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The effect of a meat extract on iron absorption in young women

**A thesis presented in partial fulfillment of the
requirements for the degree of Masters of Science in
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Abstract

Iron deficiency is a global problem for which determinants and solutions need to be investigated. The first part of this study assessed the iron status and dietary intakes of 85 non vegetarian women aged 18-40 years living in the Manawatu region. Exclusion criteria included pregnancy or breastfeeding in the past 12 months, smoking, excess alcohol consumption and recent blood donation. Dietary intakes were estimated using a 24 hour recall and a non validated food frequency questionnaire. Serum ferritin (SF), haemoglobin (Hb), C-reactive protein, height, weight and supplement use were measured. Two women (2.4%) had iron deficiency anaemia (SF<12µg/L and Hb<120g/L) and 9 women (10.6%) had depleted iron stores (SF<20µg/L). All other women had normal iron stores (SF>20µg/L). The daily mean and median iron intakes were 12.7±6.2mg and 10.8mg. 71 women (83.5%) consumed less than the Recommended Dietary Intake (RDI) of 18mg iron per day and 21.2% consumed less than the Estimated Average Requirement (EAR) of 8mg iron per day. Serum ferritin was positively associated with age and total dietary iron intake. No statistically significant relationship was found between serum ferritin and Body Mass Index or exercise, or daily intakes of energy, protein, haem iron, red meat, total meat, vitamin C, vitamin A, total tea, coffee, alcohol, fibre or calcium (p>.05).

Eighteen women who had low iron stores (SF<30µg/L) were selected to take part in a second study to investigate the effect of a meat extract (<0.5kDa sarcoplasmic fraction) on non haem iron absorption. Each subject consumed a sodium caseinate meal, a meat meal or a sodium caseinate meal containing the meat extract. Each meal was labeled with 8.5mg ⁵⁷Fe and each subject received 0.5mg ⁵⁸Fe administered by intravenous infusion. Fourteen days later iron absorption from these meals was determined using ratios of stable isotopes of iron incorporated into the red blood cells. Iron status was significantly inversely related to iron absorption. After adjusting to a serum ferritin of 40µg/L, iron absorption was 3.8% from the sodium caseinate meal, 3.9% from the meat meal and 5.1% from the meal containing the meat extract. These values were not significantly different from one another (p>.05).

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List of Abbreviations

aa	ascorbic acid
AR	Absorption Ratio
AI	Adequate Intake
AMDR	Acceptable Macronutrient Distribution Range
ANOVA	Analysis of Variance
Bd	Blood donors
BMI	Body Mass Index
BP	Bird Proof
BSA	Bovine Serum Albumin
BV	Blood Volume
Ca	Calcium
CaCl ₂	Calcium Chloride
CCM	Calcium Citrate Malate
CRP	C-Reactive Protein
Dcytb	Duodenal cytochrome b
DMT-1	Divalent Metal Transport Protein 1
EA	Egg Albumin
EAR	Estimated Average Requirement
f	Fermented
F	Females
Fe ²⁺	ferrous
Fe ³⁺	ferric
FF	Full Fat
FFQ	Food Frequency Questionnaire
Hb	Haemoglobin
Hb incorp	Haemoglobin incorporation
HCl	Hydrochloric acid
HJV	Hemojuvelin
HMW	High Molecular Weight
HP	Hydrolyzed Soybean Proteins
HR-ICP-MS	High Resolution Inductively Coupled Plasma Mass Spectrometry
ICPMS	Inductively Coupled Plasma Mass Spectrometry
IFNHH	Institute of Food Nutrition and Human Health
ISP	Isolated Soy Protein
IV	Intravenous
KPhy	Potassium Phytate
LDB	Lyophilised Dephytinised Bran
LMW	Low Molecular Weight
LPM	Low Phytate Maize
LWB	Lyophilised Whole Bran
M	Males
mFePhy	monoferric phytate
MFP factor	Meat Fish Poultry Factor
MgPhy	Magnesium Phytate

MS	Mass Spectrometry
NAA	Neuron Activation Analysis
NaPhy	Sodium Phytate
N/A	not available
nf	non fermented
NRV	Nutrient Reference Value
ns	non significant
NTIMS	Negative Thermal Ionisation Mass Spectrometry
o/a	ovalbumin
OJ	Orange Juice
P	Phytate
PA	Phytic Acid
PAL	Physical Activity Level
Pp	Polyphenols
RBC	Red Blood Cell
RDA	Recommended Dietary Allowance
RDI	Recommended Dietary Intake
RNI	Recommended Nutrient Intake
RI	Radio Isotopes
SE	Standard Error
SF	Serum Ferritin
-SH	Sulphydryl
SI	Stable Isotopes
SLS-Hb	Sodium Lauryl Sulfate-Hb
SPI	Soy Protein Isolate
SS	Semi Synthetic
Std	Standard
TA	Tannic Acid
Tae	Tannic acid equivalent
TE	Total Energy
TIBC	Total Iron Binding Capacity
TIMS	Thermal Ionisation Mass Spectrometry
TRF2	Transferrin Receptor 2
TS	Transferrin Saturation
TSF	Textured Soy Flour
Uf	Unfermented
W	White wheat flour
WB	Whole Bran
WBC	Whole Body Counting
WHO	World Health Organisation
WTM	Wild Type Maize (normal phytate content)
YK	Yod Kratin

Introduction - Organisation of Thesis

Iron deficiency is the most common nutritional deficiency worldwide. Young women are especially vulnerable to iron deficiency both in developed and developing countries. There is a wealth of literature available covering all aspects of iron related nutrition. The first chapter of this thesis reviews the literature with a particular focus on the role of iron in the body, iron requirements, iron deficiency anaemia, excess iron and measuring iron status. The mechanism of iron absorption in the human body is covered as well as factors affecting iron absorption. Methods and issues associated with measuring non haem iron absorption in human subjects are addressed. The final part of the literature review investigates dietary factors affecting non haem iron absorption and iron status. Research that has been undertaken to identify and test the meat, fish, poultry (MFP) factor is covered in detail. Throughout the literature review there is a particular focus on the iron requirements of young women.

The aim of this study was to investigate the effect of a meat extract on non haem iron absorption in young women. Prior to this the prevalence of iron deficiency in young non vegetarian females living in the Manawatu region was investigated, including an investigation of dietary intakes and factors contributing to their iron status. This is covered in Chapter 2. From this population women were selected to take part in the meat study which was an exploratory study to investigate the effect of a meat extract on non haem iron absorption. The meat extract was identified and produced by the Institute of Food, Nutrition and Human Health (IFNHH) at Massey University and was tested using pasta based meals. Iron absorption was assessed using stable isotopes (^{57}Fe and ^{58}Fe) and the double isotope technique (Chapter 3).

Chapter 4 draws conclusions from the research undertaken and provides an indication of where future work should be directed.