

**IRON BIOAVAILABILITY OF DATES (*PHOENIX
DACTYLIFERA*) AND GOAT MILK AND THEIR EFFECTS
ON IRON DEFICIENCY ANAEMIA**

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ON IRON DEFICIENCY ANAEMIA**

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ABSTRAK

PENGENALAN: Anemia kekurangan zat besi (IDA) adalah masalah kesihatan global. Peningkatan ketara ditunjukkan dalam parameter hematologi selepas diuji kurma dan susu kambing (GM) pada tikus IDA. Oleh itu, kajian ini akan memberi tumpuan kepada penilaian bioavailabiliti besi dalam kurma dan GM menggunakan sel Caco-2 dan kesannya terhadap parameter hematologi dan simpanan besi dalam subjek IDA.

BAHAN DAN KAEDAH: Kurma Ajwa, kurma Mariami, GM dan susu kambing yang diberi makan benih Ajwa (GMFA) digunakan dan sampel disediakan menggunakan kaedah pencernaan *in vitro*. Sel caco-2 telah dituai dan digunakan untuk analisis protein dan feritin, dan lengkung standard telah diplot. Kajian kuantitatif telah dijalankan di kalangan 57 wanita dewasa yang mempunyai IDA ringan dan ditugaskan dengan rejim pemakanan yang berbeza. Sampel darah diambil dan dianalisis untuk kiraan darah penuh dan profil besi. Analisis statistik dilakukan untuk membandingkan pra dan pasca rawatan. **KEPUTUSAN:** Keluk piawai menunjukkan persamaan linear: $\text{Ferritin}(\text{ng})/\text{protein}(\text{mg}) = (16.519 \times \text{roti Fe}) + 16,255$, $R^2 = 0.974$. Dengan menggunakan persamaan ini, bioavailabiliti besi daripada campuran kurma Mariami dan GMFA menunjukkan yang tertinggi ($78.01 \pm 5.26\%$) berbanding sampel lain yang diuji. Ia diikuti oleh tarikh Mariami+GM ($61.87 \pm 3.70\%$), tarikh Mariami ($49.08 \pm 2.54\%$), tarikh Ajwa+GMFA ($45.22 \pm 2.39\%$), tarikh Ajwa+GM ($42.56 \pm 8.61\%$), tarikh Ajwa ($26.48 \pm 1.32\%$), GMFA ($9.19 \pm 0.94\%$) dan GM ($0.87 \pm 1.14\%$). Peningkatan ketara dalam aktiviti hemopoietik dilaporkan selepas subjek diberi rawatan kurma dan GM berbanding kumpulan kawalan. Rawatan kurma menunjukkan peningkatan yang ketara

dalam kiraan retikulosit, hemoglobin dan isipadu sel pembungkus, manakala rawatan GM menunjukkan peningkatan ketara dalam kiraan retikulosit, sel darah merah dan hemoglobin. Subjek yang mengambil kedua-dua kurma dan GM menunjukkan peningkatan yang ketara dalam kiraan retikulosit dan hemoglobin. Tahap feritin dalam subjek telah meningkat dengan ketara selepas diberi rawatan kurma dan GM berbanding kumpulan kawalan. PERBINCANGAN: Kajian mendapati bioavailabiliti besi rawatan kurma sahaja dan rawatan GM sahaja adalah lebih rendah daripada campuran kurma dan rawatan GM. Kemasukan susu kambing dalam diet terbukti dapat meningkatkan bioavailabiliti zat besi, memperbaiki parameter hematologi dan memulihkan kandungan zat besi. GM adalah miskin dalam kandungan besi, tetapi ia mengandungi protein larut yang lebih tinggi yang menyokong penyerapan zat besi. Nampaknya, kemasukan kurma dalam diet akan kelihatan meningkatkan hemoglobin kerana ia kaya dengan zat besi dan tinggi dengan bioavailabiliti besi berbanding dengan GM. KESIMPULAN: Dapatan menyokong hipotesis bahawa kurma dan GM bermanfaat dalam IDA. Kemasukan kurma dan GM disyorkan dalam diet anemia kekurangan zat besi. Ia juga diperhatikan bahawa susu kambing tidak mengganggu penyerapan zat besi.

