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 Human Nutrition

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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 $^{57}$Fe and each subject received 0.5mg $^{58}$Fe 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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<th>Definition</th>
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<tr>
<td>aa</td>
<td>ascorbic acid</td>
</tr>
<tr>
<td>AR</td>
<td>Absorption Ratio</td>
</tr>
<tr>
<td>AI</td>
<td>Adequate Intake</td>
</tr>
<tr>
<td>AMDR</td>
<td>Acceptable Macronutrient Distribution Range</td>
</tr>
<tr>
<td>ANOVA</td>
<td>Analysis of Variance</td>
</tr>
<tr>
<td>Bd</td>
<td>Blood donors</td>
</tr>
<tr>
<td>BMI</td>
<td>Body Mass Index</td>
</tr>
<tr>
<td>BP</td>
<td>Bird Proof</td>
</tr>
<tr>
<td>BSA</td>
<td>Bovine Serum Albumin</td>
</tr>
<tr>
<td>BV</td>
<td>Blood Volume</td>
</tr>
<tr>
<td>Ca</td>
<td>Calcium</td>
</tr>
<tr>
<td>CaCl₂</td>
<td>Calcium Chloride</td>
</tr>
<tr>
<td>CCM</td>
<td>Calcium Citrate Malate</td>
</tr>
<tr>
<td>CRP</td>
<td>C-Reactive Protein</td>
</tr>
<tr>
<td>Dcytb</td>
<td>Duodenal cytochrome b</td>
</tr>
<tr>
<td>DMT-1</td>
<td>Divalent Metal Transport Protein 1</td>
</tr>
<tr>
<td>EA</td>
<td>Egg Albumin</td>
</tr>
<tr>
<td>EAR</td>
<td>Estimated Average Requirement</td>
</tr>
<tr>
<td>f</td>
<td>Fermented</td>
</tr>
<tr>
<td>F</td>
<td>Females</td>
</tr>
<tr>
<td>Fe²⁺</td>
<td>ferrous</td>
</tr>
<tr>
<td>Fe³⁺</td>
<td>ferric</td>
</tr>
<tr>
<td>FF</td>
<td>Full Fat</td>
</tr>
<tr>
<td>FFQ</td>
<td>Food Frequency Questionnaire</td>
</tr>
<tr>
<td>Hb</td>
<td>Haemoglobin</td>
</tr>
<tr>
<td>Hb incorp</td>
<td>Haemoglobin incorporation</td>
</tr>
<tr>
<td>HCl</td>
<td>Hydrochloric acid</td>
</tr>
<tr>
<td>HJV</td>
<td>Hemojuvelin</td>
</tr>
<tr>
<td>HMW</td>
<td>High Molecular Weight</td>
</tr>
<tr>
<td>HP</td>
<td>Hydrolyzed Soybean Proteins</td>
</tr>
<tr>
<td>HR-ICP-MS</td>
<td>High Resolution Inductively Coupled Plasma Mass Spectrometry</td>
</tr>
<tr>
<td>ICPMS</td>
<td>Inductively Coupled Plasma Mass Spectrometry</td>
</tr>
<tr>
<td>IFNHH</td>
<td>Institute of Food Nutrition and Human Health</td>
</tr>
<tr>
<td>ISP</td>
<td>Isolated Soy Protein</td>
</tr>
<tr>
<td>IV</td>
<td>Intravenous</td>
</tr>
<tr>
<td>KPhy</td>
<td>Potassium Phytate</td>
</tr>
<tr>
<td>LDB</td>
<td>Lyophilised Dephytinised Bran</td>
</tr>
<tr>
<td>LMW</td>
<td>Low Molecular Weight</td>
</tr>
<tr>
<td>LPM</td>
<td>Low Phytate Maize</td>
</tr>
<tr>
<td>LWB</td>
<td>Lyophilised Whole Bran</td>
</tr>
<tr>
<td>M</td>
<td>Males</td>
</tr>
<tr>
<td>mFePhy</td>
<td>monoferric phytate</td>
</tr>
<tr>
<td>MFP factor</td>
<td>Meat Fish Poultry Factor</td>
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<tr>
<td>MgPhy</td>
<td>Magnesium Phytate</td>
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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.