
**UNIVERSITI PUTRA MALAYSIA**

***OSMOTIC DEHYDRATION OF HONEYDEW (Cucumis melo L. var. inodorus) USING HIGH POWER ULTRASONIC TREATMENT***

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**By**

**FARZAD GHEYBI**

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirement for the Degree of Doctor of Philosophy**

**April 2012**

**ESPECIALLY DEDICATED TO MY BELOVED FAMILY**

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in Fulfilmentof the requirement for the degree of Doctor of Philosophy

**OSMOTIC DEHYDRATION OF HONEYDEW (*Cucumis melo* L. var. inodorus) USING HIGH POWER ULTRASONICTREATMENT**

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**April 2012**

**Chairman: Professor Russly Abd. Rahman, PhD**

**Faculty : Food Science and Technology**

Osmotic dehydration as an interesting method in food industry needs to be improved by complimentary methods to be more economical and effective. The objectives of this study were to investigate on osmotic dehydration of honeydew (***Cucumis melo* var. inodorus**), to optimize the process and to investigate the effects of high power ultrasonic on the osmotic dehydration of the fruit.

The effects of storage of fruits for 15 days on mass transfer parameters during osmotic dehydration in a fix temperature (50 °C), concentration (50 %), size (2.0 cm) and agitation (10000 Re) and also effect of different processing

factors of temperature (30-60 °C), concentration (20-70 %) of osmotic solution, size (1-3 cm) of fruit sample and agitation (0-11748.26 Re) on the osmotic dehydration of honeydew were investigated. Results showed that 15 days storage of fruit affect the mass transfer parameters of osmotic dehydration of honeydew. Results also indicated that the most important factors in osmotic dehydration of honeydew were concentration of osmotic solution and size.

Meanwhile, the optimized level of process parameters of temperature (40-60°C), concentration (45-65 %), agitation (5000-15000 Re) and time (2-4 h) was determined by using response surface method. the optimized process, considering economical, industrial and quality related constraints, was obtained at temperature of 57 $^{o}$C, concentration of 65 %, time of 2.76 hours and agitation of 14999.80 Re.

Ultrasonic treatment was applied to improve mass transfer rate in osmotic dehydration. The use of ultrasound treatment increased the water diffusivity of fruit, leading to a shorter dehydration time. Ultrasonic treatment during osmotic dehydration affected the cell structure of honeydew. The voids on the surface of the fruit and the microscopic channels on cell structure were responsible for the increase in water diffusivity. Based on the results derived from the ultrasonic regime of osmotic dehydration, short period of sonication time and rest time were needed during osmotic dehydration.

Modelling and kinetic study of osmotic dehydration of honeydew was carried out using Azuara's and Magee's, Page's, Logarithmic and Crank's models. Azuara's and Magee's models were better to be used as compared to Page's, Logarithmic and Crank's models because they can fit the solid gain (SG) data more accurately and they turn out to be good enough for fitting water loss (WL) data.

Meanwhile, based on the results from the study on the proposed model, the model could therefore be used to predict the equivalent WL and WL in any processing time by using the process parameters.

It can be concluded that storage time of honeydew affect on mass transfer parameters during osmotic dehydration and agitation of turbulent level (Re>10000) affect on mass transfer significantly. Also ultrasonic treatment can increase mass transfer (5%) during osmotic dehydration. The WL and infinite WL can be predicted proposed model that consider processing factors.

Osmotic dehydration of honeydew can be enhanced by increasing agitation level to turbulent level and applying ultrasonic treatment.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**PENYAHHIDRATAN OSMOSIS TEMBIKAI SUSU (*Cucumis melo* L. var. inodorus) DENGAN PERLAKUAN ULTRASONIK BERKUASA TINGGI**

**Oleh**

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Penyahhidratan osmosis sebagai satu kaedah yang menarik dalam industri makanan memerlukan penambahbaikan melalui kaedeh-kaedeh tambahan untuk menjadikannya lebih ekonomi dan berkesan. Objektif kajian adalah untuk mengkaji penyahhidratan osmosis atas buah tembikai susu (*Cucumis melo* var. inodorus), mengoptimumkan proses dan menyelidik kesan ultrasonik berkuasa tinggi ke atas penyahhidratan osmosis buah tembikai itu.

