

1.5 T

1

2

3

: 1.5T  
가  
: 0.01% 50% + 0.01%  
20% + +  
nuclear magnetic resonance(NMR)  
/ , (  
+ )/ , ( + )/  
가 NMR  
:  
+ )/  
NMR  
:  
가  
/ , ( + )/ , ( + )/  
가  
가

(Magnetic resonance spectroscopy, MRS)  
( , , )  
(spectrum)  
(1).  
(2-4)  
, ,  
(5 - 8).  
(<sup>1</sup>H - MRS)  
NMR  
가  
1.5T  
)  
가  
<sup>1</sup>H - MRS  
가  
NMR

: 1.5 T

(NMRS) 14.1T NMR (Bruker 500 MHz  
NMR spectrometer, Bruker, Karlsruhe, Germany)

, + + 0.2  
ml (D2O) 0.4 ml NMR NMR  
4, 3 .

+ ,  
가

+ + . +  
0.01%,

0.1%, 1%, 5%, 10%, 15%, 20%, 30%, 40%, 50%

25 ml . + +

5 ml +

50% 0.01%, 0.1%,

1%, 5%, 10%, 15%, 20% 7 20 ml

25ml

+  
2.50 - 4.00 ppm 4.7 ppm

+ 1.18 ppm +  
ppm ( + ) , 4.7 ppm , 3.25 - 3.66  
, ( + )/

<sup>1</sup>H - MRS 1.5T (GE Signa Horizon :  
GE Medical System, Milwaukee, WI, U.S.A.)

STEAM(Stimulated Echo - Acquisition Mode)

. TR (Repetition time)=3000

ms, TE (Echo time)=30 ms, TM (Mixing time)=13.7 msec,

SW (Sweep width)=2500 Hz, SI (Size)=2048 points, AVG

(Number of average)=128, NEX (Number of excitation)=1,

voxel size=8(2<sup>3</sup>) cm<sup>3</sup>

+ 25 ml falcon

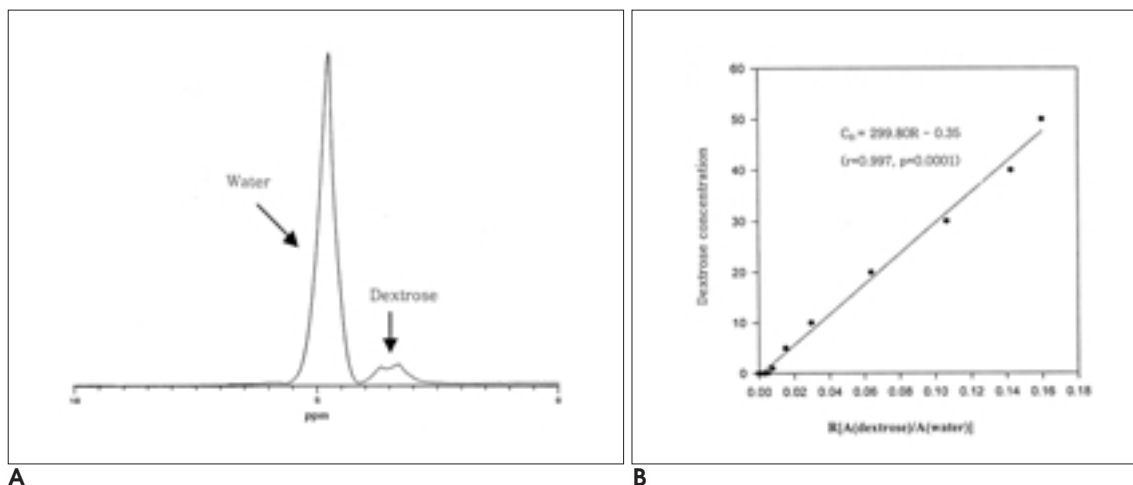
4

3

**Table 1.** The Mean Ratios of Dextrose to Water Peak [A[dextrose]/A[water]] Measured on <sup>1</sup>H-MR Spectra and High Resolution NMR Spectra in Various Dextrose Concentrations

Conc. of dextrose (%)	Mean A(dextrose)/A(water)	
	MRI	NMR
0.01	0.002	0.004
0.1	0.005	0.007
1	0.008	0.010
5	0.015	0.016
10	0.030	0.030
20	0.064	0.065
30	0.108	0.099
40	0.143	0.141
50	0.162	0.190

# Conc. : Concentration, A : area



**Fig. 1. A.** The <sup>1</sup>H-MR spectra from 30% dextrose + water solution, obtained at 1.5T commercial MR system. Water peak was single peak at 4.7 ppm and broad peak of ethanol ranged from 2.50 to 4.0 ppm.

