Guest Editorial

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CPD Articles

- Human milk fortification strategies for improved in-hospital growth of preterm infants
- South African indigenous fruits – Underutilized resource for boosting daily antioxidant intake among local indigent populations?

Review Articles

- Colon cancer and the consumption of red and processed meat: an association that is medium, rare or well done?

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- Nutrition-related cancer prevention knowledge of undergraduate students at the University of Ibadan, Nigeria

Commentary

- Eradicating malnutrition in Cameroon

SASPEN Case Study

- An unusual case of Wernicke’s encephalopathy – Thiamin deficiency in advanced gastric adenocarcinoma

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# Table of Contents

## Editor's Note

**3**

## Guest Editorial

- Value of antioxidant capacity as relevant assessment tool for "health benefits" of fruit - understated or inflated?
  *Elizabeth Joubert, Wentzel Gelderblom*

**4**

## CPD Articles

- Human milk fortification strategies for improved in-hospital growth of preterm infants
  *JE Kemp and FAM Wenhold*

**7**

- South African indigenous fruits – Underutilized resource for boosting daily antioxidant intake among local indigent populations?
  *Daniela Amalia Kucich and Merrill Margaret Wicht*

**16**

## Review Articles

- Colon cancer and the consumption of red and processed meat: an association that is medium, rare or well done?
  *SM Kassier*

**24**

## Abstracts

- Dispensing patterns of prescription-only antiobesity preparations in South Africa
  *Ilse Truter*

**29**

- Dispensing of vitamin products by retail pharmacies in South Africa: Implications for dietitians
  *Ilse Truter and Liana Steenkamp*

**29**

- Nutrition-related cancer prevention knowledge of undergraduate students at the University of Ibadan, Nigeria
  *Oluyemiwi Folake Folasire, Ayorinde Mobolani Folasire and Samuel Chikezie*

**30**

## Commentary

- Eradicating malnutrition in Cameroonian
  *Ndenkeh N. Jackson Jr. and Samuel N. Cumber*

**31**

## SASPEN Case Study

- An unusual case of Wernicke's encephalopathy – Thiamin deficiency in advanced gastric adenocarcinoma
  *J van Rensburg N, Rensburg N, Plaskett J*

**33**

## SASPEN News

**38**

## NSSA Newsbits

**39**

## ADSA Directions

**40**

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10. The Journal will be managed by an Editor and Editorial Board with the following responsibilities:

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- Maintenance of ethical standards of the articles published.
- Encouragement and support of authors.
- Promotion of the readership.
- Ensuring the spread of articles published.

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- Advertised products or services must be in compliance with Act 101, “The Code of Practice for the Marketing of Medicines in RSA”, the National Drug Policy and regulations of the Medicines Control Council (MCC), Health Profession Council of SA (HPCSA) and the South African Code for the Marketing of Breast Milk Substitutes.
- The Journal will accept advertisements for infant feeds, which are therapeutic in nature, for example lactose free feeds, breast milk fortifiers, hypo-allergic feeds and feeds designed for tube feeding. Any such advertisements shall include a phrase that normally exclusive breast milk feeding is the best food for babies.
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A change of a different type is that in global climate and the consequences it is projected to have in store for health, nutritional status and food security. The aim of the Lancet Countdown is to track the health impacts of climate change through its five working groups which plan to report annually on various global, national and/or region-specific indicators on how climate change impacts on population health. From the African perspective, the African continent can ill afford even small rises in temperature without significant adverse impact on agricultural production as well as food and water security. Indeed, the Cairo Declaration recognizes the importance of Africa’s natural capital, the combating of desertification, the eradication of poverty and the addressing of the projected consequences of climate change in supporting human, animal and plant life.

The SAJCN, together with its Management and Editorial Boards, wishes all its readers the very best for a blessed Festive Season.

References

Prof Demetre Labadarios
Editor-in-Chief: SAJCN
Value of antioxidant capacity as relevant assessment tool for “health benefits” of fruit - understated or inflated?

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Consumption of fruit and vegetables is considered to be an inherent part of a healthy diet, but more so since plant antioxidants, and in particular polyphenols, have been linked through in vivo and epidemiological studies with positive health outcomes. 1-5 As a result, polyphenols have been elevated to “lifespan essentials”, because scientific evidence indicated that they are needed by humans to achieve a full lifespan by reducing the risk of a range of chronic diseases. 4 No Dietary Reference Intake values exist for polyphenols, however, it has been suggested that their target intake value should be based on the total polyphenol content provided by the “5-a-day” portions of fruit and vegetables recommendation by the World Health Organisation. 5

In spite of mounting evidence that fruit and vegetable intake should be within an adequate range to support health, the intake of the required recommended daily portions remains a challenge to many consumers due to various factors. 6-7 When considering the rural South African black population, Kucich and Wicht8 in the current issue of the SAJCN identified availability and access (or food insecurity) as some of the reasons for the disparity between recommended and actual intake of fruit and vegetables. The authors suggest that an increased consumption of local indigenous fruits could provide a much-needed source of phenolics and antioxidants. 8 These wild fruits can play an important supplementary role in the diet of people during periods of food insecurity. A major methodological challenge, however, exists to evaluate the relative contribution of dietary polyphenols to the total antioxidant capacity (TAC) of a food and the validity of their maximal nutritional value as antioxidants in order to provide guidelines and advise consumers.

For comparative assessment of the relative “nutritional value” of ten indigenous fruits to that of blueberry and cranberry, well-known for providing high levels of antioxidants, Kucich and Wicht8 employed an Antioxidant Potency Composite Index, by combining the equally weighted results of three antioxidant assays. These assays, i.e. Total Phenolic Content (TPC), Trolox Equivalent Antioxidant Capacity (TEAC) and Total Antioxidant Capacity (H-ORACFL + L-ORACFL), reflect the ability of polyphenols to neutralise free radicals through hydrogen atom transfer and/or electron transfer. 9 ORAC values were used to indicate that consuming as little as 25 g of colpoon, Christmas berry or wild olive at least 8000 µmoles Trolox Equivalents (TEs) are added to the diet. The same amount of cranberries and blueberries would add 1600 and 3000 µmoles TEs, respectively. Louwrens et al.10 recommended a daily TAC intake per person equalling 20 513 µmoles TE for the average South African consumer, based on ORAC values calculated for a diet compiled using the “5-a-day” concept.

