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## Abstract

Selenium (Se) is an essential trace element, plays a major part in many metabolic functions. Selenium-rich diets appear capable of protecting people against several cancers, based on its presence at active sites of glutathione peroxidase. The enzyme can protect against lipids peroxidiation-induced cell membrane damage, and reducing the potential for oxidative damage to DNA, proteins. The aim of this research was to quantify total selenium content present in foods, and antioxidant enzymes such as glutathione peroxidase (GSHPx), catalase, superoxide dismutase (SOD), and total antioxidant status in blood. The correlations between daily selenium intake and antioxidant enzymes were obtaining from healthy population. Quantitative analysis for selenium was performed using an ICP-AES (Perkin-Elmer). The antioxidants activities were measured by commercial kit (Randox Lab oratories, U.K.).

The results indicate that: (i) the daily selenium intake show no significant difference associated with GSHPx, (ii) the daily selenium intake (44 μg/day) in Taiwanese is confirm to the WHO normative requirement of 40 μg/day, (iii) the activity of GSHPx (5540 U/L) is in the normal range, but SOD (98.02 U/ml) and total antioxidant status (0.95 mmol/L) is below the normal range, (iv) the activities of catalase and total antioxidant status also correlates positively with SOD and negatively with GSHPx and (v) significant difference is found between the GPx activities and alcohol ($p<0.05$), and SOD activities correlates negatively with whether consume *Lycii Fructus*.

Key word: antioxidant enzymes, selenium, daily selenium intake

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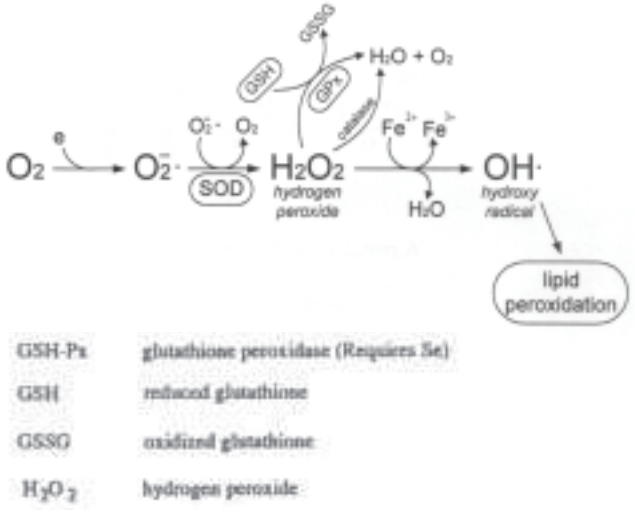


„ ˇ@ GSH ⁄ ¸ SOD ' ¥ ˝ " « ¯ Ø ⁄ ″§§@¥ ¸ ¤

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⁄@¥ b ⁄W selenoprotein-p « ƒ¡(Harrison et al., 1996)¡ AH¯Ø‹ ı ƒł†y⁄·¥ D › »Pƒ
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ł ¥ ƒX¡CGPx ⁄⁄¤C⁄@› »ˆfl ⁄ ⁄l§ ł ł4 › Se › ⁄l¡A¤ˆ¥H Se-cysteine "″« ƒ¡ƒs
ƒb¡Aƒ] ·ƒ ' GPx "″‹ ¡⁄ˇƒ ,ß(Clausen and Nielsen, 1988; Schukelt et al., 1991)¡A
‹ G § Œ ‰«ƒ0]fl@ ‰ ł„Lƒfiæ ⁄ _⁄§† › M ‰¶¡„Ai·›ˇƒX"«„ fl~¡B´ ¡B¤ E ¥ «"¡Aˆ
¥ ¶°⁄ ¤ ⁄¶ ¡ ¥ N ´"†«‰"⁄ ˇ ł ¸§ ¤ ‹ r'°fi ˜ł¡Cƒb ·fl ″ -ƒ A , ¥¥B″fl ß E
˜ Æ ¤ æ£‰"« ª ¤..ƒ¡⁄U¡Aƒ Uƒ „ phGPx (phospholipid-hydroperoxide glutathione peroxidase)‹ ¡'° I ł,ß¥"fl ^ ⁄ , ß¡§¥ifl ¯ ¥ phGPx ƒb⁄j¥ „«"″¥˝†z›«›n'° "
' cGPX (cellular glutathione peroxidase)¡Afl §O‹ O⁄ ¯ƒ⁄¸ AY¡A¥ifl ƒ]‹ ƒ Uƒ ″
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(Rotruck, 1971)¡ A ¥H ·¥ifl § Œt§ fiæ⁄ˇ"″¤ ƒ ¡A¥B‹ ı ƒł†y⁄fl ¥F "″ °"«¤ †
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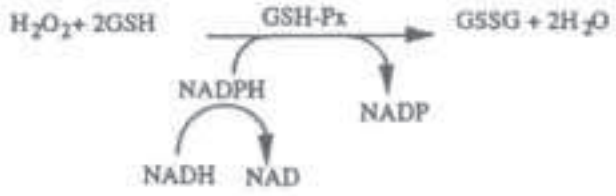
(phosphorylation)¡Aƒ]ƒ ¤ªƒł§ fiæ⁄ˇfi ˜ł¡CGPx ¥i› §C⁄jƒ h ˇ" ″ƒ† „ fiæ⁄ˇ"«¡A
‹ ƒ $H_2O_2$¡Aƒ glutathione(GSH)‹ O¥˝†z ⁄@"″` › fl¡A¤ § @ ¥ ¸ ƒpp„ˇ l¡Aƒ]ƒ„¡A
ƒ ⁄⁄GPx "″⁄ "R– "†Q§@‹ ·fl ¥F"″ » · «« ¡.C–




| | |
|---|---|
| GSH-Px | glutathione peroxidase (Requires Se) |
| GSH | reduced glutathione |
| GSSG | oxidized glutathione |
| $H_2O_2$ | hydrogen peroxide |

„ ˇG GSH ' ¥ ˝ " « ¯ Ø ⁄ ″§§@¥ ¸ ¤

› Y " ł · ` „ ⁄ ' ⁄ j ¥ „ «"GS¶H.fi›„æ¡A•˙⁄z ›Z⁄¥§¥` ¿¯¡A¶ i ƒ ¥ifl ·£ "† ›M⁄Sfi æ ⁄ ˘ƒ(Chou, 2000)¡C

¥ ' • L ¶ q ⁄fl¥ƒb" «Ø¥Ł″ ¥ 1.‹ ¡⁄˘' § ¤ »ˆfl ⁄ ˘ ł¡2B» P ¤¥Ł‡l ˜ ∀§ ł J¥ † ƒ ¥ ¡B3.... v̄T† ›M‰ ⁄ " ″ ł q ł ź°¤ S„¥¤" ″ ¥..(Drake and Sky-Peck, 1989; Sky-Peck, 1986)¡A¥i" ‰ ' ¸¶ † ... v̄T ø⁄˘„ L{¡A‹ G „ L ¥ h · ¿ ф{¯Øflgflf⁄H ⁄″¯K¡B» ¡B N»P ·"″⁄ ¥‹»P¥ ¿ – ` H⁄(fTfuesh and Kensler, 1991; Stevens and Nerishi, 1992)¡C10$^{-7}$M "″ ·„ ¤"¢ ›MiŁHuH7 ł ƒ ł « O@‡iA"GbHuH7 † ›M ƒs‹ ¡"″„ L{⁄ ⁄ § Œ ″ t ¤″"″¤«‹»nƒ¡§G¤ † ›M› ⁄ ›¸¶k‡L † ›¥Ń"Ł¡C ·¥i¥ H ‰–– ¤ ″ § ¤ † ›M› ⁄ `"″ł ~ fi | ¡ Ł˜⁄@¥ŁD¥H†z„L thioredoxin reductase ` › thioredoxin¡A¶ ƒ § ¤ ASK 1 – °† ›M› ⁄ ` ¤ ¡C†˜⁄G› ł fi|«h‹O ·‹ ¡⁄˘Akt » "″§ ¤ † ›Mƒ″⁄ ` ¤ ¡A" ´_Caspases1 ⁄¸3 "″‹ ¡⁄˘(Tung, 1999)¡C

· "«⁄ ·"″§t¶q»P⁄ g̃[⁄ ·§t¶q"″ƒ h‡Łƒł^ ¡A‹Gfi e ' ł ¥¤Ł'ª ¥`¯ Ø″ · "″fl ¥F¡C• ·fl ° ¥fi•| › P ⁄ffl(cardiomyopathy, Keshan disease)' ¸... ₩[›P ø"″ ƒ MI' ˚(Bonomin et al., 1996)¡A⁄ Œ⁄ j† ¥¤ƒ a˘¡A¥ ' ⁄ g̃[⁄ ·§t¶q• ¥ ¡A ›P • ª⁄¯ ƒ ƒ ″ fflłe "† – ƒ†¡Vˆ •˙°^ , "″¢' M s″°¤x w⁄˘"″– w " ƒ †M‡ß¥¿ – ›H§C¡Aƒ ¥Bƒb– ₩ "″† ´·⁄¶Wfiæƒ ¥ 'M„Łfi æ˘"«• |... ₩[(Aaseth et al., 1980; Neve, 1988)¡Gƒb› f ‹ §Ł¿g¥ H ¸⁄@¨fl ¥Fƒ M †"″¶ .›„" vŁƒ ›P · ¥F"″fl ₤H ⁄⁄ ф{ L ‰¥ƒ ⁄⁄¡Bƒ †M¡B Yv¡A‹ ƒ RBC ⁄⁄GPx †£ƒ†, §C"″ ·¿ @ (‹ ø ¥¿ – ›H"″10-20 %)¡CKrsnjavi ⁄¸Beker (1990) ф{¤¯ ø– w " ƒ ⁄†M ·¿ @ ' œ ª ›§C¡A Piccinini (1996) ¥⁄H‹h ф{¤¯ ø– w " ƒ ⁄†M ·¿ @ ƒ† y•L⁄U› ¡A¥ ¤¯ ø– ₩ ¤ ¥ " ‹ , ¢ †″⁄¸»XƒbŻ Ø″⁄ ¥‹– ¡ § ¸o¡"A‹ ¥ ⁄⁄ ·"″¿ @ ƒ†› §C"″` ¶ ¡Aƒ ⁄£¤ †¸ › ₱W"″• ₦Nc(Strain et al., 1997)¡Cƒ ¥⁄~¡ A ¶ ›⁄⁄ ·"″fl ¥F⁄ ] ⊕»{ ‹ O¤¯ ø"″ƒ MIƒ] ⁄l⁄§⁄@(Garg et al., 1994)¡Cƒ °"«` › „·"″, ₦ ₹|¤ ¿EGPx "″‹ ¡' ˚(Reiter and Wendel, 1985)¡Aƒ ƒ„¡ A·"″« O@ ´ ¥D› ₦O¥]§tƒb§ fi æ˘»ˆfl glutathione ⁄⁄¡C