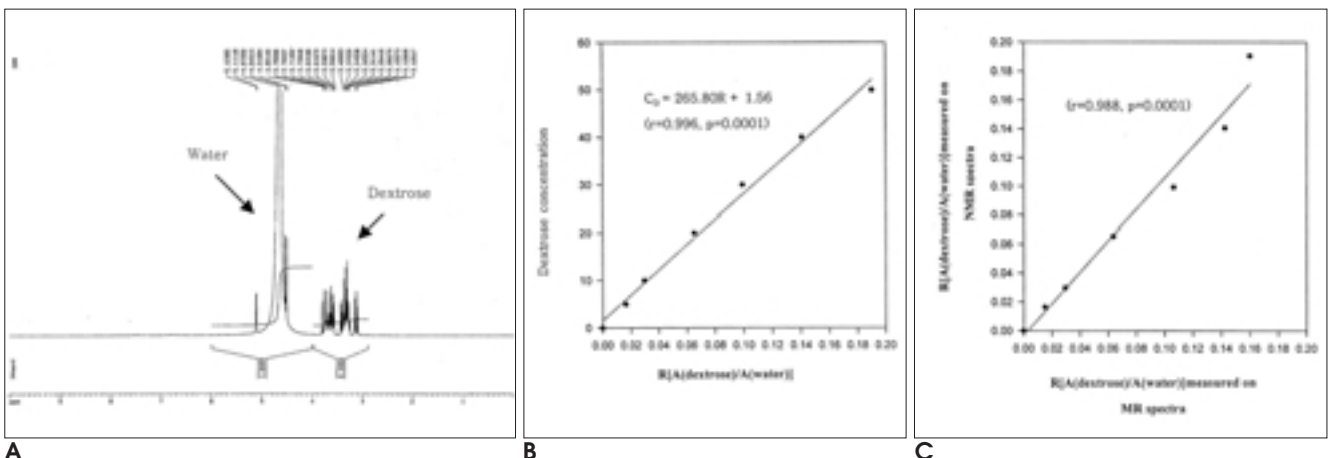
**B.** The relationship between dextrose concentration and the ratio of dextrose to water peak [A(dextrose)/A(water)] measured on <sup>1</sup>H-MR spectra.

$C_D = 299.80R - 0.354$   
 $C_D$  : (Concentration of dextrose)  
 $R$  : /  
 $(A[\text{Dextrose}]/A[\text{water}])$

NMR  
 (Fig. 2A). /  
 가 가 가  
 SAS v6.12  
 (Table 1). NMR /  
 가 0.996 ( $p=0.001$ )  
 가 가 가

NMR  
 (correlation analysis)  
 (Simple linear regression  
 analysis) 0.05  
 $C_D = 265.80R + 1.56$   
 NMR  
 0.988 ( $p=0.0001$ )  
 (Fig. 2C).

4.7 / /  
 2.50 - 4.0 ( + )/  
 (Fig. 1A).  
 4.7 ppm , 1.18 ppm 3.25 -  
 3.66 ppm +  
 (Fig. 3A). NMR  
 0.997 , + 가  
 (Fig. 3B). ( 가  
 + )/  
 0.994 ( $p=0.001$ ) 가



**Fig. 2. A.** The  $^1\text{H}$ -MR spectra from 30% dextrose+water solution, obtained at 14.1T high resolution NMR spectroscopy. Water peak was single peak at 4.7 ppm and broad peak of ethanol ranged from 2.50 to 4.0 ppm.

**B.** The relationship between dextrose concentration and the ratio of dextrose to water peak  $[A(\text{dextrose})/A(\text{water})]$  measured on high resolution NMR spectra.

