Human Nutrition: Report of a Joint FAO/WHO Expert Consultation. *FAO Food and Nutrition Paper* , pp. 1-140.

- Flach, M., 1983. The sago palm. In: *FAQ plant production and protection paper*. Rome(Italy): Food and Agriculture of the United Nations.
- Flach, M., 1997. *Sago Palm. Metroxylon sagu Rottb. Promoting the conservation and use of underutilized and neglected crops*. Rome: International Plant Genetic Resources Institut.
- Fleche, G., 1985. Chemical Modification and Degradation of Starch. In: J. R. Eds. G. Van Beynum, ed. *Starch Conversion Technology*. New York: Marcel Dekker Inc, pp. 73-100.
- Harsanto, B., 1986. *Budidaya dan Pengolahan Sagu*. Yogyakarta: Kanisius.
- Haryanto, B. & Pangloli, P., 1992. *Potensi dan Pemanfaatan Sagu*. Yogyakarta: Kanisius.
- Helgerud, T., Ga'serød, O. & Fjæreide, , T., 2010. Alginates. In: A. Imeson, ed. *Food Stabilisers, Thickeners and Gelling Agents*. Singapore: John Wiley & Sons, Ltd.
- Hermansson, A. M. & Svegmark, K., 1996. Developments in the understanding of starch functionality. *Trends in Food Science & Technology*, Volume 7, pp. 343-353.
- Hutapea, R., Pasang, P., Torar, D. & Lay, A., 2003. *Keragaan Sagu Menunjang Diversifikasi Pangan*. Manado, Pusat Penelitian dan Pengembangan Perkebunan, Badan Litbang Pertanian, pp. 173-184.
- Imeson, A., 2010. Agar. In: *Food Stabilisers, Thickeners and Gelling Agents* . Singapore: John Wiley & Sons, Ltd.
- Jacobs, H. & Delcour, J. A., 1998. Hydrothermal Modifications of Granular Starch, with Retention of the Granular Structure: A Review. Volume 8, p. 46.
- James BeMiller, R. W., 2009. *Starch : Chemistry and Technology*. 3rd ed. London: Academic Press.
- Jane, J.-L., 2009. Structural Features os Starch Granule II. In: J. BeMiller & R. Whistler, eds. *Starch, Chemistry and Technology*. s.l.:Wiley, pp. 193-277.
- Jeon, Y. S., Viswanathan, A. & Gross, R. A., 1999. Studies of Starch Esterification : Reaction with alkenyl-succinates in aqueous slurry system. In: C. Meyer, ed. *Starch*. s.l.:Wiley, pp. 90-93.
- Joon, S. K. & Seung, Y. B., 2006. Effect of Acetylation on Rheological Properties of Rice Starch. In: C. Mayer, ed. *Starch*. Seoul: Wiley Inter Science, pp. 177-185.
- Kaur, M., Oberoi, D., Sogi, D. S. & Gill, B. S., 2011. Physicochemical, morphological and pasting properties of acid treated starches from different botanical sources. *Journal of Food Science Technology*, August, 48(4), p. 460.

- Kerr, R., 1950. *Chemistry and Starch*. 2nd ed. New York: Academic Press.
- Lawal, O. S. & Adebawale, 2005. Physicochemical Characteristics and Thermal Properties of Chemically Modified Jack Bean (*Canavalia ensiformis*) Starch. *Carbohydrate Polymers*, 60(3), pp. 331-341.
- Leach, H., 1965. In: R. Whistler & E. Paschall, eds. *Starch : Chemistry and Technology*. New York: Academic Press, pp. 289-307.
- Liestianty, D., Rodianawati, I., P. & M., 2016. Chemical Composition of Modified and Fortified Sago Starch (*Metroxylonsp*) From Northern Maluku.
- M. W. Rutenberg, D. S., n.d. Starch derivatives: production and uses. In: *Starch: Chemistry and Technology*. s.l.:s.n.
- MacAllister, R. V., 1976. Nutritive Sweeteners Made From Starch. *Advance In Carbohydrate Chemistry and Biochemistry*, Volume 36.
- MacGregor, A. & Ballance, D., 1980. Cereal Chemistry. In: R. W. James BeMiller, ed. *Starch : Chemistry and Technology*. 3rd ed. s.l.:Macmillan Publishing Solutions, p. 198.
- Manan, D., Chie, R. & Rumie, A., 2003. Sago Starch Technology. In: *The Sarawak CRAUN Bulletin*. Sarawak: CRAUN Research Sdn Bhd.
- Maningat, C., Seib, P., Bassi, S. & Woo, K., 2009. Wheat Starch : Production, Properties, Modification and Uses. In: J. BeMiller & R. Whistler, eds. *Starch : Chemistry and Technology*. 3rd ed. New York: Academic Press, p. 453.
- Mason, W. R., 2004. Starch Use in Foods. In: J. BeMiller & R. Whistler, eds. *Starch Chemistry and Technology*. 3rd ed. s.l.:Macmillan Publishing Solutions, p. 747.
- Maurer, H. W., 2009. Starch in the Paper Industry. In: J. BeMiller & R. Whistler, eds. *Starch Chemistry and Technology*. 3rd ed. s.l.:Macmillan Publishing Solutions, p. 681.
- Mbougueng, P. D., Tenin, D., Scher, J. & Tchiegang, C., 2012. Influence of acetylation on physicochemical, functional and thermal properties of potato and cassava starches. *Journal Food Engineering*, pp. 320-326.
- Mizayaki, M. R., Hung, P. V., Maeda, T. & Morita, N., 2006. Recent advances in application of modified starches for breadmaking. *Trends in Food Science & Technology*, Volume 17, pp. 591-599.
- Montgomery, D. C., 1997. Design and Analysis of Experiment. In: 5th ed. New York: John-Wiley, pp. 175-180 & 427-448.

