ARTIFICIAL NEURAL NETWORKS-DIGITAL IMAGE-BASED
COLORIMETRY FOR PROTEIN ASSAY
IN NATURAL RUBBER LATEX

NONTAWAT BANG-IAM

A Thesis Submitted to the Graduate School of Naresuan University
in Partial Fulfillment of the Requirements
for the Master of Science Degree in Chemistry
July 2012
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This thesis entitled "Artificial neural networks-digital image-based colorimetry for protein assay in natural rubber latex" submitted by Nontawat Bang-iam in partial fulfillment of the requirements for the Degree of Master of Science in Chemistry is hereby approved.

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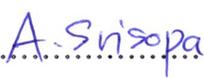
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ACKNOWLEDGEMENT

Title	ARTIFICIAL NEURAL NETWORKS-DIGITAL IMAGE-BASED COLORIMETRY FOR PROTEIN ASSAY IN NATURAL RUBBER LATEX
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Academic Paper	Thesis M.S. in Chemistry, Naresuan University, 2012
Keywords	Artificial neural networks, Digital image-based colorimetry, Natural rubber latex, Latex gloves, Extractable protein

ABSTRACT

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Digital image-based colorimetry (DIC) using a CMOS webcam camera as a detector coupled with artificial neural networks (ANNs) technique was developed for protein assay in natural rubber (NR) latex. This method was based on the RGB value (Red, Green and Blue) of different color intensity from the reaction of protein complexes with the modified Lowry reagent. All protein standard solutions and the sample data were obtained by capturing a single image in the DIC light box. All data were processed by the ANNs program to evaluate the RGB value of each digital image. Under the optimum conditions, the amount of the protein could be determined in the concentration range of 0 - 10 $\mu g\ mL^{-1}$. When comparing the results obtained from the DIC-ANNs with the spectrophotometric method, there was no statistical difference at 95% confidence level. The average mean squared error (MSE) for the protein assay was 0.037. The minimum and maximum levels of protein determination by proposed method were 1 and 100 $\mu g\ mL^{-1}$, respectively. The proposed method was successfully applied to the determination of extractable protein in NR latex and medical latex gloves which prove to be convenient, rapid and inexpensive method.

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ABBREVIATIONS

NR	=	Natural rubber
DIC	=	Digital image-based colorimetry
DSC	=	Digital still camera
DIB	=	Digital image-based titration
ANNs	=	Artificial neural networks
BPNN	=	Back-propagation neural network
SPEC	=	Spectrophotometry
RGB	=	Red, green, and blue
CMYK	=	Cyan, magenta, yellow and black
HEX	=	Hexadecimal
HSV	=	Hue, saturation and value
L*	=	Brightness value
a*	=	Red-green component
b*	=	Yellow-blue component
CMOS	=	Complementary metal oxide semiconductor
CCD	=	Charge coupled device
DSLR	=	Digital single-lens reflex camera
jpeg	=	Joint photographer's experts group
PTFE	=	Polytetrafluoroethylene
PE	=	Polyethylene
DI	=	Deionized water
$^{\circ}$C	=	Degree celsius
M	=	Molar (mol per liter)

ABBREVIATIONS (CONT.)

$mg\,L^{-1}$	=	Milligram per liter (ppm)
$\mu g\,mL^{-1}$	=	Microgram per milliliter
$\mu g\,g^{-1}$	=	Microgram per gram
μg/glove	=	Microgram/glove
cm	=	Centimeter
μm	=	Micrometer
nm	=	Nanometer
mL	=	Milliliter
h	=	Hour
V	=	Volt
DC	=	Direct current
$k\Omega$	=	Kilo ohm
AFP	=	α-fetoprotein
CAS	=	Chrome azurol S
BCA	=	Bicinchoninic acid assay
CB	=	Coomassie Blue
ASTM	=	American society for testing and materials
LEAP	=	Immunosorbent assay for antigenic protein
ELISA	=	Enzyme-linked immunosorbent assay
LED	=	Light emitting diodes
MSE	=	Means squared error
RSE	=	Relative standard error