To better understand the relationship between polyphenols, antioxidant capacity and health, and whether such a relationship has any value, the “Free Radical Theory of Ageing” needs to be examined. In 1954 Denham Harman, in his quest to explain ageing, had a “light bulb” moment, linking free radicals to ageing, although at that stage no literature existed to support this hypothesis. In a paper published in 2009 he describes the origin, evolution and eventual recognition of the “Free Radical Theory of Ageing”.11 Deleterious free radical reactions in biological systems, if unchecked, cause damage to cell structures such as lipids, proteins or DNA, inhibiting their normal function. The resultant impaired functionality may lead to “ageing” and degenerative diseases. The human antioxidant defence mechanism includes both enzymatic and non-enzymatic endogenous antioxidants, such as superoxide dismutase (SOD), catalase, glutathione peroxidase, coenzyme Q10 and glutathione, allowing cells to manage reactive oxygen species (ROS) by eliminating excess ROS to maintain redox homeostasis.12,13 Exogenous antioxidants, and most notably polyphenols, provided by the diet, subsequently gained prominence over the past 25 years or more for their ability to scavenge free radicals, leading to the hypothesis that these phytochemicals could assist in maintaining redox homeostasis in the cell. In addition, excessive amounts of polyphenols ingested through dietary supplements have also been associated with adverse effects by acting as prooxidants resulting in the induction of oxidative stress14, thereby suggesting the existence of critical thresholds for polyphenol intake to ensure their health beneficial effects. It becomes important to realise that the health benefits of polyphenol-enriched supplements, although making sense theoretically, have not been thoroughly evaluated and, that using a wrong dose and/or combinations of such supplements, could have detrimental health effects. Therefore, it is very important to accurately assess polyphenol intake instead of exclusively using the antioxidant activity of fruit and vegetables, which seems to provide unreliable and variable results. Various antioxidant assays14 have been developed through the years to determine the TAC of plant...
foods with new assays or new versions of existing assays occasionally emerging\(^9\)–\(^17\), either to broaden the base of comparison or to focus on a specific mechanism of antioxidant activity. Whilst these efforts provide the nutritionists and food scientists with an array of assays to estimate the antioxidant activity of food, they have limited or lack relevance \textit{in vivo}. For instance, many of the radical species utilised in these assays are unrelated to those effecting cellular oxidative stress. Furthermore, high antioxidant concentrations and the test environment employed (e.g. a low pH or non-buffered medium) are factors contributing to a lack of physiological and/or pathological relevance to oxidative stress.\(^1\) The most widely used methods to provide a cumulative or TAC value for food items are the ORAC, DPPH and ABTS (or TEAC) assays.\(^19\)\(^,\)\(^20\) The TFC or Folin-Ciocâltu assay, historically used to quantify the total polyphenol content of wine and later other foods, is in fact also an antioxidant method utilising a basic reaction mechanism of oxidation/reduction.\(^21\) It could be argued that the opposite may also be valid, as the so-called antioxidant assays only provide an estimate of redox-active compounds, and thus by implication polyphenols, especially for food products containing high levels of these phytochemicals.

In spite of these caveats, dietary TAC has also been used to assess the relationship between the cumulative antioxidant capacity of a food and health outcomes in humans. Several studies indicated an inverse relationship between antioxidant intake and disease risk\(^22\)–\(^29\) fuelling the interest in these dietary constituents as health promoters. In some instances, threshold values of antioxidants that will reduce certain disease risks, were suggested.\(^31\)\(^,\)\(^32\) While interpretation of the outcomes associated with daily intake of a threshold level of antioxidants may seem straightforward, many factors confound perceived outcomes and interpretation. Visioli et al.\(^3\) noted that the level of evidence from epidemiological studies on antioxidant-related wine consumption and health, varies greatly, probably due to inherent difficulties to accurately estimate dietary habits and lifestyle. Furthermore, they pointed out that the methods currently used in epidemiological studies for evaluating antioxidant intake via foods and beverages are inadequate and challenging.

Interpretation of threshold intake levels of TAC for a perceived positive health outcome is further confounded by the lack of a standardised assay. The ORAC assay has gained popularity, not least because of the effort Prior and co-workers have put into the development of a method that takes into account both hydrophilic and lipophilic antioxidants, but also to create a large ORAC database of selected foods.\(^6\)\(^,\)\(^30\) The data generated by various TAC assays are also employed by industry and even by consumers as yardsticks to compare food products, in order to identify the “best” product or the one with the “highest” TAC value. This gave rise to terms such as “superfoods” and “superfruits”, yet with little \textit{in vivo} evidence and sometimes only an \textit{in vitro} TAC value as basis. In a 2012 press release, the United States Department of Agriculture announced the removal of their USDA ORAC Database for Selected Foods from their Nutrient Data Laboratory website.\(^9\) The main reason given was the “mounting evidence that the values indicating antioxidant capacity have no relevance to the effects of specific bioactive compounds, including polyphenols in human health”. Furthermore, it stated that “ORAC values are routinely misused by food and dietary supplement manufacturing companies to promote their products and by consumers to guide their food and dietary supplement choices”. This begs the question - have we all been misguided or overstating the positive health impact of antioxidants and the value of antioxidant measurements in food? Prior\(^9\) concluded that antioxidant capacity assays do have relevance to \textit{in vivo} health outcomes, providing that the advantages, disadvantages and shortcomings of the particular \textit{in vitro} assay are defined and understood.