- Morrison, W. & Karkalas, J., 1990. Starch. In: *Methods in Plant Biochemistry*. London: Academic Press, pp. 323-352.
- Nasional, B. S., 1995. *Tepung Sagu*. Indonesia, Patent No. SNI 01-3729-1995.
- Neelam, K., Vijay, S. & Lalit, S., 2012. Various Techniques For The Modification of Starch and The Applications of Its Derivatives. *International Research Journal of Pharmacy*, 3(5), pp. 25-31.
- Oates, C. & Hicks, A., 2002. Sago starch production in Asia and the Pacific-problems and prospects. In: K. Kainuma, M. Okazaki, Y. Toyoda & J. Cecil, eds. *Proceedings of the International Symposium on Sago (Sago 2001)*. Tokyo: Universal Academy Press Inc, pp. 27-36.
- Okazaki, M. dkk, 2007. Developing processes of sago starch structure. In: M. Quevedo & A. Loreto, eds. *Abstracts of the Ninth International Sago Symposium*. Omoc: s.n.
- Olsen, B., 1994. Wheat: Production, Properties and Quality. In: London: Chapman and Hall.
- Perez, S., Baldwin, P. M. & Gallant, D. J., 2004. Structural Features of Starch Granules I. In: J. BeMiller & R. Whistler, eds. *Starch : Chemistry and Technology*. 3rd edition ed. s.l.:Macmillan Publishing Solutions.
- Polnaya, F. J., 2006. Kegunaan Pati Sagu Alami dan Termodifikasi Serta Karakteristiknya. *Jurnal Agroforestri*, 3 Desember, I(3), p. 51.
- Rahim, A., Kadir, S. & J., 2015. Chemical and Functional Properties of Acetylated Arenga Starches Prepared at Different Reaction Time. *International Journal of Current Research in Biosciences and Plant Biology*, September, 2(9), pp. 43-49.
- Raina, C., Singh, S., Bawa, A. & Saxena, D., 2006. Some characteristics of acetylated, crosslinked and dual modified Indian rice starches. *European Food Research and Technology*, Volume 223, pp. 561-570.
- Rapaille, A. & Vanhemelrijk, J., 1997. Modified Starches. In: *Thickening and Gelling Agents for Food*. 2nd ed. s.l.:Springer-Science+Business Media, B.V, p. 199.
- Rizkiana, W., 2015. *Produksi Pati Tapioka Nanokristalin Terasetilasi*, Bogor: Institut Pertanian Bogor.
- Robyt, J., 2013. *Essentials of Carbohydrate Chemistry*. s.l.:Springer-Science+Business Media, LLC.
- Rohmah, M., 2013. *Kajian Kandungan Pati, Amilosa, dan Amilopektin Tepung dan Pati Pada Beberapa Kultivar Pisang (Musa spp)*. Samarinda, Seminar Nasional 2013.