**C.** The relationship between the ratios of dextrose to water peak  $[A(\text{dextrose})/A(\text{water})]$  measured on  $^1\text{H}$ -MR spectra and high resolution NMR spectra in various dextrose concentrations.

: 1.5 T

(Table 2, Fig. 4B).

$$CD=0.29R - 7.74$$

$$C_D=384.25R - 11.72$$

CD : (Concentration of dextrose)

R : ( + )/

A[Dextrose+ethanol]/A[water]

4C).

NMR

( + )/  
가 0.991 ( $p=0.001$ )

가

( + )/

NMR

가

가

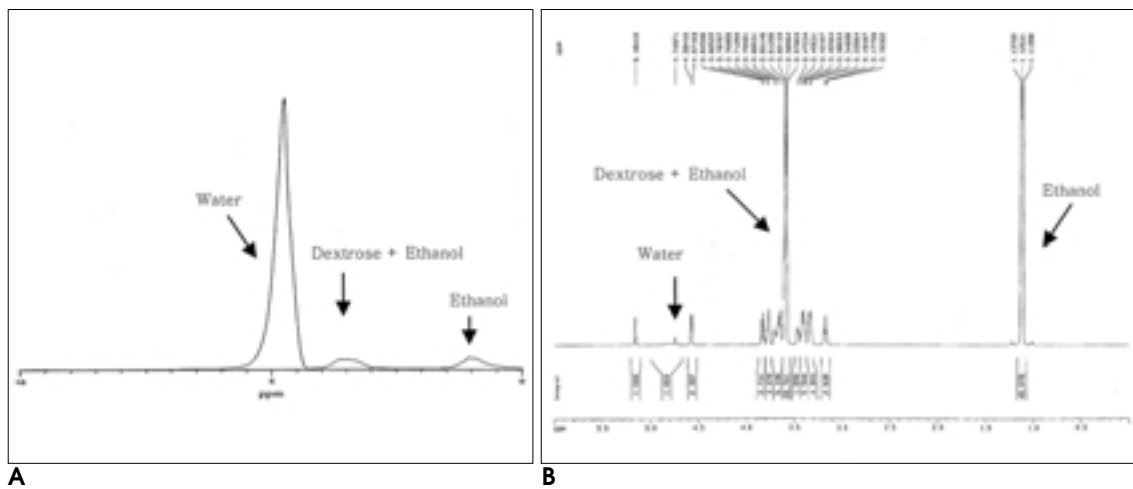
(Table 2, Fig. 4B).

( + )/

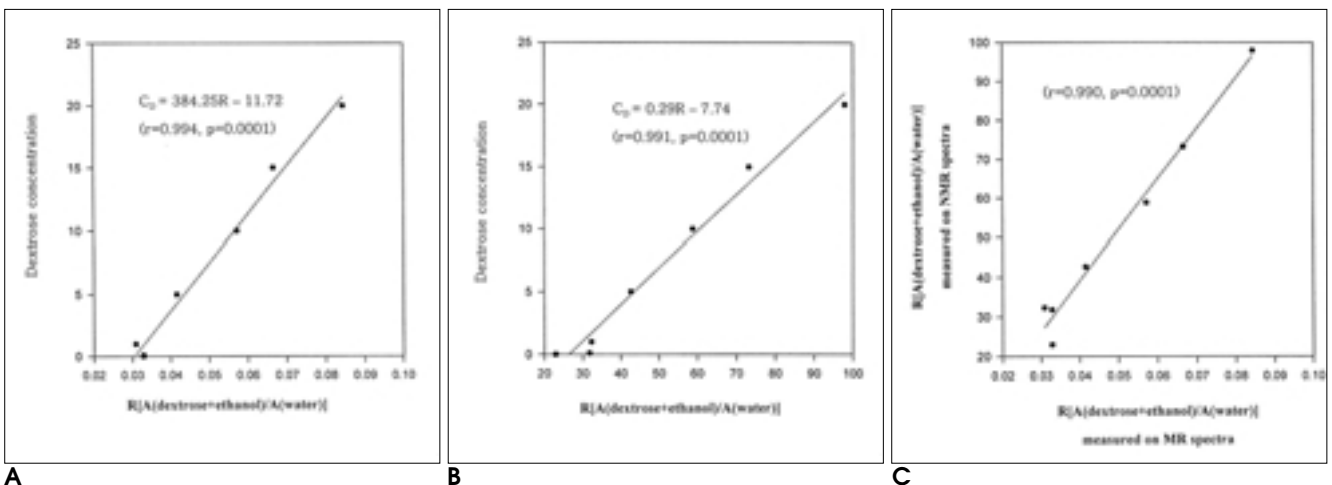
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(Table 3).