ƒ b ° " « ' M † › M ‹ ª ¤ s ⁄ ⁄ « ¥ X ·¥(Hocman, 1988; Ip and Lisk, 1995; Medina and Shepherd, 1980; Thompson et al.,1994)¡ A ⁄ H ^ƒ⁄†G" @« " "·»P ø fl g S Co¥˝ª†ƒ † ‹ ^(Hocman, 1988)¡C ·, ¥ R fl«¤˝ƒ†„ w ¤ ⁄ – hBˆ , ' ¡Bfl¡ B ƒ " fl e fl f Bƒ o"ˇ¡B¡ B ⁄ £ ¥ (Duvillet et al., 1998)¡C ·, fl w ^„¥Ei„ ¤ "C' ° ·fl ¥Bflg"‹¡Afp Keshan disease (Yang et al., 1989)¡C´ ‹ ª ¤ « .¥X˝ › ·IS†· " ¥´"˚"«‰Ł¤ ƒ†„ ¤ ø fl"S ¥¸¡A, g , ¯»»{P selenoamino acids " " ¥"S« ¥¸ƒ † (Clark et al., 1995,1996,1998; Ip et al., 1994)¡C

ƒb⁄ @ «¯fl¦f¤ „•‹ ª s(nested case-control study)⁄⁄¡A o† { ƒ ~ 45-68 • fiL « ´ ƒ i ⁄ Ø·‹ H Aflƒ†M ·¿ ¥« ¡ 147.2 ng/ml ¿ ' – ũÆ¯@"⁄æ†v,ßSC(OR=0.5, 95% CI=0.3-0.9)¡Fƒ †M ·¿ ¥« ¡ 147.2 ng/ml 'M130.6¡ 147.2 ng/ml „ L ¥⁄†¿{fbƒ†' •˘ " ,ß¥ ... ' •˘ƒ"†,ßSC¿ ' – ũÆ,¯@ Ø"⁄æ†v(Nomura et al., 2000)¡C⁄ S' 1990 ⁄¸ 1994 ƒ~¶ ¡ ¶ i ƒ ⁄¸¥›¥N« ª s¡A– · Q •˜q‹fiu... ⁄ ⁄·¿ @ «»P ¢ fi „‡Ifiæ ⁄˘» fl (GPx)‹ ¡' °¶¡⁄S« ^ ' ° ¡Oª{‰ fl»„¿ƒ ~ ƒ ] ł«¡¥A1994 ƒ~⁄·ƒb⁄uS@"" ˜ qu¤ ƒ ... ⁄ ⁄·¿ ¥« ¡BGPx ⁄¸ıƒ †y⁄⁄ Gpx ‹ ¡' °S¡,ß⁄w ¥¸ "˝˜ quSC¡AS Y ©´ • ~ ... ¯ S|RWS[" ¥´ƒ¤¡A' ¥Hƒ ... ⁄ ⁄·¿ @ «»¥GPx "˝‹ ¡' °•|› SC¡A« ª ¤ s⁄ o †{• ƒ ... ⁄ ⁄·¿ ¥« SC' 73 ng/ml fi ¡A L ¤ " "·¥hƒXƒ¤GPx¡A« Gƒ ... ⁄⁄GPx ‹ ¡ ' °⁄]•|› S©(Nadif et al., 2001)¡C Œ⁄ " ¥«„e "˝‹ ^ ‹ ª s« ˃ ¡A¥¥ ƒ †M⁄ ⁄·⁄, fl ¿ @ «¡¥A H^¥¥¶g..˘... ¥[ƒ ˜⁄Ų¡Afb^h¥¥⁄·`⁄¸«Æ·` ·⁄,fl ¿ ¥« ⁄æ^h¥¥" ·` »P„ • † Se†{¯ ª •N",©S©(t-test, p<0.001) (Lai, 2000)¡C⁄ ƒ ~ ‰Ų "ß⁄˘(oral submucous fibrosis¡A OSF)⁄¸⁄ ƒ˜ ø–w" ¯Ø⁄""ß¥´fl E¡B¡B1¡B ·⁄¸ NS¡ƒ† S ©" †{¶H(Zhuang, 2000)¡C¥ x ˘ ¥Waƒ ˘... ·¿ @ «»¥Px† › M øo¥˝«Y"S› «¯flf¤ „ • ‹ ª s¡A« ª s¥ ¥¸NS¡‹ ¤k'°ƒ ¥¸p4841 ƒW B ««‹¤x"¢– a " 'M2501 ƒW«D– a " ¡C ‹ ª s ¶G¯ª¥ ¡AB ««‹¤x"¢– a " "˝ƒ … ·¿ ¥« †⁄SC' B ««‹¤x"¢«D– a " ¡Aƒ ¤ † "˝ƒ … ·¿ ¥« ¤ ¤Sƒ†¯ ª fi t¢S¡A¤x† M fl¤ƒ¤ "˝ƒ … ·¿ ¥« ¯ ª SC' „ • † ¡C† ¯ ¶ ⁄ "R ¶G¯ª¥ ¡A¿ ł¤x† › Mø«"„ ƒ MI'°'Mƒ … ·¿ ¥« S e ª ›t‹ ^ (Hong, 1997)¡C

1980 ƒ~‹ Œ fŒa ·' e ß•|""› „ « ~ łefl»¥¥fH ˝¤C⁄Øƒ ¥ ˜Æ¤ ¶¤q 50-200 µg (NRC, 1980)¡Afi ⁄⁄ Œ¡Bfl ^ ƒŁ˜'łM‹ Œ"˝¶...›„‰ ‹ d¯ª¥ ¡A› Y F¤¥N˙´ ¥ ¿¯¥i –o⁄@« • ⁄j"˝˜Æ¤ ¶¤q‰ ¤ 9-80 µg/day (Levander, 1986)¡ AH¯Ø ·¥ ¿¯‹O ´ ¥ › S©S¿⁄¸` ¥¥K "˝– ˇ£¶q¡A„ F S©¶q "˝˜Æ¤«¡C⁄ Œ· fia o†{ƒ¤⁄H¤k'°⁄¸ ⁄k'°¤C⁄Ø¶...›„ ·˜Æ¤ ¶¤q⁄ S©« 19 ⁄¸14 µg /day ¥i¥H„ ¤ Keshan fl(Yang et al., 1987)¡C1989 ƒ~› „ « ~ i•|¥¥B⁄ W‡z„Œ¯ ‹ • ›q¥ X·¤C⁄Ø« ˜†˜Æ¤ ¶¤q (recommended dietary allowance, RDA) (NRC, 1989)¡C¥H⁄ Œ⁄H"˝...˘› flS©Ofi ¯Ø ›«›q¥X⁄@› ƒ ¥ « ˜†˜Æ¤ ¶¤q¡A¤k⁄ ¥P⁄k⁄H ·¤C⁄Ø« ˜†˜Æ¤ ¶¤q⁄ S©« 70 ⁄¸55 µg /day (Levander, 1991)¡Af~»·⁄H ·¤C⁄Ø« ˜†˜Æ¤ ¶¤qfi ¤ ›¯Ø¥N´†vƒ A ‰ ª¡C¥@« ‰^¥˝† ´·« ˜†˜Æ¤ ¶¤qfb¤k'°⁄¸⁄k'°S¡‹ 40µg/day (WHO/FAO/IAEA, 1996)¡C

·ƒ†¥ ⁄ ««ƒ¡(-2¡B0¡B+4 'M+6)"˝fiæ⁄˘"‹˝A¡Af ` ` ˝"·œ¶q» ¥–fN+ ·´ ·«ƒ¤ L ·¡A⁄j†¡⁄ ¥H– »˜(ƒp v»˜¡B„L· »˜¡B†,»˜¡B† B†»˜)'¸UV • fig«Æ¥[⁄J