- Ruddle, K., Johnson, D., Townsend, P. & Rees, J., 1978. *Palm sago : a tropical starch from marginal lands*. Honolulu(Hawaii): Univ. Press of Hawaii.
- Saartrat, S., Puttanlek, C., Rungsardthong, V. & Uttapap, D., 2005. Paste and gel properties of low-substituted acetylated canna starches. *Carbohydrate Polymers*, Volume 61, pp. 211-221.
- Seisun, D., 2010. Introduction. In: A. Imeson, ed. *Food Stabilisers, Thickeners and Gelling Agents*. Oxford: John Wiley & Sons, Ltd, p. 6.
- Sim, S., Oates, C. & Wong, H., 1991. Studies on sago starch. Part 1 : characterization and comparison of sago starches obtained from Metroxylon sago processed at different times. In: *Starch/Starke 43*. s.l.:s.n., pp. 459-66.
- Singh, H., Sodhi, N. S. & Singh, N., 2013. Structure and Functional Properties of Acetylated Sorghum Starch. *International Journal of Food Properties*, pp. 311-325.
- Sodhi, N. S. & Singh, N., 2004. Characteristics of acetylated starches prepared using starches separated from different rice cultivars. *Journal of Food Engineering*, 18 November, Issue 70, pp. 118, 126.
- Tako, M., Tamaki, Y., Teruya, T. & Takeda, Y., 2014. The Principles of Starch Gelatinization and Retrogradation.
- Tarigans, D., 2001. Sagu Memantapkan Swasembada Pangan. *Warta Penelitian dan Pengembangan Pertanian*, 3(5), pp. 1-3.
- Tester, R. F. & Debon, S. J., 1999. Annealing of starch - a review. *International Journal of Biological Macromolecules*, 1 December, Volume 27, p. 3.
- Tester, R. F., Karkalas, J. & Qi, X., 2004. Starch-composition, fine structure and architecture. *Journal of Cereal Science 39*, p. 154.
- Tester, R. & Karkalas, J., 2002. Starch. In: *Polysaccharides from Eukaryotes*. Weinheim: Wiley-VCH, pp. 381-438.
- Truong, V. D. & Avula, R. Y., 2010. Sweet Potato Purees and Powders for Functional Food Ingredients. In: R. C. Ray & K. I. Tomlins, eds. *Sweet Potato : Post Harvest Aspects in Food*. New York: Nova Science Publishers, Inc, pp. 117-161.
- Wang, W., Powell, A. & Oates, C., 1995. Pattern of enzyme hydrolysis in raw sago starch : effects of processing history. *Carbohydrate Polymer*, Volume 26, pp. 91-7.
- Wani, I. A., Sogi, D. S. & Gill, B. S., 2012. Physicochemical properties of acetylated starches from some Indian kidney bean (*Phaseolus vulgaris L.*) cultivars. *International Journal of Food Science and Technology*, pp. 1-7.

- Wattanachant, S., Muhammad, S. K. S., Hasim, D. M. & Rahman, R. A., 2002. Suitability of sago starch as a base for dual-modification. *Songklanakarin Journal of Science Technology*, 24(3), pp. 431-438.
- Whistler, R. L. & BeMiller, J. N., 1997. *Carbohydrate Chemistry for Food Scientist*. St.Paul(Minnesota): Eagan Press.
- Wiriani, D., Rusmarilin, H. & Yusraini, E., 2016. Karakteristik Fisikokimia dan Fungsional Pati Pisang dan Pati Kentang Hasil Heat Moisture Treatment (HMT) dan Pengaruhnya Terhadap Sifat Fisik dan Sensori Bihun Instan Pati Kentang. *Jurnal Rekayasa Pangan dan Pertanian*, IV(1), p. 10.
- Wrostlard, R., 2012. *Food Carbohydrate Chemistry*. s.l.: 1. Wiley-Blackwell & Institute of Food Technologists.
- Wurzburg, O. B., 1995. Modified Starch. In: M. Dekker, ed. *Food Polysaccharides and Their Applications*. New York: s.n., pp. 83-85.
- Xie, S. X., Liu, Q. & Cui, S. W., 2005. Starch Modification and Applications. In: S. W. Cui, ed. *Food Carbohydrate*. s.l.:CRC Press.
- Xu, Y., Miladinov, V. & Hanna, M. A., 2004. Synthesis and Characterization of Starch Acetates with High Substitution. *Cereal Chemistry*, 81(6), p. 737.
- Yuliasih, I., 2011. *Fraksinasi dan Asetilasi Pati Sagu (Metroxylon sagu) Serta Aplikasi Produknya Sebagai Bahan Campuran Plastik Sintetik*, Bogor: Institut Pertanian Bogor.