**Fig. 3.** The  $^1\text{H}$ -MR spectra from 15% dextrose + water + ethanol solution, obtained at **A.** 1.5T commercial MR system, and **B.** 14.1T high resolution NMR system. The two  $^1\text{H}$ -MR spectra show that the same metabolite peaks are presented at the same range of chemical shift.



**Fig. 4. A.** The relationship between dextrose concentration and the ratios of (dextrose + ethanol) to water peak  $[A(\text{dextrose} + \text{ethanol})/A(\text{water})]$  measured on  $^1\text{H}$ -MR spectra.  
**B.** The relationship between dextrose concentration and the ratios of (dextrose + ethanol) to water peak  $[A(\text{dextrose} + \text{ethanol})/A(\text{water})]$  measured on high resolution NMR spectra.  
**C.** The relationship between the ratios of (dextrose + ethanol) to water peak  $[A(\text{dextrose} + \text{ethanol})/A(\text{water})]$  measured on  $^1\text{H}$ -MR spectra and high resolution NMR spectra in various dextrose concentrations.

(Fig. 5C).

0.979 ( $p=0.0001$ )

(Fig. 5A).

$$C_D = 27.89R - 15.68$$

CD : (Concentration of dextrose)

R :  $A[\text{Dextrose+ethanol}]/A[\text{ethanol}]$ 

NMR

0.999 ( $p=0.0001$ )

(Fig. 5B).

$$CD = 27.14R - 16.98$$

NMR

0.981 ( $p=0.0001$ )

**Table 2.** The Mean Ratios of (dextrose+ethanol) to Water Peak [ $A[\text{dextrose+ethanol}]/A[\text{water}]$ ] Measured on  $^1\text{H}$ -MR Spectra and High Resolution NMR Spectra in Various Dextrose Concentrations

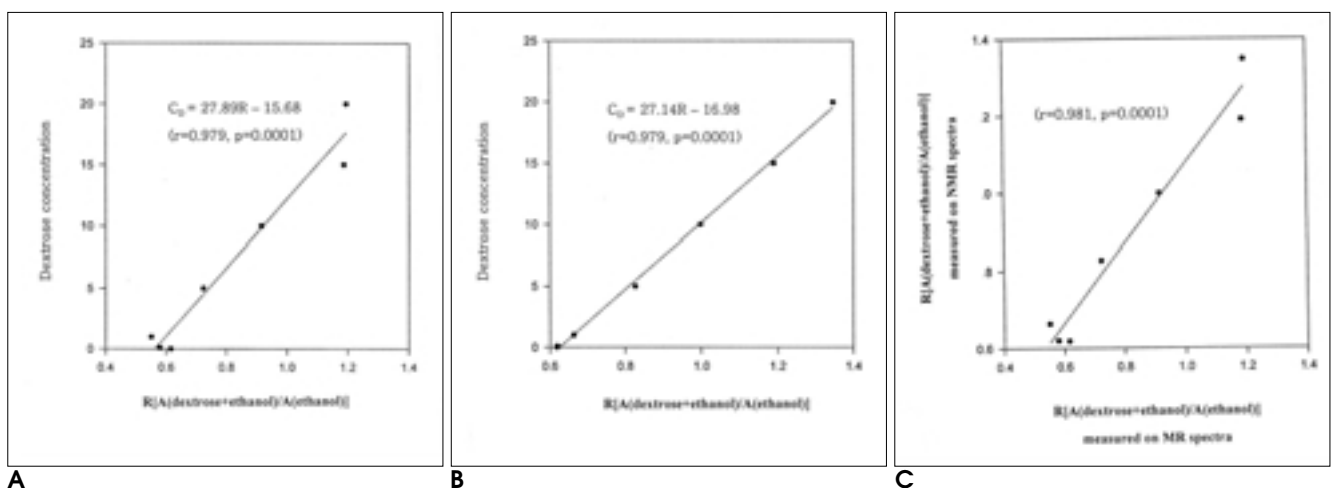
Conc. of dextrose (%)	Mean $A[\text{dextrose+ethanol}]/A[\text{water}]$	
	MRI	NMR
0.01	0.033	22.9
0.1	0.033	31.8
1	0.031	32.3
5	0.042	42.7
10	0.057	58.9
15	0.068	73.3
20	0.083	97.9

