UNIVERSITI PUTRA MALAYSIA

TEXTURAL AND RHEOLOGICAL CHARACTERISATIONS OF SAGO STARCH AND SAGO STARCH SUGAR GELS

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By

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

TEXTURAL AND RHEOLOGICAL CHARACTERISATIONS OF SAGO STARCH AND SAGO STARCH SUGAR GELS

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September 2011

Chair : Assoc. Prof. Ir. Chin Nyuk Ling, PhD

Faculty : Faculty of Engineering

The behaviour of native sago starch was investigated through characterisation, rheological and textural measurements in finding its use as a gelling agent in frozen-baked products. The effects of sago starch (6-8%), sugar (25-35%), and shearing speed of mixer (20-50 rpm) on rheological and textural characteristics of gel were investigated by means of response surface methodology. Increase in sago starch and sugar levels both increased ($P < 0.01$) gel stiffness. Higher shearing speeds reduced ($P < 0.05$) gel stiffness due to a decrease in starch swelling and an increase in starch breakdown during cooking.

The values of the experimental variables which minimised and maximised the textural parameters of hardness, gumminess, resilience, cohesiveness, and springiness were estimated by means of ridge analysis to determine the processing conditions at which these extremes can be reached. The maximum gel cohesiveness

brought by the processing variables was set as the criterion to obtain optimum formulation and processing of sago-starch based gels.

Utilising the optimised formulation and processing condition for gel setting, the pasting behaviour, rheological and textural characteristics of sago starch-sugar gels were compared with those of corn, wheat, tapioca, and potato starches. The morphological and thermal properties of these starches were investigated via scanning electron microscopy and differential scanning calorimetry respectively. High-amylose cereal starches (wheat and corn) produced harder gels (hardness = 225.1–248.0 g), while low-amylose root starch (tapioca) produced softer gels (hardness = 4.9 g). Sago and potato starches produced gels with high cohesiveness (0.90–0.94), indicating good setting of gels.

The effect of freezing and thawing on rheological and textural characteristics of gels were investigated. The freezing and thawing processes greatly increased the viscoelasticity and hardness of sago starch-sugar gels. These negative effects were significantly reduced by reheating the freeze-thawed gels at high temperature (80 °C). The freeze-thaw stability of various starch gels were investigated by gravimetric measurements of the water of syneresis after three freeze-thaw cycles. Sago starch produced gels with relatively low syneresis (3.23%) compared with corn (15.5%) and wheat (4.26%) starches. The high cohesiveness and low syneresis of sago starch-sugar gels, and their ability to recover from structural changes caused by freezing and thawing, implied potential use of sago starch as a gelling agent in frozen-baked products.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

TEKSTUR DAN SIFAT REOLOGI KANJI SAGU DAN GEL SAGU GULA

Oleh

TENG LI YUEN

September 2011

Pengerusi : Prof. Madya Ir. Chin Nyuk Ling, PhD

Fakulti : Fakulti Kejuruteraan

Sifat kanji sagu telah dikaji-selidik melalui pengukuran reologi dan tekstur untuk memperluaskan penggunaannya sebagai ejen gel dalam produk bakeri sejukbeku. Pengaruh kanji sagu (6-8%), gula (25-35%) dan kelajuan putaran pengaduk (20-50 rpm) pada sifat-sifat reologi and tekstur gel telah diselidik dengan menggunakan kaedah permukaan tindakbalas (*response surface methodology*). Peningkatan kepekatan kanji sagu and gula didapati meningkatkan ($P < 0.01$) keteguhan gel. Kelajuan putaran pengaduk mengurangkan ($P < 0.05$) keteguhan gel sebab kadar pembengkakan granul kanji telah berkurang manakala kadar pemecahan granul telah meningkat dalam proses memasak.

Nilai-nilai pembolehubah eksperimen yang meminimalkan serta memaksimumkan parameter tekstur kekerasan, kebergetahan, ketahanan, kepaduan dan kekenyalan gel telah dianggar melalui analisis bubungan (*ridge analysis*) untuk menentukan keadaan pemprosesan di mana ekstrim-ekstrim parameter tersebut boleh diperoleh. Kepaduan

gel maksimum telah ditetapkan sebagai kriteria untuk mendapatkan formulasi dan keadaan pemprosesan bagi menghasilkan gel kanji sagu yang optimum.

Dengan menggunakan rumusan dan keadaan pemprosesan bagi penghasilan gel yang optimum, sifat pempasturan serta ciri-ciri reologi dan tekstur gel sagu telah diperbanding dengan gel kanji jagung, gandum, ubi kayu dan ubi kentang. Sifat morfologi and sifat termal kanji ini juga telah dikaji dengan menggunakan mikroskop penskanan elektron dan kalorimetri penskanan pembezaan. Kanji bijirin (gandum dan jagung) yang tinggi dengan amilosa menghasilkan gel yang lebih keras (kekerasan = 225.1–248.0 g), manakala kanji ubi kayu menghasilkan gel yang lebih lembut (kekerasan = 4.9 g). Kanji sagu dan kanji ubi kentang menghasilkan gel yang berkepaduan tinggi (0.90-0.94). Ini merupakan satu ciri gel yang sempurna.

Pengaruh pembekuan dan penyahbekuan pada sifat reologi dan tekstur gel telah dikaji-selidik. Proses pembekuan dan penyahbekuan telah meningkatkan viskoelastis dan kekerasan gel sagu dengan ketara. Kesan negatif ini dapat dikurangkan dengan memanaskan gel pada suhu yang tinggi (80 °C). Kestabilan sejukbeku-nyahbeku gel kanji telah dikaji melalui penyukatan air sineresis selepas tiga kitaran sejukbeku-nyahbeku. Gel kanji sagu menunjukkan tahap sineresis yang rendah (3.23%) berbanding dengan gel kanji jagung (15.5%) dan kanji gandum (4.26%). Nilai kepaduan gel yang tinggi dan tahap sineresis yang rendah, serta keupayaan gel sagu untuk memulih daripada perubahan struktur akibat proses sejukbeku-nyahbeku ternyata potensi kanji sagu untuk digunakan sebagai ejen gel dalam produk bakeri sejukbeku.

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I certify that a Thesis Examination Committee has met on 6 September 2011 to conduct the final examination of Teng Li Yuen on his thesis entitled "Textural and Rheological Characterisations of Sago Starch and Sago Starch Sugar Gels" 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 degree of 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 institution.

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TENG LI YUEN

Date: 6 September 2011

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