In the final analysis of the value of the TAC of fruit as a relevant assessment tool for “health benefits” as employed by Kučich and Wicht\(^9\), we can argue that such a value is adequate to provide the analyst with a global content value for phytochemicals, including polyphenols that undergo and modulate redox type reactions. However, these assays may not reflect the structural complexity of these compounds that governs their physicochemical properties related to their absorption, metabolism and excretion. Characterisation and accurate quantification of individual polyphenols in foods are critical to assess their relevance and contribution to a healthy diet. The development of the Phenol-Explorer, another web-based database, was a step in the right direction. This comprehensive database on individual polyphenol content in foods also allows retrieval of data on the biotransformation and pharmacokinetics of dietary polyphenols, in addition to data on the effects of food processing on polyphenol content of food.\(^25\)\(^–\)\(^34\) Mounting scientific evidence points to important roles for polyphenols and their metabolites in cellular responses that are independent of their antioxidant activity\(^35\)\(^–\)\(^39\) Virgili and Marino\(^34\) concluded that “… the “antioxidant hypothesis” is to be considered in some cases an intellectual “shortcut” possibly biasing the real understanding of the molecular mechanisms underlying the beneficial effects of various classes of food items”.

References

Value of antioxidant capacity as relevant assessment tool for “health benefits” of fruit - understated or inflated?


Human milk fortification strategies for improved in-hospital growth of preterm infants

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Introduction

In South Africa, eight out of every 100 babies are born prematurely.1 Despite many advances in the nutritional care of preterm infants, poor in-hospital growth and extra-uterine growth restriction (EUGR) remain a problem in industrialised and developing countries.2-4 In a cohort of very low birth weight (VLBW) preterm infants in Johannesburg, South Africa, a high rate of early growth failure was shown.5 Human milk is the feed of choice for all infants,6 yet it may need to be fortified for optimal growth and development. Standard fortification of human milk seldom meets the recommended intake of protein, leading to inadequate post-natal growth. This article aims to critically review different human milk fortification strategies with a focus on in-hospital growth of premature infants in resource-limited settings. Super, adjustable and target fortification are compared to standard fortification. Different growth outcome parameters limit comparability of findings, but super fortification and adjustable fortification present opportunities to explore. More uniform growth outcome assessment is recommended. Practical implementation and cost-effectiveness in the local setting need to be investigated.

Keywords: fortification, human milk, preterm infant

Human milk is the preferred feed for preterm infants, yet it may need to be fortified for optimal growth and development. Standard fortification of human milk seldom meets the recommended intake of protein, leading to inadequate post-natal growth. This article aims to critically review different human milk fortification strategies with a focus on in-hospital growth of premature infants in resource-limited settings. Super, adjustable and target fortification are compared to standard fortification. Different growth outcome parameters limit comparability of findings, but super fortification and adjustable fortification present opportunities to explore. More uniform growth outcome assessment is recommended. Practical implementation and cost-effectiveness in the local setting need to be investigated.

Introduction

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In this article the term human milk is used synonymously with breast milk and refers to mother’s own milk and banked donor milk. Multicomponent human milk fortifiers specifically designed for use in low birth weight and preterm infants are under discussion, while fortification refers to the addition thereof to human milk.

Human milk

The advantages of human milk to premature infants are numerous, especially if the infant’s own mother’s milk is used. The benefits which are dependent on both the dose and the duration of breastfeeding include the reduction in the incidence of necrotising enterocolitis (NEC), late-onset sepsis and retinopathy, better feeding tolerance and improved neurodevelopmental outcomes.11,12 The benefits can be attributed to nutritional and non-nutritional factors in human milk, such as bioactive, growth and immunological factors. The composition of human milk is dynamic and does not only vary from mother to mother, but also from feed to feed and within a feed. The nutrients in human milk originate from synthesis in the lactocyte, from maternal stores and from her dietary intake. Despite variations in maternal intake and nutritional status, the nutritional quality of human milk is remarkably conserved. Mature human milk (from mothers who delivered at term) contains approximately 65 to 70 kcal (273 to 294 kJ), 0.9 to 1.2 g protein, 3.2 to 3.6 g fat and 6.7 to 7.8 g carbohydrates per 100 ml.11 The biggest variations in macronutrient content occur in the fat component, with hind milk having higher concentrations of fat than foremilk. Furthermore, milk from mothers who have delivered prematurely (preterm milk) differs from mature milk. These differences include higher protein, free amino acids, fat and sodium concentrations but lower concentrations of calcium compared to mature milk. These differences are, however, only seen in the first few weeks of life. Levels of protein, fat and sodium decline over time until they are similar to those seen in mature milk.7,11,12

Challenges in the use of human milk for the premature infant include the availability of mother’s own milk, sustainability of expressing milk when infants are not feeding on the breast, the effect of pasteurisation on the nutritional and immunological content of donor milk, and transmission of viruses, including human immunodeficiency virus. The most important challenge is probably that unfortified human milk does not meet the nutritional requirements of most preterm infants.2,13 This is particularly problematic in those born before 34 weeks gestational age; infants with a birth weight of less than 1800 g; those who are small for their gestational age (SGA); infants with fluid restrictions; and, those with co-morbidities that increase nutrient requirements.7,9 To illustrate the above, the protein and energy requirements of a 1 kg infant are compared to the nutritional content of mature human milk at volumes typically prescribed for preterm infants. As can be seen from Table 1, human milk at the lower fluid intake of 150 ml/kg body weight/day does not meet protein or energy requirements as recommended by the American Academy of Paediatrics (AAP).14

Table 1: Protein, fat and energy requirements

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mature milk (100 ml)</th>
<th>Preterm milk (150 ml/kg body weight/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>1.8 g</td>
<td>0.6 g</td>
</tr>
<tr>
<td>Fat</td>
<td>3.6 g</td>
<td>1.2 g</td>
</tr>
<tr>
<td>Energy content (kcal)</td>
<td>126</td>
<td>54</td>
</tr>
</tbody>
</table>

Table 1: Protein, fat and energy requirements.
and the European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN). This poses a particular problem in infants who cannot tolerate large volumes of milk and in those with fluid restrictions. At higher fluid intake, energy requirements can be met by mature human milk, but protein stays below the recommendation, even at the highest volume.