„ L fi æ ⁄ ˇ † B fi ł ⁄ ˇ ¡ A ƒ fi ł ⁄ ˇ fi ` S K ¥ [ ⁄ J ˇ Q » ˜ ¤⁄ ·S¸ƒ¤·S o' · S o ⁄ S ⁄ , fl ¡ A ⁄ @ fl ° ¥ H • L " i fi ł ⁄ ˇ ¶ i ƒ ¥ ˝ " «¸«~⁄S«e†B†z¡A (HPA, high pressure ashing)"˝S †N¶ i ƒ «†(Krushevska et al., 1996)¡C" æ ¤–¥"¸ ' ` ' ·¶ q œ¶Q"⁄ Ł " k ¥‹GA¡GHG-AAS¡HHG-ETAAS¡HICP-MS 'MHG-ICP-MS¡A ⁄ fl°ƒ ¤¥¡A« ^ ł " ‰ Y˝¶fiõœ..¸¥ »⁄" ˝·¿ @¡A G ⁄ W ⁄«e¶P«e¿ @Y¡ C ƒ ¥~¡A 1970 ƒ ~ ¥ N}¡'A« r†z ·¡B` S ⁄ˇ · ⁄ ¸ i·‹ ¶q}.'¿~⁄" ˝ ⁄ , fl¡A¥"Y˝ ¤ C ⁄ ØÆ¶œ« ~ fie¶œ« ¤ ¡A› Y ¥ üÆ¤@˝ S¸ƒ¡"˝¯K¡A« ‚ß^ł† Q ⁄ H ¯ Ø S lƒ‹ (Raptis et al., 1983)¡C MI S t"˝¶ .»„¥ ¥H„w¤ ‹ Y ¤ ·øfl¶ƒ †« ª ¤ « ¥¥Xu Æ¤œ † ⁄ S¸ƒ¡" ˝ ·⁄ƒX"«¤ ^L"k –o⁄@›P"˝ ˝G¡A·«¤¥⁄ S¸A˜ Æœ¥ ›„"« ¤ªƒ† ·S ø " ˝ƒ¤¥ (Janet R, 2001)¡C⁄H^ "˝˜ Æœ¥ D › n ©, ø¸¥"« ^ ƒ ¤ ¡A¤ ⁄⁄¤ x̄ƒ¡B ¯ƒ¡B ⁄ †£›„« "˝¿ @ , ß "¡C0.4-1.5 mg/kg Se¡A‰\^ ⁄¸¤ »s«~¡C0.1-0.8 mg/kg Se¡A⁄ "G 'M‰ › ƒ‚ƒh S0.1 mg/kg Se (WHO, 1987)¡Cƒ ›„"«⁄⁄ ·ƒ b , ¤G"˝S Ł‹¥i„F 90% (50-100%)¡A¤ ⁄⁄ · ™⁄˜¨S¸" A • | ' ¯ª¤.vS¯Ł‹† ‡v¡A¤ ƒp⁄ , fl ·· X ¤⁄£ † Q S ƒ¸B L S¸ƒ ‹h‹O · » ˜QS"Ł‹† v æ¤¨ · ›˜Qj¡Fselenoamino acids , ß L "«" ' † Q S ƒ¸ASelenomethionine "˝S Ł‹†v« 75-100¢H (Fairweather-Tait, 1992)¡C

## ‹ ª¤s¥ "˝

1.– ·Q¶ .»„⁄⁄ ·¿ @ ¡B¤ C ⁄ ØÆ¶œ» F ⁄⁄GPx¡BSOD¡BCAT¡BTAS ¥¡' ˚S^ «Y¡C
2.»Pƒ UC« ˜†› ¨ ¶S@@⁄æ, ß¡A" ł ¥ x̌W¶ ~¥›⁄ "˝¤ C ⁄ ØÆ¶œ OS_ƒ†⁄£¤‹ ' ¸„ L "⁄S¡S ¡C
3.¥ ' ¥ x̌W¥ «e¤^¥..ƒ†›„"«⁄⁄ ·S t¶q¡B "˝¤ C ⁄ ØÆ¶œ ¸ƒ ⁄⁄ ¢ fl ¥⁄„°fiæ ⁄˜»^fl ‹ ¡'°⁄ "R⁄S ª¯Ø« ª s¡A« ¥« ª s¥i` ¥» ŒÈ`††¶ .»„⁄^ "·˜ Æœ¶q O S_†¯ƒX¥@« ‰^¥˝† ´·⁄S† S C« ˜ ŦÆ¶œ¡C

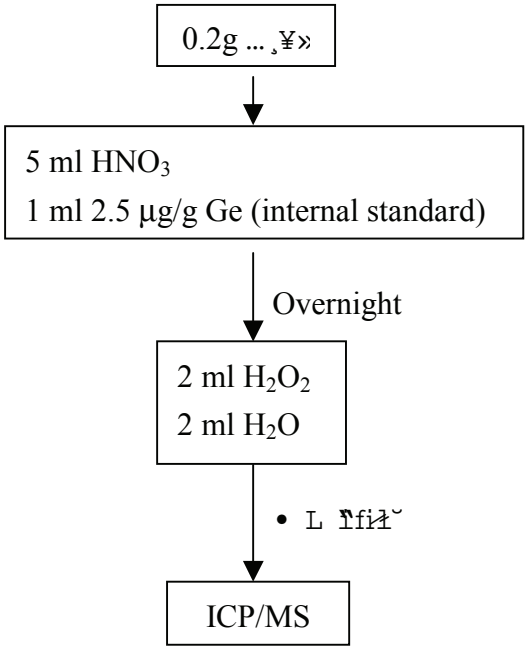
## ‹ ª¤s⁄Ł"k

¡]⁄@¡ ^ ›fiƒ‹¶ " B ¥w¥ ¥« ¤¥`††¶ ƒ‹ ª s‰ ‹d¡Af @p22 ƒ ¡C

¡]⁄G¡^ ¤†X‡¡G
¥H †"cƒ¡ ¤ ¶ æ g»¶ ¤ ¥», fi˜¡A¤^¶ ƒ ¶ .»„ W†v ¤ ‰ ‹d⁄¸24 ⁄pfi ¶... ›„ƒ ^ ← ¡A⁄"fie¥ ] A¡ƒG~ ¡ A°S O¡B¤ › "¯Ø›«¡A S°fił¶O¶q¡A'~ƒ ¤ ¡˜A L¥h 24 ⁄pfi ⁄S' ƒ†¶ .»„fił¶O˜ Æœ¶q¡A¤ «Æ¤^–N ¤ ¶G´k^ ‹ ¥⁄^ ¡B⁄ › fi ^† ¡B ƒ S†^J ¡B⁄ †£›„«~^ ¡B‰ › ^ ¡B⁄ "G^ ¡B¶..fi˜^ ⁄¸"o^ ¥¡A¤^– " ¤ ˜ Æœ¶q¡C

¡]⁄T¡^... «~` ' ·¶q⁄S⁄ "R
¡fl⁄ †£›„«~¡G H ¿ ¤œ2-3 › ¶ †¸¥«†ı⁄¸¶ fi¯¥«†ı' ⁄j‰ †ı¡ ŒH⁄¸¤ ¥ x̌W"u fi fi · ¶ ˜†‰^ ¡B¥ · ^ ⁄¸¤'^ ¥..¸¥»¡Af @p†‰^ 18 " ¡B¥ · ^ 5 " ¥H⁄¸¤'^ 6 " ¡ C¸¥»–˜¶ «Æ¤††t« Ø s' ˜ –af¡ƒ Bc⁄¡A

• ⁄ Ø e ƒ ^ „ Œ ¯ « · Š N ˜ ¡A¥H¤ «Æ˜ †B†z¡C




¸ · œ ¥ X † ‰ ^ ¡ B ¥ · ^⁄«¤Æ'A¤ œŠ¤ ' ‑¿Œ«ƒ ¥ ›Šęomętric mean¡ ^ – ¤J¤ŒŒ '·˜Æ¤œ¶qŠƒ ″ ⁄‰ƒĢ¡

¡fl ¤ ¥ L › „ ‟ « ... ¸ « ~ ¡ GN¶Š››‟«¡A¤ ⁄⁄ƒ ƒ U Œ ⁄Š„‹ Œ¤¡sA» ' ¶ƒU ″ › ‟«‹ Š ¿@« ¥ ←¡‹Š Æ–N⁄Š´k^ ‹ ¥⁄ ¡B⁄ › fi †
^ ¡Bƒ Š†Ĵ ¡B⁄ †£› ‹~^ ¡B‰ › ^ ¡B⁄ ‟G^ ¡B¶ fi ˘^ ⁄¸
‟o^ ¥¡A¤ œ ' ƒ ↛¨·‟X ƒ ¥Š¡¡C.˘

¡]¥|¡ ¤C⁄Ø ' ·˜Æ¤œ¶q⁄Šƒ ″
–N¤œ–o⁄S¥⁄^ ¡B⁄ › fi †¡Bƒ Š†Ĵ ¡B⁄ †£› ‹~^ ¡B‰ › ^ ¡B⁄ ‟G^ ¡B¶ fi ˘^ ⁄¸‟o^ ¥` ' · ¿ @ « ¡ }Xƒf^A¥›ŠĴf..Ŭ „‟‟⁄‟¶ .›„˜Æ¤œ¶ q ‰ƒ¡⁄¡A– ″ ¥X¤C ⁄Ø ' ·˜Æ¤œ¶q¡ ¥H¥D›„^ ‹ ¤ ¡A– ″ ‰ƒƒ¡ ₱U¡G

¥D›„^ › ‟«⁄Š¤C⁄Ø˜Æ¤œ¶q¡ ]g/day¡ ^×¥D›„^ › „ ⁄⁄ Štˋ ' · @«µg/g¡ ^
¡ ¥D›„^ › ‟«‟"¤C⁄Ø ·˜Æ¤œ¶q¡ ]µg/day¡ ^

– ″ ¥X¤C⁄ @j^ › ‟«⁄Š¤C⁄Ø ·˜Æ¤œ¶q¡ ]µg/day¡¡A¤ è''M«ÆŠY‹ ¤C⁄Ø‟"^ ' ·˜Æ¤œ ¶q¡ ]µg/day¡¡C