ABSTRACT

INTRODUCTION: Iron deficiency anaemia (IDA) is a global health problem. Significant increase was shown in haematological parameters after tested date palm and goat milk (GM) on IDA rats. Therefore, this study will focus on the assessment of iron bioavailability in dates and GM using Caco-2 cell lines and their effects on haematological parameter and iron store in IDA subject. **MATERIALS AND METHODS:** Ajwa date, Mariami date, GM and goat milk fed Ajwa seed (GMFA) were prepared using *in vitro* digestion method. The caco-2 cells were harvested and used for analysis, and a standard curve was plotted. A quantitative study was conducted among 57 female adults who having mild IDA and assigned with different feeding regime. Blood samples was taken and analysed for full blood count and iron profile. Statistical analysis was performed to compare pre- and post-treatment. **RESULTS:** The standard curve showed a linear equation: $\text{Ferritin}(\text{ng})/\text{protein}(\text{mg}) = (16.519 \times \text{bread Fe}) + 16.255$, $R^2 = 0.974$. Using this equation, the bioavailability of iron from the mixture of Mariami date and GMFA shows the highest ($78.01 \pm 5.26\%$). It is followed by Mariami date+GM ($61.87 \pm 3.70\%$), Mariami date ($49.08 \pm 2.54\%$), Ajwa date+GMFA ($45.22 \pm 2.39\%$), Ajwa date+GM ($42.56 \pm 8.61\%$), Ajwa date ($26.48 \pm 1.32\%$), GMFA ($9.19 \pm 0.94\%$) and GM ($0.87 \pm 1.14\%$). Significant improvement in the haemopoietic activity was reported after subjects were given with date palm and GM treatment. Date palm treatment shows a significant increment in reticulocyte count, haemoglobin and packed cell volume, while GM treatment shows a significant increment in reticulocyte count, red blood cell

and haemoglobin. Subjects who consume both date palm and GM show significant increments in reticulocyte count and haemoglobin. Furthermore, a significant improvement in ferritin levels was also observed. DISCUSSION: The study found the iron bioavailability of date palm treatment alone and GM treatment alone was lower than a mixture of date palm and GM treatment. The inclusion of goat's milk in the diet was proven to increase iron bioavailability, improve haematological parameters and restore iron content. GM is poor in iron content, but it contains a higher soluble protein which favours iron absorption. Apparently, the inclusion of dates in the diet would appear to increase haemoglobin as it is rich in iron and high in iron bioavailability as compared to GM. CONCLUSION: Findings support the hypothesis that date palm and GM is beneficial in IDA. Inclusion of date palm and GM is recommended in the diet. It was also noted that goat milk does not interfere with iron absorption.

اصخلمل

هو مشكللة صحفة عالهفة .لوحظ زيادة معنوفة في معاللت الدم (IDA) مقدمة :نفر الدم الزاجم عن نقص الحديد لذلك ، ستركز هذه الدراسة على توكيم التوافر الحيوي IDA. بعد اخنار نخفل السمر وحلفب الماعز على نيران وناثراةا على معلمة الدم ومخنن Caco-2 للحديد في السمر والكائنات المعدلة وراثيّا باستخدام خطوط خلايا المواد والطرق :تم استخدام سمر العجوة ، سمر ماريامي ، حلفب الماعز المعدل وراثيا IDA. الحديد في موضوع caco-2 وتم نخضير العفة بطرؤة المضرم المخيري .تم حصاد خاليا (GMFA) المغذي بنور عجوة واستخدامها لتحليل البروتين والنيروبين ، وتم رسم منحنى فياسي .أجريت دراسة كلفة على 57 أنثى بالغة وتم تخصيص نظام نغذفة مختلف .تم اخذ عيفلت الدم وتحليلها لتعداد الدم الكامل IDA مصابات بزوع معدل من وبيانات الحديد .تم إجراء التحليل الإحصائي لمقارنة قبل وبعد العلاج .النتائج :أظهر المعدل في القياسي معادلة