The listed challenges are far outnumbered by the advantages of using human milk. Different interventions have been proposed for overcoming the challenge of inadequate nutrient delivery by human milk. These include using mother’s own milk (unpasteurised) rather than donor milk (which usually comes from mothers who gave birth at term); increasing the volume of milk; using more hind milk than foremilk; and, fortification. In resource-poor settings where human milk fortifiers are not available, circumstantial evidence even proposes the addition of skim milk powder. To the authors’ knowledge (and confirmed by personal communication with Ziegler on 26/02/2015), there are no published reports on the use of skim milk powder as fortifier, and it may not supply sufficient trace minerals. Therefore, use of skim milk powder can currently not be recommended as an alternative in a country where fortifier is commercially available.

**Human milk fortification strategies**

Fortification of expressed breast milk (EBM) can be done by using modular components (for example, adding a protein supplement) or by using commercially available fortifier designed specifically for use in low birth weight infants. The use of modular supplements poses many challenges, including accurate measurement of the minute amounts needed, especially if the patient is bolus fed. A further potential problem is the increased osmolality of the human milk. Even though the addition of modular components may aid in meeting the preterm infant’s micronutrient requirements, the micronutrient composition thereof does not “complement” that of human milk, carrying the risk of either overfeeding or underfeeding of micronutrients.

The use of human milk fortifiers is now considered standard practice in most neonatal units. Fortifiers can either be bovine or human milk based, in powder or liquid form, and may contain hydrolysed or intact protein. In South Africa, there is only one commercially available fortifier, namely FM85 (Nestle, South Africa), which contains extensively hydrolysed cow’s milk protein in powdered form. The nutritional analysis of FM85 used in this article was correct at the time of going to press.

**Standard fortification**

Standard fortification (the addition of fortifier in amounts per volume as prescribed by the manufacturer) usually starts once the intake of EBM reaches 100 ml/kg body weight/day. As an empirical dose of nutrients is added with this type of fortification, it does not always match the nutritional needs of the individual infant. In Table 1, the nutritional requirements of a 1 kg infant are compared to different volumes of human milk fortified with FM85 at the standard dosage of 1 g/20 ml EBM. Compared to recommendations by AAP and ESPGHAN, energy supply will be sufficient at an intake of 150 ml/kg body weight, but it will exceed recommendations at higher volumes. In contrast, protein supply will only be adequate at volumes of 180 ml/kg body weight and higher. Protein intake of 4.5 g/kg body weight/day as recommended by ESPGHAN for extremely low birth weight infants (ELBW) (recommendation not shown in Table 1), will not be met, even at an intake of 200 ml/kg body weight. Even though protein requirements of infants weighing more than 1 kg can theoretically be met at high volumes, it is rarely achievable in practice. Furthermore, the high energy intake to be given in order to meet protein requirements is controversial, as excessive energy may be stored as adipose tissue. To counteract the problem of providing too much energy relative to the amount of protein, the protein to energy ratio should be considered. As can be seen from Table 1, the ratio of protein to energy recommended by ESPGHAN is neither met with human milk alone, nor with the standard addition of fortifier.

Aslanoglu et al. and Corvaglia et al. measured actual nutrient content of human milk including standard fortification. Both groups reported protein levels below the recommended 3.5 to 4.0 g/kg body weight/day at intakes of 150 ml/kg body weight/day. A Cochrane review in 2004 on multicomponent fortifiers, recommended “the evaluation of both short-term and long-term outcomes in search of the “optimal” composition of fortifiers,” implying that follow-up research should focus on alternatives to standard fortification so as to increase protein intake. We hence conducted a literature search in April 2015 (CINAHL, MEDLINE Ovid without revisions, Web of Science) for studies on human milk fortification published in the English language since 2004. Table 2 summarises all studies identified which met the following criteria: single-intervention studies; exclusive use of human milk (thus no preterm formula); comparison of alternative fortification strategies to standard fortification; and, in-hospital growth as a primary outcome. The table does not include studies where fortified milk was compared to unfortified milk or those

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>AAP (14)</th>
<th>ESPGHAN (15)</th>
<th>AAP (14)</th>
<th>ESPGHAN (15)</th>
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<tr>
<td>Protein</td>
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<td>3.5 to 4.0</td>
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<td>98 to 105</td>
<td>117 to 126</td>
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<td>462 to 567</td>
<td>412 to 441</td>
<td>491 to 529</td>
</tr>
<tr>
<td>Protein/energy ratio</td>
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<td>3.2 to 3.6</td>
<td>1.3** to 1.8***</td>
<td>(1.6****)</td>
</tr>
<tr>
<td>Protein/energy ratio g/100 kcal</td>
<td>0.6 to 0.9</td>
<td>0.8 to 1.0</td>
<td>0.3** to 0.4***</td>
<td>(0.37****)</td>
</tr>
</tbody>
</table>

*4.2 kJ/kcal used in conversion.
**Lowest protein and highest energy used in calculation.
***Highest protein and lowest energy used in calculation.
****Mid-values of protein and energy used in calculation.

**Table 1: Enteral protein and energy requirements of a 1 kg preterm infant compared to the nutritional content of unfortified and fortified mature human milk**

**Enteral protein and energy requirements**

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>AAP (14)</th>
<th>ESPGHAN (15)</th>
<th>AAP (14)</th>
<th>ESPGHAN (15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>3.4 to 4.2</td>
<td>3.5 to 4.0</td>
<td>1.4 to 1.8</td>
<td>1.6 to 2.2</td>
</tr>
<tr>
<td>Energy kcal/day</td>
<td>110 to 130</td>
<td>110 to 135</td>
<td>98 to 105</td>
<td>117 to 126</td>
</tr>
<tr>
<td>Energy kJ/day*</td>
<td>462 to 546</td>
<td>462 to 567</td>
<td>412 to 441</td>
<td>491 to 529</td>
</tr>
<tr>
<td>Protein/energy ratio</td>
<td>2.6 to 3.8</td>
<td>3.2 to 3.6</td>
<td>1.3** to 1.8***</td>
<td>(1.6****)</td>
</tr>
<tr>
<td>Protein/energy ratio g/100 kcal</td>
<td>0.6 to 0.9</td>
<td>0.8 to 1.0</td>
<td>0.3** to 0.4***</td>
<td>(0.37****)</td>
</tr>
</tbody>
</table>

*4.2 kJ/kcal used in conversion.
**Lowest protein and highest energy used in calculation.
***Highest protein and lowest energy used in calculation.
****Mid-values of protein and energy used in calculation.
comparing different types of fortifiers (for example, liquid versus powder). The studies summarised in Table 2 are discussed under the different fortification strategies: super, adjustable and target fortification.