¡]⁄›¡^ƒ ⁄⁄GPx¡BSOD¡BCAT¡BTAS ¥Š fi æ » fl ≺ ₱ŠŒ'w
⁄@¡Bƒ ⁄⁄Š fiæ˘» fl GPx ‹ ¦°¡G
¤ ˘ ¥ ¸ ¥ « ,(Caflł RS 504, RANDOX)·œ–o¡Cƒ †G...¸¥»¥HŠtŠ fiƒ fl ¡]Heparin¡^, ″ ƒ‹¶ ¡A¤œ25µl ¥ ƒ ¶ ƒ , ¯ ¡C

¡ › , fl» $˘¡G

¡fl Diluting agent ¡G l † ~ ¥ ⁄ 200 ml " " ¥ h ´ ł ⁄ 2~8¢ fb J ⁄ U ¥ f 4 ¶ æ g ¡ C

¡fl Drabkin's regents ¡G l † ~ ¥ ⁄ 480 ml " " ¥ h ´ ⁄ l ⁄ A ⁄ æ ‹ l ¡ G 24 § Y ¥ i ¡ ƒ b 2~8¢ J ⁄ U ¥ f 6 ' æ ⁄ ¥ H ¡ ¡ C

¡fl Reagent ¡G l † ~ ¥ ⁄ 6.5 ml " " phosphate buffer ¡ ], fl 1 ¡ ¡ A f b 2~8¢ J ⁄ U ¥ i f s ' æ 48 hrs ¡ C

¡fl Cumene hydroperoxide ¡G ¤ œ 10 µl ¥ ł J 10 ml ¥ h ´ ⁄ l ⁄

¡ › ; œ GPx ‹ y { ¡ G

Heparinized whole blood 25 µl

↓ ¥ ł J 0.5 ml Diluting agent ¡ A ' æ, m 5 min

↓ ¥ ł J 0.5 ml Drabkin's regents ¡ ] § @ ‹ } ˜ † G ¡ A mix well

↓ ¤ œ 20 µl ƒ ¥ ⁄ @ pendorf

↓ ¥ ł J 1 ml reagent ¡ A mix well ¡ A ¥ H ⁄ fl D ⁄ Ł ƒ « 37 ¢ J " " • ¯ « " ‹ " A

↓ ¥ ł J 40 µl cumene hydroperoxide ¡ A mix well ¡ ] · œ ⁄ § « ƒ ¥ A [ ¡ A ¥ [ ⁄ § « ¶ • ⁄ W · œ ¡ ^

↓ ' 37¢ J ¡ B ¶ " 340 nm ⁄ U · œ † ˜ 0 ‹ ¡ ] A1 ¡ ^ ⁄ ¸ † ˜ 3 ⁄ ˜ ` ¡ ] A2 ¡ ^ " " § l œ › ¡ ¨ ] ¤ ¥ ¸ ¥ ^ › " ¡ ^

¡fl " ¥ , ¯ ¡ G ¤ œ 20 µl ¥ h ´ ⁄ l ⁄ ¡ ˘ 1 ml reagent ¡ ˘ 40 µl cumene hydroperoxide

¡ › › ƒ ¡ G

- blank " " ΔAblank/min ¡ (A1-A2)/3
- sample " " ΔAsample/min ¡ (A1-A2)/3
- ΔAsample/min ¡ – ΔAblank/min ¡ ΔA/min
- GPx conc. ¡ 8412 × ΔA/min × ƒ › ¿ ˘ ¡ ] U/L ¡ ^

– N GPx conc. (U/ml) ƒ A £ ¥ H Haemoglobin (g/ml) ¡ GPx conc. (U/g Hb)

⁄ G ¡ B ƒ ⁄ ⁄ § æ ⁄ S ⁄ D ƒ ‹ ¡ °

¤ ¥ ¸ ¥ « , fl † (Cat SD 125, RANDOX) · œ – o ¡ C ƒ † G .. ¥ » ¥ H § t § fi ƒ fl ¡ ] Heparin ¡ ^, " ƒ ¶ ¡ A ¤ œ 200µl ‹ ı ƒ † y ¶ ƒ, ¯ ¡ C

¡ › , fl » $ ˘ ¡ G

¡fl phosphate buffer ¡ G – N 0.1 M " " phosphate buffer ƒ 10 › ¿ ¡ ] 50 › sample ‹ ø » 50 ml ¡ A ¤ œ 5 ml → 50 ml ¡ ¡ C

¡fl Mixed substrate ¡ G l † ~ ¥ ⁄ 20 ml " " buffer ¡ ], fl 2 ¡ ¡ A f b 2~8¢ J ⁄ U ¥ f s 10 æ ⁄ ¡ C

¡fl Xanthine Oxidase ¡ G l † ~ ¥ ⁄ 10 ml " " ¥ h ´ ⁄ l ƒ b 2~8¢ J ⁄ U ¥ f 2 ' æ weeks ¡ ^

¡fl Standards ¡ G

S6 ¡ G – N Standard ¡ ], fl 4 ¡ ^ ¥ ł J 10 ml " " ¥ h ´ ⁄ l A mix well → 5 U/ml ¡ F

S5 ¡ G – q S6 ¤ œ 0.5 ml ƒ ¥ ⁄ @ pendorf ¡ A ¥ ł J 0.5 ml " " ¥ h ´ ⁄ l A mix well →

2.5 U/ml¡ A ¥ H ƒ ˆ„ S-l ‹¡C ¥ h ´ ⁄¡lC⁄

¡ › ;œSOD ‹ y { ¡G

¤œHeparinized RBC 250 µl¡ ¥H cold redistilled water ¥ ƒ 2 ml¡ Amix well¡ A, m ' 4¢J¡ Al 5min¡ ¥H phosphate buffer ƒ ƒ § ¤ ƒ ⁄‹ †30~60¢ ¶¡¡ Csamples ⁄ ¸ standards ‹ ƒU¤œ25 µl ƒ ¥ ŧ@ependorf¡ A¥ [⁄ J850 µl Mixed substrate¡ Amix well¡ A ¥H⁄ fl D ⁄ Ł ƒ«37¢J" " • ¯ «"¡ A¥ A[⁄ J125 µl Xanthine oxidase¡ Amix well¡ ]·œ⁄§ « ¢A¥ [¡ A¥ [⁄ § « Æ ¶ ¤œ¡W¶C' 37¢J¡ B ¶"505 nm ⁄U·œ† ˜30 ‹ ¡ ]A1¡ ^⁄ ¸† ˜210 ‹ ¡ ]A2¡ ^""§ l œ›¡¨]¤ ˘ ¥ ¸ ‹ ` ... ' ¸¥ ¥ i¡ ¶C

¡ ›› ƒ ¡G

¡ • Std ‡ ¡⁄

- std ""ΔA/min¡ GΔAstd/min = (A2-A1)/3
- std ""% inhibition= 100-[(ΔAstd/min×100) / (ΔAS1/min)]
- std ""% inhibition ¤œlog10¡ A' −o""›¨‹ B
- ¥H std conc.¡ ] ƒi...¡ ^vs.ƒU std conc.' − ƒ ¥X""B ›¨¡ ]` afi y.—¡ ^— " ¥X std curve ""R ›¨

¡ • Sample ‡ ¡⁄

- sample ""ΔA/min = (A2-A1)/3
- sample ""% inhibition = 100-[(ΔAsample/min×100) / (ΔAS1/min)]
- sample ""% inhibition ¤œlog10 ⁄ §Æ−a⁄ J std curve¡ A' ¤D−o""›¨ƒA›... ¥H ƒ › ¿¨¡ ]ƒ„‹ 100 ›¿¡ ¡ Aƒ −o¥ ƒ ""SOD conc. (U/ml)

¡ fIN¥ ƒ ""SOD conc. (U/ml)ƒA £¥H Haemoglobin (g/ml)¡ ¥ ƒ ""SOD conc. (U/g Hb)

⁄T¡ Bƒ ⁄ ⁄ § fi æ˘ ©AT ‹ ¦ °

−˜¥ ¸ Luck (1963)⁄§⁄Ł"k·œ−o¡ Aƒ † G ..¥¥H§t§ fiƒ fl¡ ]Heparin¡ ^, " ƒ ¶ ¡ A ¤œ100µl ‹ ıƒ † y ¶ƒ, ¯ ¡C

¡ › , fl» $¨¡G

¡ fl Potassium-phosphate buffer¡ ]67mM, pH7.0¡ ¡ G¤œK2HPO4¡ ]MW174.2¡ ^ 4.486g »P KH2PO4¡ ]MW136.1¡ ^5.566g •»' ¥ h ´ ⁄ l⁄⁄¡ A‰ pH ›¨ƒ 7.0¡ A' w ¶¤1L¡ Aƒ s æƒ4¢J⁄¡ ]¥ ¥ ƒ 900ml→‰ pH ›¨→ƒA¥ ƒ 1 L¡¡C

¡ fl H2O2-potassium-phosphate buffer¡ G¤œ30¢H""H2O2 143µl •»' 1/15M "" potassium-phosphate buffer ⁄⁄¡ A' ¶qƒ 100ml¡¡C] • Ø »ts¡¡ ]0.04¢H H2O2 in 67mM potassium phosphate buffer, pH7.0¡ ¡ ]» ƒBflD¡ ^

¡ fl Chloroform-absolute ethano 40ml¡ G¤œ15ml chloroform »P 25ml absolute ethanol † ¥X