بإستخدام $R^2 = 0.974$ ، خطفة :نيروبين (نانوغرام / (بروتين (مجم) = $16.519 \times \text{خز حديد} + 16.255$ أعلى نسبة) $78.01 \pm 5.26\%$ GMFA هذه المعادلة ، أظهر التوافر البيولوجي للحديد من خليط سمر ماريامي و مقارنة بالعيفلت الأخرى المخيرة .تلك تاريخ المريمي +المدير العام $61.87 \pm 3.70\%$ ، تاريخ المريمي ± سمر العجوة +المدير العام 42.56 ، $45.22 \pm 2.39\%$ GMFA + سمر العجوة ، $(49.08 \pm 2.54\%)$ تم $GMFA (0.87 \pm 1.14\%)$ $GMFA (9.19 \pm 0.94\%)$ $GMFA (\% \text{تاريخ العجوة}) 26.48 \pm 1.32$ ، 8.61% .الإبالغ عن نحن معنوي في النشاط المكون للدم بعد إعطاء الموضوع بنخفل السمر والمعالجة المعدلة وراثيا مقارنة بمجموعة التحكم .يُظهر علاج نخفل السمر زيادة كبيرة في عدد الخلايا الشبكية والهيموجلوبين وحجم الخلايا المكسدة ، بينما يُظهر العلاج المعدل وراثيّا زيادة كبيرة في عدد الخلايا الشبكية وخاليا الدم الحمراء يظهرون زيادات كبيرة في عدد الخلايا GM والهيموجلوبين .الشخص الذين يُنقلون كل من نخفل السمر ومقارنة بمجموعة GM الشبكية والهيموجلوبين .نحن مستوى النيروبين بشكل ملحوظ بعد معالجة نخفل السمر والتحكم .المنافسة :وجدت الدراسة أن التوافر البيولوجي للحديد في معالجة نخفل السمر وحده والمعالجة المعدلة وراثيّا وإحدها كانت أول من خليط النخفل والمعالجة المعدلة وراثيّا .ثبت أن إدراج حلفب الماعز في النظام الغذائي يزيد من التوافر الحيوي للحديد ،

ويحسن معايير الدم ويعد محتوى الحديد .جزرال موتورز نؤير في محتوى

الحديد ، لكّنه يحتوي على بروتين قابل للذوبان أعلى مما يساعد على امتصاص الحديد .على ما يبدو ، فإن إدراج السمّ في النظام الغذائي يبدو أنه يزيد الهيموجلوبين أنه غني بالحديد ومرتفع في التوافر البيولوجي للحديد مقارنة بالخاصة :تدعم النتائج الفرضية القائلة بأن نخيل السمّ والمعدّل وراثيًا منبّدان في المؤسسة الدولية GM. مع في النظام الغذائي لفقر الدم الزاجم عن نقص الحديد .لما لوحظ أن GM للنمّية .يوصى بإدراج نخيل السمّ و .حليب الماعز ال يعارض مع امتصاص الحديد

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Appendix 3: Food diary

Appendix 4: Publication



LIST OF ABBREVIATION AND UNIT OF MEASUREMENTS

Hb	Haemoglobin
ID	Iron deficiency
IDA	Iron deficiency anaemia
Fe	Iron
Mg	Magnesium
Zn	Zinc
Cr	Chromium
Mn	Manganese
Cu	Copper
Se	Selenium
CVDs	Cardiovascular diseases
ACE	Angiotensin-converting enzyme
Mg	Magnesium
Ca	Calcium
MCTs	Medium chain triglycerides
CLA	Conjugated linoleic acid
LAB	Lactic Acid Bacteria
MUFA	Monounsaturated fatty acids

PUFA	Polyunsaturated fatty acids
NO	Nitric oxide
DCYTB	Duodenal cytochrome B
HO-1	Heme oxygenase-1
dNTP	Deoxyribonucleotide triphosphates
RNR	Enzyme ribonucleotide reductase
WHO	World Health Organization
DMSO	Dimethyl sulfoxide
DMEM	Dulbecco's Modified Eagle medium
IRPs	Iron Regulatory Proteins
IRE	Iron-responsive Elements
TfR	Transferrin Receptor
UTR	Untranslated Region
mRNA	Messenger Ribonucleic Acid
DNA	Deoxyribonucleic Acid
HAMP	Hepcidin Antimicrobial Peptide
EPO	Erythropoietin
HIFs	Hypoxia Inducible Factors
KCs	Kupffer cells
RPMs	Red Pulp Macrophages