**Super fortification**

Super fortification (also called blind fortification) involves the addition of greater than standard amounts of fortifier, for example adding the standard dosage to a lower volume of milk than that recommended by the manufacturer. This alternative is a relatively simple approach and, apart from the extra amount of fortifier needed, it does not imply any additional costs or manpower for example, for the nutritional analysis of milk samples. Higher protein delivery can be achieved, but additional energy and micronutrients are also provided. This fortification strategy may therefore not change the protein to energy ratio sufficiently to promote gain in lean body mass. Hypercalcaemia may be a risk and testing serum calcium and serum phosphorous more regularly should be considered.8

Kanmaz et al.25 (Table 2) reported two levels of blind fortification (moderate and aggressive) compared to standard fortification in a group of ELBW and VLBW infants with a gestational age of about 28 weeks. Moderate and aggressive fortification led to non-significant increases in weight and length, but head circumference increased significantly. The lack of significant increases in weight and length can possibly be explained by the estimated protein intake of only 3.3 to 3.6 g/kg body weight/day in the intervention groups, which would not be considered adequate for preterm infants with a birth weight of around 1000 g.14,15 This is supported by the fact that the serum urea levels did not increase. It is not clear from the article what energy intake was estimated to be, but the protein to energy ratio might provide some additional explanation.

**Individualised fortification: Adjustable fortification**

Adjustable fortification refers to a more customised method of fortification where the metabolic response of the infant is used to guide the stepwise addition of extra protein. This extra protein is usually added in the form of a modular protein supplement and is done “on top of” the addition of standard amounts of fortifier. Blood urea nitrogen (BUN) values, which have been shown to correlate closely to enteral protein intake in infants, guide the amount of additional protein needed.8,13,21

Alan et al.22 (Table 2) compared adjustable fortification, using an additional protein supplement, to standard fortification in preterm infants fed exclusively with their own mother’s milk. The estimated median amount of daily protein intake in the intervention group of 4 g/kg body weight/day (range: 3.4 - 4.6) was within the AAP14 and ESPGHAN15 recommendations and significantly higher than the intake in the control group. The estimated protein to energy ratio in the intervention group was 3.3 g/100 kcal which also fall within the recommended ranges. Statistically significant increases in daily growth indices for weight, length and head circumference, as well as in length and head circumference gain velocities, were seen in the intervention group. It is important to note that these results were achieved without adjustment in volume or energy intake. The median daily volume intake in both groups was about 140 ml/kg body weight/day, making this type of fortification strategy suitable for fluid restricted preterm infants. In a similar study by Biasini et al.24 (Table 2), the estimated protein intake of 4.8 g/kg body weight/day in the adjustable fortification group was higher than in the study by Alan et al.,22 but the protein to energy ratio was comparable at 3.4 g/100 kcal. In the latter study, however, statistically significant increases were only reported in head circumference and length, and only in a sub-group analysis of ELBW infants. It should be kept in mind that in both studies, nutritional content of fortified milk was estimated and not measured. Furthermore, in the study by Biasini et al.,24 40% of milk was donor milk, which may have had a lower nutritional content than preterm mother’s own milk.

In a randomised controlled trial by Arslanoglu et al.26 (Table 2), an additional fortifier in addition to the protein supplement were added based on twice weekly BUN levels. Infants received mother’s own milk as well as banked donor milk. Protein content of fortified milk, which in this study was analysed and not estimated as in the aforementioned studies, was significantly higher in the intervention group. Protein intake, but not fat or energy intake, was significantly correlated with weight gain (g/kg body weight/day) and head circumference gain (mm/day), both of which were significantly higher in the intervention group than in the standard fortification group. Even though linear growth was also somewhat faster in the intervention group, it did not reach statistical significance when compared to the standard fortification group.

**Individualised fortification: Target fortification**

Target fortification is tailored to the individual preterm infant’s needs by analysis of maternal milk before fortification. Maternal and/or donor milk is usually analysed with infrared spectroscopy equipment that provides qualitative (macronutrients) and quantitative information of a milk sample as small as 5 ml.8,17,19 Creamatocrit analysis can also be used. In a study by Rochow et al.20 (Table 2) individualised fortification was done using a stepwise approach, starting with determining the nutrient content in pooled human milk followed by standard fortification. The last step involved the addition of monomeric supplements to reach target levels of protein, fat and carbohydrate. The target levels for macronutrients were defined based on the ESPGHAN15 recommendations and assumed an intake of 150 ml/kg body weight/day. Weight gain in the individual fortification group was similar to infants receiving standard fortification, but feeding volume was significantly higher in the latter group and could have influenced the results. A linear relationship between milk intake and weight gain was only demonstrated in the individual fortification group.

A different approach to target fortification was reported by Hair et al.25 (Table 2) where fat was the only macronutrient added in addition to standard fortification. In this study a human milk-derived fortifier and a human milk cream supplement were used to provide an exclusive human milk-based diet. In the individual fortification group, human milk cream was added to increase energy to 20 kcal/oz (20 kcal/28 ml). Compared to the standard fortification group, this group had significant increases in weight and length, but not in head circumference. Unfortunately, the level of protein and the total volume of milk consumed are not clear, making comparisons with other studies difficult.