# Conc. : Concentration, A : area

**Table 3.** The Ratios of (dextrose+ethanol) to Ethanol Peak [ $A[\text{dextrose+ethanol}]/A[\text{ethanol}]$ ] Measured on  $^1\text{H}$ -MR Spectra and High Resolution NMR Spectra in Various Dextrose Concentrations

Conc. of dextrose (%)	Mean $A[\text{dextrose+ethanol}]/A[\text{ethanol}]$	
	MRI	NMR
0.01	0.616	0.619
0.1	0.631	0.62
1	0.655	0.664
5	0.724	0.827
10	0.916	0.998
15	1.187	1.189
20	1.194	1.346

# Conc. : Concentration, A : area



**Fig. 5.** **A.** The relationship between dextrose concentration and the ratios of (dextrose+ethanol) to ethanol peak [ $A[\text{dextrose+ethanol}]/A[\text{ethanol}]$ ] measured on  $^1\text{H}$ -MR spectra.  
**B.** The relationship between dextrose concentration and the ratios of (dextrose+ethanol) to ethanol peak, [ $A[\text{dextrose+ethanol}]/A[\text{ethanol}]$ ] measured on high resolution NMR spectra.  
**C.** The relationship between the ratios of (dextrose+ethanol) to ethanol peak [ $A[\text{dextrose+ethanol}]/A[\text{ethanol}]$ ] measured on  $^1\text{H}$ -MR and high resolution NMR spectra in various dextrose concentrations.

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NMR

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NMR

(in vitro)

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(5, 6).

+

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<sup>1</sup>H -

NMR

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+

MRS

. Ishikawa

가

가

(7)

NMR

가

NMR

가

가

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NMR

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NMR

1. . Localized single voxel <sup>1</sup>H MR spectroscopy toward routine clinical use. 1996;34: 185-191
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## Quantification of Dextrose in Model Solution by $^1\text{H}$ MR Spectroscopy at 1.5 T<sup>1</sup>

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**Purpose:** To evaluate the feasibility of proton magnetic resonance spectroscopy ( $^1\text{H}$ -MRS) using a 1.5T magnetic resonance (MR) imager for quantification of the contents of model solutions.

**Materials and Methods:** We prepared model solutions of dextrose + water and dextrose + water + ethanol at dextrose concentrations of 0.01% to 50% and 0.01% to 20%, respectively. Using these solutions and a 1.5T MR imager together with a high-resolution nuclear magnetic resonance (NMR) spectroscope, we calculated the ratios of dextrose to water peak, (dextrose + ethanol) to water peak, and (dextrose + ethanol) to ethanol peak, as seen on MR and NMR spectra, analysing the relationships between dextrose concentration and the ratios of peaks, and between the ratios of the peaks seen on MR spectra and those seen on NMR spectra.

**Results:** Changes in the ratios between dextrose concentration and dextrose to water peak, (dextrose + ethanol) to water peak and (dextrose + ethanol) to ethanol peak, as seen on MR spectra, were statistically significant, and there was good linear regression. There was also close correlation between the ratios of the observed on MR and NMR spectra. The results depict the quantification of dextrose concentration according to the ratios of spectral peaks obtained by proton MRS at 1.5T.

**Conclusion:** Using proton MRS at 1.5T, and on the basis of the ratios of spectral peaks, it was possible to quantify the concentration of dextrose in model solutions of dextrose + water and dextrose + water + ethanol. The results of this study suggest that for quantifying the contents of biofluids, the use of low-tesla  $^1\text{H}$ -MRS is feasible.

**Index words :** Glucose

Magnetic resonance (MR), spectroscopy

Magnetic resonance (MR), experimental

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