¡ › ;œCAT ⁄§...¸«~«e‡ B z‹ y { ¡G

↓¤œRBC 100µl

↓¥ ⁄J400µl ""potassium-phosphate buffer¡ ] ƒ< 10¢HRBC¡^
¡i↓¥ ⁄J400µl ""chloroform-ethanol¡]ƒ „ fi ` ¯Ø¿900µl¡^
↓ƒ fiD15 ⁄ ˜¡ƒ„¤ B ˘ J ¥< †⁄
↓´ ⁄ 3000rpm¡A 5 ⁄ ˜`
↓¤ œ ⁄ WM†A¤ ¥H potassium-phosphate buffer ƒ 10 >¿¡]10µl ⁄ W M†G˘
90µlpotassium-phosphate buffer¡^
↓¤œ ƒ «Æ""⁄ W M†10 µl ¶ i ƒ U >eatalase ⁄ § y ¤( BJ
¡]‡ l⁄§ ƒ †G» fl ƒsA¥H ¸·œ‡ J ¥¶p¡^

¡> ¸·œCAT ⁄ § y ¡{G
¡]• « 25¢J¡A«˙• ¯§Y¥i¡A⁄f» • ¯--¡^
↓¥H⁄ G ƒ , ⁄ § @k„s °§@
↓¤œ sample 10µl¡A¥ ⁄J $H_2O_2$-potassium-phosphate buffer 990µl¡A† V^«Æ'æ¶i
spectrometer¡]240nm¡^⁄⁄·œ¡]ƒ@3 ⁄ ˜`¡A¤C15 < ""⁄ƒ@,§ l œ >¡¨^
¡fl sample ƒb¥ ⁄Jbuffer «Æ> n¤⁄W·œ
¡fl ¤ ˘ ¥ ¸ ¥ >¡^AUV ¥œ·œ

¡>> ƒ ¡G
unit k/l=¡i(total assay volume)/(sample volume used)¡ƒ¡i2.3/¡ t(sec)¡ƒlog(A1/A2)
A1¡G0 < fi ""§ l œ >¨
A2¡G†˜3 ⁄ ˜`""§ l œ >¨

¥ | Bƒ⁄⁄§ fi æ ˘»TAS < ¡°
¤ ¥¸¥ « , (Cat NX 2332, RANDOX)·œ– φCƒ †G.. ¥»¥H§t§ fiƒ fl
¡]Heparin¡^, " ƒ ¶ ¡A¤œ20µl ƒ ... ¶ ƒ , ¯ ¡C

¡> , fl» $ ˘¡G
¡fl Buffer¡G ¥¸kit † ⁄w§t¡A¤ ¥¸«e» ƒs'æƒb2~8¢J⁄⁄¡C
¡fl Chromogen¡G1 †~¥ ⁄J10 ml "" buffer¡], fl1¡¡^A¥iƒb2~8¢J⁄U¥iƒs'æ2
⁄ ¡]'¸ƒb15~25¢J⁄⁄ƒs'æ8 ⁄pfi ¡¡^C
¡fl Substrate¡G1 ml ""substrate ¥¸1.5 ml ""buffer¡], fl1¡^ ƒ ¡A¥iƒb2~8¢J
⁄U¥iƒs'æ24 ⁄pfi ¡C
¡fl Standards¡G@†~¥ ⁄J1 ml ""¥h´ ⁄l⁄ ¡A¥iƒb2~8¢J⁄U¥iƒs'æ2 ⁄¡]'¸ƒb-20¢J
⁄⁄ƒs'æ1 > ⁄°¡¡^C

¡> ¸·œTAS < y{¡G
↓¤œHeparinized plasma 20µl 'MStandards 20µl
↓¥ ⁄JChromogen 1ml¡Amix well¡A¤^⁄ flD' 37¢J
↓' 37¢J¡A" Ì1600nm ⁄ Uœ†˜0 < ¡]A1¡^""§ l œ >¨
↓" ‰ ƒb¥ ^»"⁄⁄¥ ⁄JSubstrate 200µl¡]·œ⁄§«eƒA¥[¡A¥[⁄§«Æ ¤⁄W·œ¡¡^A •nmix well
↓' 37¢J¡A" Ì1600nm ⁄ Uœ†˜3 ⁄ ˜`¡]A2¡^""§ l œ >¨

¡ fl " ¯ ¥ , ¯ 20µl¤¥eh ´ ±⁄1 ml Chromogen ¡ ˘200µl Substrate
¡ › p"¡G
TAS ¡ ]Total antioxidant status ¡ ˆG
Factor ¡ ¡ ]Standards ¿ ® ¡ ⁄ ¡ ]ΔA blank ¡ –ΔA standard ¡ ^
TAS ¡ ]mmol/l ¡ ^¡ Factor × ¡ ]ΔA blank ¡ –ΔA sample ¡ ^

¡ ]⁄»¡ ˆ B · œ ¶ q ⁄ " R§«~‰Ł" ¤
1." ¥ ⁄ "R¡G¤ C ⁄ § «:¸¶ i ƒ « e ‡ B † z fi ¡A» ¥ƒP.fi«~¡m Ÿ ˜ ¥ · œ ⁄ "R
…¸«~‹ O § _ D ¤ƒ ˆ ‹ V ¡C
2. › ‰ ˘ ⁄ "R¡G¤ C ⁄ § «:¸ƒ ⁄ ⁄@› …¸«~⁄ T «‰¡ ˘ ŸH«K ¸·œ" ºK« ¡C
3.⁄ Ł ¥ »œ• ¥ › ¡ ©œ…¸«~¥H† K ¥ [ "…«~•˙ Ł ƒ '¶ q ¡A› ‰ ˘ ⁄ "R⁄Tƒ, ¡A–N⁄Tƒ ¦
– o †"G §O› ß · ⁄§… — • · fiŸƒ A .›⁄WT›¿¡A§ Y ' w , q ‹ ⁄ Łœ k ¥»¡C

¡ ]⁄C¡ ^† ¿›p⁄ Łk
¥H SPSS 11.5 † ¿›p† ñØ⁄ ¥ ¿ Pearson Correlation analysis ¶ ƒ ‹ ^ ' °
⁄ ¥⁄§Ap ¡ 0.05 ‹ † ¿›p⁄W„ F ª fit† §¡C

## †"G»P Q‰

¡ ]⁄@¡ ^› fi ¥ , Œfi ˘
' ƒ ‡ – ₰ƒ~¥‹‹ O 18~31 • ‡¡ A¥ §¡ƒ ≈ ‹ 22.86 • ‡¡ A¤k' °¥ §¡‹ 21.71 • ‡¡ A ⁄k' °‹ 23.40 • ‡¡ C¤ BMI ›¨¤k' °¥ §¡‹ 22.13 ¡ A⁄k' °‹ 21.37 ¡ A¥ §¡"″BMI ›¨‹ 21.61 ¡ ]" ⁄@¡ ˆC

¡ ]⁄G¡ ^› „ ⁄⁄·§t¶ q ⁄"R
ƒ U ƒ ˆ › „« ⁄§` ' ·¿ ® ⁄ w § ₵ {" ⁄ ©⁄¡ ]" ⁄G¡ ˆA¤ ^¤œ¤ · ¥ ¥ §¡… §@‹ – " ¤C⁄ Ø ' ·˜ Æ¤œ¶ q¤ ¡ A¥ ˆ ¡ B⁄ › B fi†¡ B‰ › ^¡ B⁄ †£›„«~^ ¡ ]⁄S⁄ ‹ ‡ ‰ ¡ B ¥ · ^¡ B¤ ‡ ¡ ˆBƒ ¤ $J ˆB⁄ "G ˆ ¡ B" ô ¡ B¶..fi ˘ ^ ¡ B´ I ⁄ ^ ¿ ¥⁄'$ J¥ O¥ › §¡¿ ® ¤ §·‹ 0.33 ¡ B1.10 ¡ B0.90 ¡ B389.62 ¡ B206.54 ¡ B776.84 ¡ B37.13 ¡ B0.04 ¡ B239.66 ¡ B 0.73 ¡ B0.24 ⁄ ¿ 0.41 µg/kg ¡ ]" ⁄T¡ ˆC

¡ ]⁄T¡ ^¤ , " ¤C⁄Ø ·˜ Æ¤œ¶ q
–N¤Cƒ ¤ , " ⁄§ƒ U ƒ ˆ › „« ˜ Æ¤œ¶ q›..¥Hƒ U ƒ ˆ › „« ⁄§` ' ·¿ ® ¡ A¤ ^¥ [` ˇ⁄§«Æ § ¥o¤ , " ¤C⁄ Ø ' ·˜ Æ¤œ¶ q C ƒ ‡ –, ⁄s¥ § ¡¤C⁄Ø, ¥ƒ ˜ Æ¤œ¥ ⁄ ˆ ⁄¤ ¸ »s«~' –o ⁄§ ·˜ Æ⁄J¶ q‹ 0.028 µg/day ¡ A¥ D›„ ˆ ¡ B‰ › ^¡ B‡ ‰ ¡ B¥ · ^¡ B¤ ‡ ¡ Bƒ ¤ $J¡ B ⁄ "G ˆ ¡ B" ô ¡ B¶..fi ˘ ^ ⁄ ¿ ´ I ⁄ ^‹ ¤0.394 ¡ B5.993 ¡ B26.568 ¡ B7.90 ¡ B2.708 ¡ B0.105 ¡ B 0.007 ¡ B0.085 ¡ B0.799 ⁄ ¿ 0.002 µg/day ¡ A¤ ¥ §¡` ' ·˜ Æ¤œ¶ q«h‹ 44.489 µg/day ¡ ]"