Kesan penyimpanan buah selama 15 hari dan diproses pada satu keadaan tetap penyahhidratan osmosis bagi suhu (50 °C), kepekatan (50 %), saiz (2 cm) dan pengadukan (10000 Re) dan bagi faktor-faktor pemprosesan yang berlainan bagi suhu (30-60 °C), kepekatan larutan osmosis (20-70%), saiz (1-3 cm) dan

pengadukan (0-11748.26 Re) ke atas penyahhidratan buah tembikai susu telah dikaji. Keputusan menunjukkan penyimpanan buah selama 15 hari memberi kesan kepada kadar pemindahan jisim penyahhidratan osmosis tembikai susu. Keputusan juga menunjukkan faktor paling penting dalam penyahhidratan osmosis tembikai susu ialah kepekatan larutan osmosis dan saiz sampel.

Dalam pada itu, kesan peningkatan tahap gelora pengadukan atas pemindahan jisim dalam kepekatan yang tinggi menunjukkan bahawa pengadukan larutan osmosis perlu ditentukan bersama dengan kepekatan dan suhu larutan. Proses pengoptimuman, dengan mengambil kira kekangan dari segi ekonomi, industri dan kualiti, telah dicapai pada suhu 57 °C, kepekatan 65 %, masa 2.76 jam dan pengadukan pada 14999.80 Re.

Perlakuan ultrasonik yang digunakan adalah untuk memperbaiki kadar pemindahan jisim dalam penyahhidratan osmosis. Penggunaan perlakuan ultrasonik meningkatkan keresapan air bagi buah, maka dengan itu memberikan masa penyahhidratan yang singkat.

Penyahhidratan osmosis diiringi oleh perlakuan ultrasonik telah mengubah struktur sel tembikai susu. Liang pada permukaan buah dan saluran mikroskopik pada struktur sel bertanggungjawab kepada peningkatan dalam peresapan air. Berdasarkan keputusan daripada regim ultrasonik

penyahhidratan osmosis, tempoh pendek masa pensonikan dan masa rehat diperlukan semasa proses penyahidratan osmosis ini.

Pemodelan dan kajian penyahhidratan osmosis buah tembikai susu telah dilakukan dengan menggunakan model Azuara, Magee, Page, Logarithmik dan Crank. Model Azuara dan Magee adalah lebih baik berbanding dengan model Page, Logaritmik dan Crank kerana data peningkatan pepejal (SG) dapat disesuaikan dengan lebih tepat dan juga cukup berguna untuk disesuaikan dengan data kehilangan air (WL). Tambahan pula model Azuara mempunyai kelebihan membenarkan pengiraan nilai keseimbangan WL dan SG. Walau bagaimanapun, adalah penting untuk ditekankan bahawa model Logaritmik mempunya pemadanan yang baik untuk WL dan model Page untuk SG.

Sementara itu, berdasarkan daripada keputusan kajian pada model yang dicadangkan, ianya boleh digunakan untuk meramalkan WL setara dan juga WL dalam mana-mana masa pemprosesan menggunakan parameter-parameter proses.

Boleh disimpulkan bahawa ciri-ciri bahan mentah mempunyai kesan pada kadar pemindahan jisim penyahhidratan osmosis dan tahap gelora pengadukan (Re>10000). Penyahhidratan osmosis juga boleh ditingkatkan (5%) dengan monggunakan perlakuan ultrasonik. Penilaian model yang dicadangkan

berlandaskan kepada faktor-faktor pemprosesan menunjukkan ia mempunyai keupayaan yang baik untuk meramal WL dan WL tak terhingga.

Penyahhidratan osmosis tembikai susu boleh dilakukan dengan meningkatkan tahap gelora pergadukan dan menggunakan perlakuan ultrasonik.

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I certify that an Examination committee met on 29 April 2012 to conduct the final examination of Farzad Gheybi on his Doctor of Philosophy thesis entitled "Osmotic Dehydration of Honeydew (Cucumis melo var. inodorus) and in Combination with High Power Ultrasonic Treatment" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and University Pertanian Malaysia (Higher Degree) Regulation 1981. The committee recommends that the candidate be awarded the relevant degree. Members of Examination Committee are 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 other institutions.

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**FARZAD GHEYBI**

Date: 19 April 2012

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