**Adverse effects of fortification**

The standard addition of fortifier to human milk appears to be generally safe and well-tolerated by most infants. According to a Cochrane review27 on multicomponent fortification of human

---

Table 1: Nutrient unit AAP (14) ESPGHAN (15)

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>AAP</th>
<th>ESPGHAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein (g/day)</td>
<td>3.4 to 4.2</td>
<td>3.5 to 4.0</td>
</tr>
<tr>
<td>Calcium (mg/day)</td>
<td>300 to 500</td>
<td>400 to 500</td>
</tr>
<tr>
<td>Iron (mg/day)</td>
<td>7 to 10</td>
<td>7 to 10</td>
</tr>
<tr>
<td>Zinc (mg/day)</td>
<td>2.0 to 2.5</td>
<td>2.5 to 3.0</td>
</tr>
</tbody>
</table>

*Statistically significant increases in daily growth indices for weight, length, and head circumference were seen in the intervention group.*
Table 2: Outcomes of alternative human milk fortification intervention strategies

<table>
<thead>
<tr>
<th>Alternative fortification strategy</th>
<th>Study Design</th>
<th>Sample Size</th>
<th>Initiation of standard fortification</th>
<th>Initiation of alternative fortification</th>
<th>Volume and type of milk</th>
<th>Type of fortifier and supplement</th>
<th>Growth parameter</th>
<th>p-value</th>
<th>Other outcomes, including adverse effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Super-fortification</td>
<td>Randomised controlled trial: n = 84</td>
<td>When volume of intake at: 90 to 100 mL/kg/d GA (weeks): SF: 31</td>
<td>When volume of intake at: 150–170 mL/kg Day of life:</td>
<td>Full volume (mL/kg/d): SF: 155 ± 4.6 MF: 154 ± 6</td>
<td>Fortifier: Eoprotin (Milupa, Germany) (Cow’s milk based)</td>
<td>W gain (g/d):</td>
<td>0.38</td>
<td>Feeding tolerance: NS differences in feeding tolerance, residuals, abdominal distension, frequency of stooling 1 Patient in MF group developed NEC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GA ≤32wk</td>
<td>MF: 30.5</td>
<td>MF: 12 AG: 156 ± 6.9</td>
<td>W (g): Duration: Type:</td>
<td>L at discharge (cm)</td>
<td>0.85</td>
<td>Biochemistry: NS differences in S-urea, S-calcium, S-phosphorous, S-ALP</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>BW ≤1500 g</td>
<td>SF: 1106</td>
<td>Until discharge from hospital Human milk (no indication if donor milk was used)</td>
<td>AF (median age): Day of life: 8 (for SF and AF)</td>
<td>AF: 143.5 (125 – 163) Eoprotin (Milupa, Germany) (Cow’s milk based)</td>
<td>HC (cm/wk)</td>
<td>0.001</td>
<td>Blood gas within normal range; no metabolic acidosis</td>
<td></td>
</tr>
<tr>
<td>Adjustable fortification (AF)</td>
<td>Prospective observational intervention:</td>
<td>n = 58 When volume of intake at: 80 mL/kg/d</td>
<td>When volume of intake at: not clear from article Median volume (mL/kg/d):</td>
<td>Fortifier:</td>
<td>W velocity (g/kg/d): 0.053</td>
<td>L velocity (mm/d): 0.008</td>
<td>Feeding tolerance: NS differences in “feeding interruption” (abdominal distention and/or GRV &gt; 50% and/or vomiting)</td>
<td></td>
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<tr>
<td></td>
<td>GA ≤32wk</td>
<td>Median age: Day of life: 17</td>
<td>Day of life: 8 (for SF and AF)</td>
<td>Type: Protein supplement:</td>
<td>Daily growth index for W (%) 0.026</td>
<td>Clinical outcome: Similar between groups: NEC, BPD, ROP requiring laser treatment</td>
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<tr>
<td></td>
<td>BW ≤1500 g</td>
<td>Mean W (g): 1501 ±252 Duration:</td>
<td>At least two weeks (median duration 21 d)</td>
<td>Type: Subgroup analysis of GA ≤28wk:</td>
<td>Daily growth index for L (%) 0.027</td>
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</tr>
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</table>

(Continued)
### Table 2: (Continued)

<table>
<thead>
<tr>
<th>Alternative fortification strategy</th>
<th>Study</th>
<th>Design</th>
<th>Sample</th>
<th>Initiation of standard fortification</th>
<th>Volume of milk</th>
<th>Type of fortifier and supplement</th>
<th>Intervention</th>
<th>Outcomes in terms of in-hospital growth</th>
<th>Other outcomes, including adverse effects</th>
<th>Reference</th>
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</thead>
<tbody>
<tr>
<td><strong>Adjustable fortification</strong></td>
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<tr>
<td>Randomised controlled trial:</td>
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<td>n = 32</td>
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<td>90 ml/kg/d</td>
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<td>150 ml/kg/d</td>
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<td>150 to 160 ml/kg/d</td>
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<td>FM85 (Nestle, Italy)</td>
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<td>W gain (g/kg/d)</td>
<td>&lt; 0.01</td>
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<tr>
<td>Fortifier and additional protein supplement (based on twice-weekly S-BUN levels) compared to SF</td>
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<td>GA ≤ 34wk</td>
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<td>Protein supplement:</td>
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<td>Own mother’s milk or banked donor milk</td>
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<td>Until W of 2000 g (at least 14 days)</td>
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<td>In ELBW sub-group (W 580–980 g; GA 23–30wk):</td>
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<td></td>
<td>W gain (g/kg/d)</td>
<td>0.05</td>
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<td>Length gain (cm/wk)</td>
<td>0.04</td>
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<td></td>
<td>HC gain (cm/wk)</td>
<td>0.02</td>
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<tr>
<td><strong>Adjustable fortification</strong></td>
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<td>Randomized controlled trial:</td>
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<td>n = 61</td>
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<td>Full enteral feeding</td>
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<td></td>
<td>Until discharge or transfer to other hospital or when &gt;50% of milk taken directly from breast</td>
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<td></td>
<td>In ELBW sub-group (W 580–980 g; GA 23–30wk):</td>
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<td></td>
<td>W gain (g/kg/d)</td>
<td>0.05</td>
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<td>Length gain (cm/wk)</td>
<td>0.04</td>
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<td></td>
<td>HC gain (cm/wk)</td>
<td>0.02</td>
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### Table 2: (Continued)