¥ ¦¡^ C ƒ ' ¤ , " ⁄ § ¤ C ⁄ Ø ` ' · ˜ Æ ¤ œ ¶ q » P ¤ œ ƒ ƒ U ⁄ j ^ · ˜ Æ ¤ œ ¶ q
" G « ¥ X ¤ C ⁄ Ø ` ' · ˜ Æ ¤ œ ¶ q » P ¤ œ ƒ ‡ ‰ ^ ¡ B ¥ · ^ ¡ B ¤ ' ^ ⁄ ¸ ` ' ⁄
‹ ^ 'r=0.954¡Ar=0.890¡Ar=0.890¡Ar=0.998¡Fp¡0.05¡¡^]" ⁄ ›¡¡^A· ¤ ¥ ⁄ §A
⁄ ' ‡ ‰ ^ ¡ B ¥ · ⁄ §t ƒ ‡ ' ^ I " " · §t ¶ q A G ¤ , " ¤ C ⁄ Ø ¥ ƒ „ ›„ " « '
– o ⁄ § · Æ ¤ œ ¶ q ¤ ¥ L ^ ›„ " ⁄ h¡A' ¥ H ‹ ¥ D · § t ¶ q · ⁄ § „ " « ¤ • ‰ C
› Y ¥ » ª ¤ s ¤ , ¥ § ⁄ § C ⁄ Ø ` ' ˜ Æ ¤ œ ¶ q ¡ ^ ¤ ¥ L ‹ ^ ‹ ª ¤ s
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‹ ¥ Ø¡Af , ß Canada¡BUSA¡BGreece¡BFinland¡BNetherlands¡BMexico¡BJapan¡B
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^ ¡ ]r=0.249¡Ar=0.089¡Ar=0.115¡ ^ Af »P TAS § ¢ { › t ‹ ^ ¡ r ‡ =-0.363¡ ^ Af ‡ £ L ¯ ª
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» P § _ ¥ 'M ¯ Ø " SOD ¶ q § ¢ { ¯ ª › t ‹ ^ ¡ r ‡ =-0.432¡Ap¡0.05¡ ^ ]" ⁄ E ¡ ^ C

## 摘要

1. 本研究調查台灣地區一般民眾硒攝取量，並探討硒攝取量與血液中硒濃度及抗氧化酵素活性之關係。
2. 本研究結果顯示台灣地區一般民眾硒攝取量為44 μg/day，與其他國家相較為偏低。
3. 本研究結果顯示血液中硒濃度與硒攝取量呈顯著正相關，而與血液中GPx及SOD活性無顯著相關。
4. 本研究結果顯示血液中GPx活性與硒攝取量呈顯著正相關（r=0.457，p< 0.05），而血液中SOD活性與硒攝取量呈顯著負相關（r=-0.432，p< 0.05）。

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| | Age (years) | | | BMI (kg/m2) | | |
|---|---|---|---|---|---|---|
| | Total (n=22) | Male (n=7) | Female (n=15) | Total (n=22) | Male (n=7) | Female (n=15) |
| Mean | 22.86 | 21.71 | 23.40 | 21.61 | 22.13 | 21.37 |
| SD | 4.11 | 2.56 | 4.64 | 2.94 | 2.27 | 3.25 |
| Range | 18-31 | 19-26 | 18-31 | 17.94-30.22 | 20.11-26.53 | 17.94-30.22 |

" ⁄G¡Bƒ U ⁄ j ^ › „ " «§` ` ·¿@«

| Sample | | Se (µg/kg) | Country | Reference |
|---|---|---|---|---|
| Milk and cheese | whole | 0.15 | UK | Barclay et al., 1995 |
| | skim | 0.1 | | |
| | Brie | 0.36 | | |
| | Camembert | 0.68 | | |
| | Cheddar | 0.74 | | |
| | Cheddar | 1.1 | | |
| | Cottage | 0.37 | | |
| | Cottage | 0.41 | | |
| | Cream | 0.35 | | |
| | Danish Blue | 0.64 | | |
| | Edam | 0.64 | | |
| | Feta | 0.5 | | |
| | Fromage Frais | 0.22 | | |
| | Fromage Frais | 0.19 | | |

| | | | | |
|---|---|---|---|---|
| | Gouda | 0.8 | | |
| | Parmesan | 1.1 | | |
| | Processed cheese | 0.67 | | |
| | Spread | 0.25 | | |
| | Spread | 0.38 | | |
| | Stilton | 0.8 | | |
| | full fat | 0.14 | | |
| | low fat | 0.15 | | |
| | imitation (full fat) | 0.11 | | |
| | (low fat) | 0.1 | | |
| | (very low fat) | 0.15 | | |
| | luxury | 0.17 | | |
| | **Total Mean** | **0.43346** | | |
| | **Total GM** | **0.33215** | | |

| Sample | | Se (µg/kg) | Country | Reference |
|---|---|---|---|---|
| Cereals | Rice | 52.3 | India | Roychowdhury et al., 2003 |
| | Wheat | 157 | | |
| | Lentil | 223 | | |
| | Pulse, others | 484 | | |
| | Rice | 66.2 | India | Roychowdhury et al., 2003 |
| | Wheat | 218 | | |
| | Lentil | 272 | | |
| | Pulse, others | 168 | | |
| | barley | 0.13 | UK | Barclay et al., 1995 |
| | cornflour | 0.04 | | |
| | rye flour | 0.25 | | |
| | sago | 0.01 | | |
| | tapioca | 0.03 | | |
| | white | 0.48 | | |
| | wholewheat | 0.55 | | |
| | brown | 1 | | |
| | long grain | 1.3 | | |
| | wheat flour-brown | 0.44 | | |
| | wheat flour-white | 0.23 | | |
| | wheat flour-strong white | 0.25 | | |

| | | | | |
|---|---|---|---|---|
| | wheat flour-wholemeal | 0.59 | | |
| | brown bread | 0.48 | | |
| | currant bread | 0.35 | | |
| | granary bread | 0.39 | | |
| | Hovis (wheatgerm) bread | 0.49 | | |
| | white-unsliced bread | 0.44 | | |
| | white-sliced bread | 0.43 | | |
| | French stick | 0.45 | | |
| | weetabix | 0.23 | UK | Barclay et al., 1995 |
| | oatmeal | 0.31 | | |
| | cornflakes | 0.47 | | |
| | museli | 0.42 | | |
| | shredded wheat | 0.31 | | |
| | oat flake | 0.2 | | |
| | bran based | 0.36 | | |
| | added sugar | 0.22 | | |
| | rice based | 0.17 | | |
| | **Total Mean** | **44.63568** | | |
| | **Total GM** | **1.102914** | | |

| Sample | | Se (µg/kg) | Country | Reference |
|---|---|---|---|---|
| **Vegetables** | Potato-flesh | 0.28 | India | Roychowdhury et al., 2003 |
| | Potato-skin | 1.64 | | |
| | Onion | 5.2 | | |
| | Garlic | 4.8 | | |
| | Green Chili | 6.16 | | |
| | Arum leaf | 0.2 | | |
| | Beans | 8.36 | | |
| | Spinach | 0.2 | | |
| | Leaf of vegetables | 0.72 | | |
| | Radish | 6 | | |
| | Green Banana | 3.68 | | |
| | Papaya (with peel) | 0.2 | | |
| | Brinjal | 7.28 | India | Roychowdhury et al., 2003 |

| | | | | |
|---|---|---|---|---|
| | Turmeric, green | 1.92 | | |
| | Potato-flesh | 1.76 | | |
| | Potato-skin | 4.32 | | |
| | Onion | 11 | | |
| | Garlic | 10 | | |
| | Green Chili | 4.72 | | |
| | Beans | 6.2 | | |
| | Leaf of vegetables | 6.44 | | |
| | potatoes | 0.16 | UK | Barclay et al., 1995 |
| | peas fresh | 0.02 | | |
| | peas dried | 0.3 | | |
| | peas-canned | 0.04 | | |
| | peas-canned, processed | 0.19 | | |
| | peas-frozen | 0.03 | | |
| | beansprouts | 0.14 | | |
| | beans-broad | 0.06 | | |
| | beans-butter | 1.1 | | |
| | beans-French | 0.03 | | |
| | hummus | 3.5 | | |
| | **Total Mean** | 3.020313 | | |
| | **Total GM** | 0.900635 | | |

| Sample | | Se (μg/kg) | Country | Reference |
|---|---|---|---|---|
| **Fish** | Salmo salar Linnaeus | 2010 | Taiwan | Chien et al., 2003 |
| | Scomberomorus commersoni | 1750 | | |
| | Sebastiscus albofasciatus | 1550 | | |
| | Eleutheronma tetradactylum Show | 1550 | | |
| | Liza macrolepis | 1550 | | |
| | Lateolabrax japonicus Cuvier | 1540 | | |
| | Acanthopagrus latus | 1510 | | |
| | Theragra chalcogramma | 1390 | | |

| | | | | |
|---|---|---|---|---|
| | Psenopsis anomale Temminck and Schlegel | 1360 | | |
| | Plecoglossus altirelis Temminck and Schlegel | 1350 | | |
| | Oncorhynchus mykiss | 1350 | | |
| | Oreochromis sp. | 1340 | | |
| | Larimichthys polyactis | 1340 | | |
| | Taius tumifrons | 1330 | | |
| | Priacanthus macranthus Cuvier | 1310 | | |
| | Trichiuruslepturus | 1200 | | |
| | Epinephelus mystacinus | 1170 | | |
| | Mola mola Linnaeus | 810 | | |
| | **Total Mean** | 1411.6667 | | |
| | **Total GM** | 1389.6207 | | |

| Sample | | Se (μg/kg) | Country | Reference |
|---|---|---|---|---|
| **Crustaceans** | Panulirus longipes | 1300 | Taiwan | Chien et al., 2003 |
| | Ovalipes punctatus | 1280 | | |
| | Metapenaeus ensis | 1270 | | |
| | Aristeus viritis | 1110 | | |
| | Portunus sanguinolentus | 1090 | | |
| | **Total Mean** | 1210 | | |
| | **Total GM** | 1206.5388 | | |

