UNIVERSITI PUTRA MALAYSIA

RHEOLOGICAL AND TEXTURAL CHARACTERISTICS OF MANGO JAM CONTAINING DIFFERENT GELLING AGENTS

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

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Chair: Associate Professor Chin Nyuk Ling, PhD

Faculty: Engineering

The main objective of this study was to investigate the rheological, textural, optical, and physicochemical characteristics of mango jam with HM pectin, CMC, and sago starch as the gelling agent. The effect of type and concentration of the hydrocolloids namely HM pectin (0.1, 0.7, and 1.2%), CMC (0.5, 1.25, and 2%), and sago starch (2, 6, and 10%) contents on the main characteristics of mango jam such as, physico-chemical properties (a_w, and moisture content), optical measurements (L^*, a^*, b^*, and ΔE), textural measurements (hardness and work of shear), rheological properties through steady-shear and dynamic measurements were assessed as response variables. In addition, the treated samples were produced to study the effect of the freeze-thaw treatment on these samples. The results indicated that both the type and concentration of the hydrocolloids affected the physico-chemical properties of the modified mango

jams compared to the control. The water activity and moisture content were both influenced significantly ($p < 0.05$) in terms of there concentration levels. Colour measurements of mango jams containing sago starch seemed to be whiter (L^*) and less yellow (b^*) in both untreated and treated samples compared with those HM pectin and CMC. The total colour difference showed that the colour characteristics of mango jam prepared with sago starch was not similar with HM pectin and CMC. The textural properties measured revealed that hardness and work of shear in jams containing sago starch were in the same domain as HM pectin and CMC. The hydrocolloid concentration has a significantly influenced ($p < 0.05$) on both the hardness and work of shear. The effect of freeze-thaw treatment was significant ($p < 0.05$) on hardness and work of shear in sample prepared with sago starch. However, in HM pectin and CMC, freeze-thaw treatment was not significant ($p > 0.05$). In steady-state shear measurements of the modified mango jam, the most appropriate rheological model was the Herschel-Bulkley with high goodness of fitting ($R^2 > 0.9814$) for each of the hydrocolloids used in both untreated and treated samples between the three models studied, namely, Power Law, Herschel-Bulkley, and Mizrahi-Berk. The apparent viscosity decreased with temperature while increased with the concentration level. In addition, apparent viscosity decreased in samples that were treated. Dynamic measurements showed that the dynamic moduli (G' and G'') decreased with temperature but increased with the concentration level in each of the hydrocolloid investigated. Freeze-thaw treatment decreased the loss and storage modulus in each of the hydrocolloids studied. The calculated tan δ value from dynamic measurements was in the range of 0.1 to 1 in most of the frequency window. This result revealed that the

samples behaved as weak gels. Thus, in giving an overall picture, sago starch showed similar textural and rheological characteristics as HM pectin and CMC in mango jam as a gelling agent.

Abstrak ini dibentangkan kepada Senat Universiti Putra Malaysia bagi memenuhi salah satu syarat untuk bergraduat ijazah Master Sains

CIRI RHEOLOGI DAN TEKSTUR BAGI JEM MANGGA MENGANDUNGI PELBAGAI LARUTAN AJEN GEL

Oleh

MARJAN JAVANMARD

Mac 2011

Pengerusi: Professor Madya Nyuk Ling, PhD

Fakulti: Kejuruteraan

Objektif utama kajian ini adalah untuk mengkaji ciri-ciri reologi, tekstur, optik, dan fiziko-kimia bagi jem mangga dengan pektin HM, CMC, dan kanji sagu sebagai agen perjelan. Kesan bagi jenis dan kepekatan kandungan beberapa jenis hidrokoloid iaitu pektin HM (0.1, 0.7 dan 1.2%), CMC (0.5, 1.25 dan 2%) dan kanji sagu (2, 6 dan 10%) terhadap ciri-ciri utama jem mangga seperti ciri-ciri fiziko-kimia (a_w , dan kandungan lembapan), ukuran-ukuran optik (L^*, a^*, b^*, dan ΔE), ukuran-ukuran tekstur (kekentalan dan kerja ricih), ciri-ciri reologi melalui kukuh-ricih dan ukuran-ukuran dinamik telah dinilai sebagai pembolehubah-pembolehubah tindakbalas. Sebagai tambahan, sampel yang dirawat telah dihasilkan bagi mengkaji kesan rawatan cair-beku terhadap sampel-sampel ini. Hasil kajian menunjukkan kedua-dua jenis dan kepekatan hidrokoloid mempengaruhi ciri-ciri fiziko-kimia bagi jem mangga yang diubahsuai berbanding kawalan. Aktiviti air dan kandungan lembapan sangat

dipengaruhi ($p < 0.05$) oleh paras kepekatan hidrokoloid. Ukuran warna bagi jem mangga yang mengandungi kanji sagu kelihatan lebih putih (L^*) dan kurang kuning (b^*) bagi kedua-dua jenis sampel yang dirawat dan tidak dirawat berbanding dengan HM pektin dan CMC. Perbezaan warna keseluruhan menunjukkan ciri-ciri warna jem mangga yang disediakan dengan kanji sagu adalah berlainan dengan yang mengandungi HM pektin dan CMC. Sifat tekstur yang diukur mendedahkan bahawa kekentalan dan kerja ricih bagi jem yang mengandungi kanji sagu adalah di dalam domain yang sama seperti HM pektin dan CMC. Kepekatan hidrokoloid mempunyai signifikan yang ketara ($p < 0.05$) terhadap kekentalan dan kerja-ricih. Kesan rawatan cair-beku adalah signifikan ($p < 0.05$) terhadap kekentalan dan kerja-ricih bagi sampel yang disediakan dengan kanji sagu. Walau bagaimanapun, tiada perbezaan yang ketara ($p > 0.05$) yang ditunjukkan di dalam HM pektin dan CMC menggunakan rawatan cair-beku. Di dalam pengukuran ricih keadaan mantap bagi jem mangga yang diubahsuai, model reologi yang paling sesuai di antara ketiga-tiga model yang dikaji (Power Law, Herschel-Bulkley, and Mizrahi-Berk) ialah Herschel-Bulkley yang menunjukkan padanan yang terbaik bagi setiap hidrokoloid yang digunakan di dalam kedua-dua sampel yang dirawat dan tidak dirawat. Kelikatan ketara berkurangan terhadap suhu manakala akan meningkat dengan tahap kepekatan. Sebagai tambahan, kelikatan ketara berkurangan di dalam sampel-sampel yang dirawat. Ukuran dinamik menunjukkan bahawa modulus dinamik (G' dan G'') berkurangan dengan suhu tetapi meningkat dengan tahap kepekatan bagi setiap hidrokoloid yang dikaji. Rawatan cair-beku mengurangkan modulus kehilangan dan penyimpanan bagi setiap hidrokoloid yang dikaji. Nilai tan δ yang dikira daripada ukuran dinamik adalah dalam julat 0.1

hingga 1 dalam kebanyakan julat frekuensi. Keputusan ini menunjukkan bahawa sampel berkelakuan sebagai gel lemah. Oleh sebab itu, pada keseluruhannya, kanji sagu menunjukkan ciri-ciri tekstur dan reologi yang sama seperti pektin HM dan CMC bagi jem mangga sebagai agen pengegelan.

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I certify that a Thesis Examination Committee has met on March 2011 to conduct the final examination of Marjan Javanmard on his thesis entitled "Rheological and Textural Characteristics of Mango Jam Containing Different Gelling Agents" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the Master of Science. The members of the Supervisory Committee were as follows:

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institutions.

Marjan Javanmard

Date:

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