<table>
<thead>
<tr>
<th>Alternative fortification strategy</th>
<th>Study</th>
<th>Intervention</th>
<th>Outcomes in terms of in-hospital growth</th>
<th>Other outcomes, including adverse effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Target fortification (TF)</strong></td>
<td></td>
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<tr>
<td><strong>Prospective clinical trial:</strong></td>
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</tr>
<tr>
<td>Design:</td>
<td>n = 10 (plus 20 for matched-pairs)</td>
<td>When volume of intake at:</td>
<td>When volume of intake at:</td>
<td>Feeding volume:</td>
<td>W gain similar between groups but feeding volume in SF group significantly higher than in IF group (p &lt; 0.001)</td>
</tr>
<tr>
<td>GA &lt;32w</td>
<td>Step-wise introduction over a 3 day period, full amount of target fort on day 4</td>
<td>147 ± 5 mL/kg/d (TF)</td>
<td>Similac (Abbott Nutrition, USA)</td>
<td></td>
<td>No feeding intolerance seen (GRV &gt; 50% previous feeding volume; emesis; abdominal distention; decrease/delay/discontinuation of feeds)</td>
</tr>
<tr>
<td>BW &lt;1500 g</td>
<td>Volume of intake not indicated</td>
<td></td>
<td>Supplements:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Day of life:</td>
<td>30</td>
<td>Protein:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Type:</td>
<td>Carbohydrate:</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Fortifier plus additional protein, fat and carbohydrate supplements (based on human milk analysis) compared to SF (matched-paired groups of infants in the same neonatal unit)</td>
<td>Not indicated</td>
<td>Polycose (Abbott Nutrition, USA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BW &lt;1500 g</td>
<td>Duration:</td>
<td>Minimum of 3 consecutive weeks</td>
<td>Own mother’s milk</td>
<td></td>
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<tr>
<td><strong>Target fortification</strong></td>
<td></td>
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</tr>
<tr>
<td><strong>Prospective randomised trial:</strong></td>
<td>n = 78</td>
<td>When volume of intake at:</td>
<td>When volume of intake at:</td>
<td>Feeding volume:</td>
<td>W velocity (g/kg/d) 0.03</td>
</tr>
<tr>
<td>GA</td>
<td>100 mL/kg/day or sooner</td>
<td>Once standard fortified feeds tolerated</td>
<td>Prolact+H/MF (Prolacta Bioscience, USA)</td>
<td></td>
<td>No cases of NEC or death reported</td>
</tr>
<tr>
<td>SF</td>
<td>Not indicated</td>
<td>Day of life:</td>
<td>HC (cm/wk) 0.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TF</td>
<td>Not indicated</td>
<td>Day of life:</td>
<td>L velocity (cm/wk) 0.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BW 750 to 1250 g</td>
<td>Duration:</td>
<td>Type:</td>
<td>Supplement:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fortifier plus additional human milk cream supplement (based on human milk analysis) compared to SF</td>
<td>Until 36 weeks PMA or when weaned from fortification</td>
<td>W velocity from time</td>
<td>Prolact CR (Prolacta Bioscience, USA)</td>
<td>0.02</td>
<td>NS in number of sepsis episodes</td>
</tr>
<tr>
<td>BW 750 to 1250 g</td>
<td>Type:</td>
<td>Supplement:</td>
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<tr>
<td></td>
<td>Fat:</td>
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<td></td>
<td>BW regained (g/d)</td>
<td>0.02</td>
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<td>W velocity from time</td>
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<td></td>
<td>BW regained (g/kg/d)</td>
<td>0.02</td>
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<td></td>
<td>L velocity from birth (cm/wk)</td>
<td>0.01</td>
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<tr>
<td></td>
<td>HC from birth (cm/wk)</td>
<td>0.58</td>
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</tbody>
</table>

In the studies summarised in Table 2, adverse effects of the alternative fortification strategies were mostly reported in terms of feeding intolerance and in changes in biochemical markers. No study reported significant differences in feeding intolerance, usually defined as abdominal distention, vomiting, abnormal gastric residual and feeding interruption. Alan et al., Arslanoglu et al. and Hair et al. specified that no NEC was reported in the intervention groups in their respective studies; however, Kanmaz et al. reported NEC in one patient in the moderate fortification group. With the exception of increased serum urea levels in one study, all changes in biochemical markers reported in the studies in Table 2, were not statistically significant. Kanmaz et al., Biasini et al. and Rochow et al. are the only studies that reported on the incidence of metabolic acidosis, which were either not seen or did not occur more than prior to fortification.

A study by Moltu et al., on the other hand, was discontinued due to an increase in late-onset septicaemia and electrolyte disturbances in the intervention group. This disconcerting outcome needs further investigation. In this study, the intervention group received additional enteral amino acids, long chain polysaturated fatty acids and vitamin A in addition to standard fortification. The multi-component nature of the study, which also included different types and amounts of total parenteral nutrition and preterm formula, limits conclusions with regards to the fortification strategy per se. Furthermore, the estimated enteral energy intake of 166 kcal/kg body weight/day in the intervention group far exceeded the recommendations of both ESPGHAN and AAP.