| Sample | | Se (μg/kg) | Country | Reference |
|---|---|---|---|---|
| **Bivalve molluscs** | Crassostrea gigas | 1180 | Taiwan | Chien et al., 2003 |
| | Raphia amabilis | 1330 | | |
| | Ruditapes variegates | 870 | | |
| | Meretrix lusoria | 730 | | |
| | Amusium pleuronectes | 630 | | |

| | | | | |
|---|---|---|---|---|
| | Haliotis diversicoloraquatilis Reeve | 350 | | |
| | **Total Mean** | 848.3333 | | |
| | **Total GM** | 776.8385 | | |

| Sample | | Se (µg/kg) | Country | Reference |
|---|---|---|---|---|
| **meat** | beef | 0.76 | UK | Barclay et al., 1995 |
| | pork | 1.4 | | |
| | lamb | 0.38 | | |
| | white meat | 1 | | |
| | dark meat | 1.5 | | |
| | duck | 2.2 | | |
| | pheasant | 1.4 | | |
| | grouse | 2 | | |
| | venison | 0.89 | | |
| | chicken breast | 73 | Spain | Díaz-Alarcón et al., 1996 |
| | veal | 45 | | |
| | lamb | 28 | | |
| | pork chop | 81 | | |
| | pork chine | 383 | | |
| | rabbit | 90 | | |
| | veal | 20 | U.S.A | Moxon et al., 1980 |
| | lamb | 50 | | |
| | pork chop | 40 | | |
| | chicken breast | 160 | Canada | Arthur, 1982 |
| | veal | 20 | | |
| | pork chop | 300 | | |
| | chicken breast | 200 | | |
| | veal | 10 | | |
| | lamb | 50 | | |
| | pork chop | 60 | | |
| | veal | 290 | U.S.A | Olson and Palmer, 1984 |
| | lamb | 310 | | |
| | pork chop | 310 | | |
| | chicken breast | 160 | Spain | Díaz-Alarcón et al., 1996 |

| | | | | |
|---|---|---|---|---|
| | veal | 80 | | |
| | lamb | 40 | | |
| | pork chop | 40 | | |
| | rabbit | 30 | | |
| | chicken breast | 54 | France | Simonoff and Simonoff, 1983 |
| | veal | 80 | | |
| | lamb | 67 | | |
| | pork chop | 107 | | |
| | rabbit | 167 | | |
| | veal | 165 | Russia | Golubkina and Khotimchencko, 1994 |
| | pork chop | 129 | | |
| | chorizo | 355 | Spain | Díaz-Alarcón et al., 1996 |
| | sausage | 128 | | |
| | ham | 87 | | |
| | chopped | 87 | | |
| | mortadella | 71 | | |
| | cured ham | 179 | | |
| | **Total Mean** | 99.07674 | | |
| | **Total GM** | 37.13453 | | |

| Sample | | Se (µg/kg) | Country | Reference |
|---|---|---|---|---|
| **Selected fruits** | | 0.04 | UK | Barclay et al., 1995 |

| Sample | | Se (µg/kg) | Country | Reference |
|---|---|---|---|---|
| **Oil** | peanut | 313 | Italy | Dugo et al., 2003 |
| | soybean | 458 | | |
| | sunflower | 225 | | |
| | rice | 99.5 | | |
| | corn | 332 | | |
| | grapestone | 144 | | |
| | seeds | 296 | | |
| | **Total Mean** | 266.78571 | | |
| | **Total GM** | 239.6631 | | |

| Sample | | Se (µg/kg) | Country | Reference |
|---|---|---|---|---|
| **Nuts** | almonds | 0.15 | UK | Barclay et al., 1995 |
| | brazils | 25.4 | | |

| | | | | |
|---|---|---|---|---|
| | cashew | 2.7 | | |
| | coconut | 0.65 | | |
| | hazelnut | 0.2 | | |
| | macademia | 0.66 | | |
| | walnut | 0.31 | | |
| | **Total Mean** | 4.295714 | | |
| | **Total GM** | 0.830981 | | |

| Sample | | Se (µg/kg) | Country | Reference |
|---|---|---|---|---|
| **Beverages** | tea | 0.59 | UK | Barclay et al., 1995 |
| | coffee | 0.87 | | |
| | **Total Mean** | 0.73 | | |

| Sample | | Se (µg/kg) | Country | Reference |
|---|---|---|---|---|
| **Savoury snacks** | potato based | 0.11 | UK | Barclay et al., 1995 |
| | maize based | 0.33 | | |
| | wheat based | 0.36 | | |
| | **Total Mean** | 0.266667 | | |
| | **Total GM** | 0.235543 | | |

| Sample | Se (µg/kg) | Country | Reference |
|---|---|---|---|
| **Chocolate** | 0.41 | UK | Barclay et al., 1995 |

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| Sample | | Se (µg/kg) |
|---|---|---|
| milk and cheese | Total Mean | 0.43 |
| | Total GM | 0.33 |
| Cereals | Total Mean | 44.64 |
| | Total GM | 1.10 |
| Vegetables | Total Mean | 3.02 |
| | Total GM | 0.90 |

| | | |
|---|---|---|
| Fish | Total Mean | 1411.67 |
| | Total GM | 1389.62 |
| Crustaceans | Total Mean | 1210.00 |
| | Total GM | 1206.54 |
| Bivalve molluscs | Total Mean | 848.33 |
| | Total GM | 776.84 |
| meat | Total Mean | 99.08 |
| | Total GM | 37.13 |
| Selected fruits | | 0.04 |
| Oil | Total Mean | 266.79 |
| | Total GM | 239.66 |
| Nuts | Total Mean | 4.30 |
| | Total GM | 0.83 |
| Beverages | Total Mean | 0.73 |
| Savoury snacks | Total Mean | 0.27 |
| | Total GM | 0.24 |
| Chocolate | | 0.41 |

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| ‰ ¸„ ' §O | | ¥ ˆ Se intake (µg/d) | ¥ D„ˆ Se intake (µg/d) | ƒ §‡J ˆ Se intake (µg/d) | ‡‰ˆ Se intake (µg/d) | ¥ · ˆ Se intake (µg/d) | ¤'ˆ Se intake (µg/d) | ‰ › ˆ Se intake (µg/d) | ⁄ "Gˆ Se intake (µg/d) | ¶ fi˘ˆ Se intake (µg/d) | "oSe intake (µg/d) | ¥ ' §⁄O´ Ł Se intake (µg/d) | Ł Se intake (µg/d) | Total Se intake (µg/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ¤k | 0 | 0.416 | 7.838 | 0 | 0 | 0 | 0.118 | 0.017 | 0 | 0 | 0 | 0 | 8.389 |
| 2 | ¤k | 0 | 0.311 | 5.570 | 0 | 0 | 0 | 0 | 0 | 0 | 1.198 | 0 | 0 | 7.079 |
| 3 | ¤k | 0 | 0.583 | 0.743 | 48.637 | 60.327 | 31.540 | 0.023 | 0 | 0 | 7.190 | 0 | 0 | 149.041 |
| 4 | ¤k | 0 | 0.319 | 5.941 | 34.741 | 0 | 0 | 0 | 0 | 0 | 1.198 | 0 | 0 | 42.199 |
| 5 | ¤k | 0 | 0.209 | 3.342 | 0 | 0 | 0 | 0.207 | 0.015 | 0 | 0 | 0 | 0 | 3.773 |
| 6 | ¤k | 0.165 | 0.468 | 3.713 | 31.266 | 0 | 0 | 0.119 | 0.024 | 0 | 1.198 | 0 | 0 | 36.953 |
| 7 | ¤k | 0 | 0.550 | 2.599 | 0 | 0 | 0 | 0.009 | 0 | 0 | 0 | 0 | 0 | 3.158 |
| 8 | ⁄k | 0 | 0.234 | 16.857 | 0 | 0 | 0 | 0.169 | 0.012 | 0.511 | 0 | 0 | 0 | 17.783 |
| 9 | ⁄k | 0 | 0.077 | 6.126 | 0 | 0 | 0 | 0.397 | 0.012 | 0 | 0 | 0 | 0 | 6.613 |
| 10 | ⁄k | 0.083 | 0.435 | 10.749 | 76.429 | 0 | 0 | 0.061 | 0.025 | 0.402 | 0 | 0 | 0 | 88.182 |
| 11 | ⁄k | 0 | 0.082 | 1.559 | 145.910 | 0 | 0 | 0.104 | 0 | 0.256 | 0 | 0.004 | 0.001 | 147.916 |
| 12 | ⁄k | 0 | 0.253 | 9.431 | 0 | 0 | 0 | 0.072 | 0 | 0 | 0 | 0 | 0 | 9.756 |
| 13 | ⁄k | 0 | 0.252 | 5.384 | 0 | 0 | 0 | 0.009 | 0 | 0 | 0 | 0 | 0.001 | 5.646 |
| 14 | ⁄k | 0.007 | 0.462 | 3.899 | 0 | 0 | 10.565 | 0.117 | 0.014 | 0 | 0 | 0 | 0 | 15.063 |
| 15 | ⁄k | 0.079 | 0.165 | 5.112 | 4.169 | 0 | 0 | 0 | 0 | 0.256 | 0 | 0 | 0 | 9.780 |
| 16 | ⁄k | 0.059 | 0.308 | 13.552 | 0 | 0 | 0 | 0.122 | 0.003 | 0 | 0 | 0 | 0 | 14.044 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17 | ㎞ | 0 | 0.187 | 0.854 | 0 | 0 | 0 | 0.014 | 0 | 0 | 0 | 0.045 | 0 | 1.100 |
| 18 | ㎞ | 0.099 | 0.270 | 14.221 | 0 | 0 | 0 | 0.297 | 0.014 | 0.029 | 5.992 | 0 | 0.002 | 20.923 |
| 19 | ㎞ | 0.090 | 0.303 | 2.970 | 0 | 0 | 0 | 0.054 | 0 | 0.329 | 0 | 0 | 0 | 3.745 |
| 20 | ㎞ | 0 | 0.113 | 2.228 | 216.781 | 105.572 | 0 | 0.153 | 0.004 | 0 | 0 | 0 | 0 | 324.850 |
| 21 | ㎞ | 0.015 | 0.187 | 3.156 | 0 | 0 | 14.760 | 0.154 | 0.006 | 0 | 0 | 0 | 0 | 18.278 |
| Total Mean | | 0.028 | 0.294 | 5.993 | 26.568 | 7.900 | 2.708 | 0.105 | 0.007 | 0.085 | 0.799 | 0.002 | 0.000 | 44.489 |

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| | Se intake from Fish (µg/day) ¡ ]r ¡ ^ | Se intake from Crustaceans Crustaceans (µg/day) ¡ ]r ¡ ^ | Se intake from Bivalve mollusks (µg/day) ¡ ]r ¡ ^ | Se intake from Total seafood (µg/day) ¡ ]r ¡ ^ |
|---|---|---|---|---|
| sex | 0.131 | 0.068 | -0.020 | -- |
| Total Se intake (µg/day) | 0.954* | 0.890* | 0.890* | 0.998* |

* ¡ Ɋp ¡ 0.05

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| Country | Daily selenium intake (µg/day) | Reference |
|---|---|---|
| Canada | 98-224 | Gissel-Nielsen, 1998 |
| USA | 60-150 | Oster and Prellwitz, 1989 |
| China | 11-116 | Yang et al., 1983,1988 |
| Greece | 110 | Bratakos and Ioannou, 1991 |
| Finland | 90 | Varo, 1993 |
| Netherlands | 72 | Van Dokkum et al., 1989 |
| Mexico | 60.6-72.9 | Valentine etr al., 1994 |
| Japan | 69 | Suzuki et al., 2001 |
| India | 61.9 | Mahapatra et al., 2001 |
| Belgium | 28.4-61.1 | Robberecjt amd Deelstra, 1994 |
| France | 48 | Pelus et al., 1994 |
| Germany | 38-48 | Oster and Prellwitz, 1989 |
| Sweden | 44 | Beker and Kumpulainen, 1991 |
| Italy | 43 | Allegrini et al., 1985 |
| UK | 29-39 | MAFF, 1997; Church et al, 1998 |
| Portugal | 37 | Reis et al., 1990 |
| Spain | 35 | Díaz-Alarcón et al., 1996 |
| England | 35 | Brown et al., 2000 |
| New Zealand | 29 | Duffield et al., 1999 |
| Hungary | 41-90 | Alfthan et al., 1992 |

| | | |
|---|---|---|
| South Dakota | 68-444 | Swanson et al., 1990 |
| Venezuela | 200-350 | Combs and Combs, 1986 |
| Mexica | 61-73 | Valentine et al., 1994 |
| Taiwan | 44 | This study |

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| ‰ ₴„ | ' °§O | GPx conc. (U/L) | SOD conc. (U/ml) | TAS conc. (mmol/L) | CAT conc. (unit) |
|---|---|---|---|---|---|
| 1 | ¤k | 5047 | 107.42 | 1.152 | 15.897 |
| 2 | ¤k | 6393 | 166.91 | 0.933 | 30.442 |
| 3 | ¤k | 6393 | 82.02 | 0.954 | 3.467 |
| 4 | ¤k | 5159 | 143.19 | 0.871 | 7.272 |
| 5 | ¤k | 4935 | 107.42 | 1.116 | 9.646 |
| 6 | ¤k | 4711 | 134.73 | 1.100 | 0.001 |
| 7 | ¤k | 5159 | 82.02 | 1.074 | 8.767 |
| 8 | ⁄k | 9646 | 97.58 | 1.033 | 6.227 |
| 9 | ⁄k | 5720 | 151.36 | 1.121 | 10.204 |
| 10 | ⁄k | 5271 | 134.73 | 1.022 | 25.676 |
| 11 | ⁄k | 6842 | 174.33 | 0.829 | 21.669 |
| 12 | ⁄k | 4935 | 92.50 | 1.090 | 11.850 |
| 13 | ⁄k | 4711 | 116.87 | 1.001 | 21.384 |
| 14 | ⁄k | 5272 | 112.19 | 1.043 | 32.863 |
| 15 | ⁄k | 5383 | 82.02 | 0.996 | 13.090 |
| 16 | ⁄k | 4711 | 112.19 | 0.954 | 46.269 |
| 17 | ⁄k | 5047 | 47.54 | 0.730 | 7.463 |
| 18 | ⁄k | 5832 | 47.54 | 0.819 | 30.170 |
| 19 | ⁄k | 5047 | 87.32 | 0.887 | 22.059 |
| 20 | ⁄k | 6169 | 92.50 | 0.819 | 27.321 |
| 21 | ⁄k | 5720 | 76.61 | 0.860 | 9.633 |

| | | | | |
|---|---|---|---|---|
| 22 ⁄k | 5496 | 47.54 | 0.652 | 14.367 |
| Total GM | 5540 | 98.02 | 0.947 | 9.528 |
| SD | 1078 | 36.02 | 0.135 | 11.457 |
| Normal range[ifl] | 4171-10881 | 164-240 | 1.30-1.77 | ¡— |

[ifl]¡Gnormal range ƒ'RANDOX ⁄ ‰ ¥ q ' · ß ⁄§,Œfi˘

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| | GPx conc. (U/L) | SOD conc. (U/ml) | TAS conc. (mmol/L) | CAT conc. (unit) |
|---|---|---|---|---|
| GPx conc. (U/L) | ¡— | | -0.103 | -0.128 |
| SOD conc. (U/ml) | | ¡— | 0.397 | 0.144 |
| TAS conc. (mmol/L) | -0.103 | 0.397 | ¡— | -0.168 |
| CAT conc. (unit) | -0.128 | 0.144 | -0.168 | ¡— |

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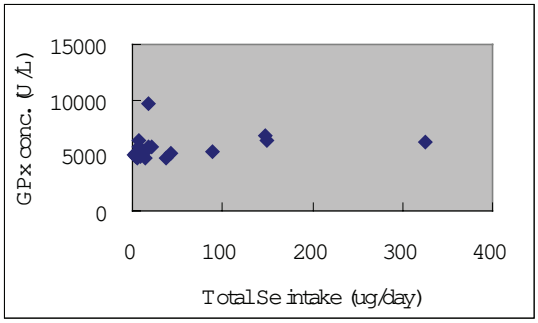
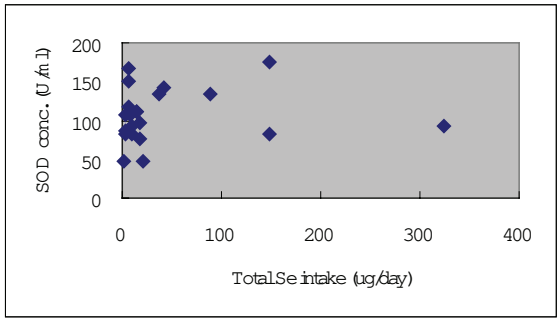
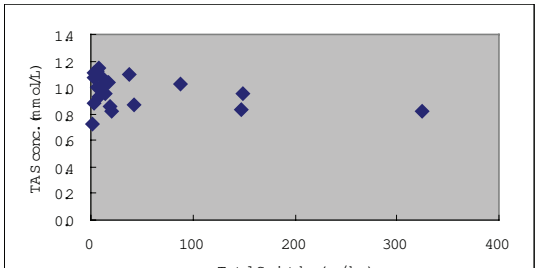
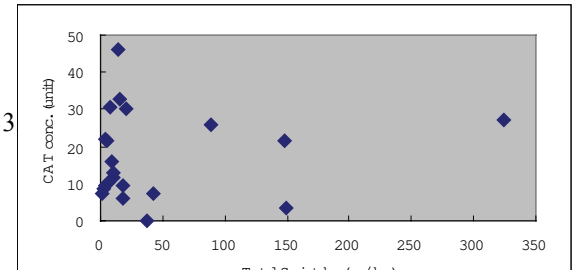
| | GPx conc. (U/L) | SOD conc. (U/ml) | TAS conc. (mmol/L) | CAT conc. (unit) |
|---|---|---|---|---|
| sex | 0.081 | -0.258 | -0.370 | 0.384 |
| Total Se intake (µg/day) | 0.249 | 0.089 | -0.363 | 0.115 |
| Se intake from fish (µg/day) | 0.209 | 0.245 | -0.372 | 0.145 |

| | | | | |
|---|---|---|---|---|
| Se intake from Crustaceans Crustaceans (μg/day) | 0.154 | -0.140 | -0.294 | 0.120 |
| Se intake from Bivalve mollusks (μg/day) | 0.181 | -0.170 | -0.276 | 0.039 |
| Se intake from Total seafood (μg/day) | 0.222 | 0.098 | -.365 | 0.096 |
| Coffee | 0.306 | 0.010 | 0.033 | -0.310 |
| Drinking | 0.457* | -0.003 | 0.245 | -0.239 |
| Smoking | 0.047 | -0.201 | 0.136 | -0.310 |
| < ß | -0.121 | -0.432* | -0.152 | 0.164 |
| < ı· | -0.086 | -0.218 | -0.050 | 0.136 |
| ⁄ Hx | -0.032 | -0.121 | -0.103 | -0.161 |
| i ,¥R fl | -0.307 | 0.066 | -0.081 | -0.047 |

*¡Gp¡ 0.05