Conclusion and recommendations

Different strategies have been proposed to improve in-hospital growth in preterm infants fed human milk. The studies cited in Table 2, where these strategies were compared to standard fortification, were comparable in terms of inclusion and exclusion criteria, the gestational age of the infants and the use of exclusive human milk. They differed in terms of birth weight of the participants, timing of standard fortification, total volume of human milk received, duration of study and type of fortifier and modular supplements used. Despite this heterogeneity, it seems noteworthy that the most promising results were seen in terms of improved growth in head circumference and length, and primarily in the smaller, more immature preterm infants. The significance of this needs to be investigated further because, firstly, head circumference and length may be indicators of growth in lean body mass and, secondly, the smaller, more immature preterm infants are also the most vulnerable to impaired neurocognitive development.

An important difference between these studies relates to the parameters in which in-hospital growth was reported, ranging from growth in units/body weight/day to growth indices and velocities. This makes comparisons between the studies difficult and for future research uniformity in this regard should be aimed at. In this regard the recently published proceedings of a Consensus Development Conference, may be a useful starting point. They stated that “...the aim of postnatal growth is not to lose more than 1 SDS [standard deviation] in weight and head circumference from birth to discharge”. This recommendation implies a preference for growth indices that are expressed in terms of Z-scores.

A further recommendation by the aforementioned Consensus Development Conference is that standard fortification should be initiated for all infants with a birth weight of less than 1800 g and, if this does not lead to appropriate growth, individualised fortification (target or adjustable) should be considered. For application in a resource-poor setting like South Africa, a lower birth weight of 1500 g may be considered as the cut-off for standard fortification, as this is the weight recommended by other authors, including the AAP. In this regard, neonatal practitioners in South Africa should reach consensus as well.

For preterm infants where standard fortification does not lead to sufficient in-hospital growth, adjustable and super fortification may be strategies to consider. Due to the high cost and manpower needed for the implementation of target fortification, it would not be a suitable option in a resource-limited setting. Super fortification is currently practiced in some units in South Africa where the amount of additional fortifier is based on theoretical calculations of the nutrient content of breast milk. These calculations should be tested against the measured nutrient content of milk from South African mothers of preterm infants. The effect on in-hospital growth should be evaluated as well, as the protein content may not be increased sufficiently given the current composition of FM85. The focus should be on attaining the recommended protein to energy ratio. Since serum urea levels are tested routinely in preterm infants in South African hospitals, adjustable fortification could be implemented if appropriate protocols are set in place. Such protocols should be designed taking into consideration the current status of neonatal units where overcrowding and insufficient staffing are often a reality. Essential to any fortification strategy should be the promotion of the use of breast milk, especially mother’s own milk for preterm infants.

Declaration of conflict of interest: No conflict of interest. Currently there is no link between the authors and the manufacturers (Nestle, South Africa) of the fortifier referred to in the article. The manufacturers were also not involved in any stage of the conceptualisation or writing of the article. On two occasions, JEK was sponsored by the NNIA to attend NNIA workshops.

Supplementary information

Supplementary information for this article can be accessed here http://dx.doi.org/10.1080/16070658.2016.1217646.

References


17. FM85 Product information leaflet for healthcare professionals. Nestle South Africa.


Received: 17-02-2016 Accepted: 11-05-2016
1) Which one of the following statements is not true?  
a) Human milk is the feed of choice for all infants but it may need to be fortified to meet the nutritional requirements of preterm infants, especially the very small, very immature infant.  
b) Inadequate protein intake places preterm infants at risk of poor growth and neurocognitive impairment.  
c) South Africa, poor post-natal growth in preterm infants has not been reported.  

2) The composition of mature human milk per 100mL is approximately:  
a) 65 to 70kcal; 3.2 to 3.6g protein; 0.9 to 1.2g fat; 6.7 to 7.6g carbohydrates.  
b) 65 to 70kcal; 0.9 to 1.2g protein; 3.2 to 6.7g fat; 3.6 to 7.6g carbohydrates.  
c) 65 to 70kcal; 0.9 to 1.2g protein; 3.2 to 6.5g fat; 6.7 to 7.5g carbohydrates.  

3) When compared to mature human milk, preterm human milk contains:  
a) More protein and fat, but less calcium.  
b) More protein, fat and calcium.  
c) More protein and fat, but less calcium.  

4) Which one of the following statements is not true with regards to “standard fortification”?  
a) It refers to the addition of fortifier to human milk in amounts per volume as prescribed by the manufacturer.  
b) It is usually started once the intake of expressed breast milk reaches 150mL/kg body weight/day.  
c) An empirical dose of nutrients is added which does not necessarily match the nutritional needs of the individual infant.  

5) At standard fortification levels, 150mL/kg body weight/day of human milk fortified with FMB85*:  
a) Meets the ESPGHAN recommendation for both protein and energy.  
b) Meets the ESPGHAN recommendation for energy, but not for protein.  
c) Meets the ESPGHAN recommendation for protein to energy ratio.  

6) The protein to energy ratio for enteral feeding of preterm infants recommended by the American Academy of Pediatrics is:  
a) 2.5 to 3.4g protein/100kcal  
b) 3.2 to 3.6g protein/100kcal  
c) 0.8 to 1.0g protein/100kcal  

7) Which one of the following statements describes “super fortification” the best?  
a) Fortifier is added to preterm infant formula.  
b) Fortifier is added to human milk in larger amounts per volume than that prescribed by the manufacturer.  
c) It is a type of individualized fortification where fortifier is added to human milk based on S-BUN levels.  

8) In the study by Kamnass et al, the following result was reported with regards to blind feeding:  
a) Significant increases in head circumference in cm/m/d (p 0.001).  
b) Non-significant increases in weight in g/kg/d (p 0.024).  
c) Non-significant increases in head circumference and weight.  

9) Which one of the following statements is not true?  
a) Insufficient trace elements may be supplied if skim milk powder is used to fortify human milk.  
b) Increased osmolality may be a potential problem when modular components are used to fortify human milk.  
c) Hypercalcemia may be a potential problem of super fortification.  

10) Which one of the following statements describes “adjustable fortification” the best?  
a) It is a type of individualized fortification where fortifier and, in some instances additional protein supplements, are added to human milk based on S-BUN levels.  
b) It is a type of individualized fortification where fortifier is added based on the macronutrient analysis of human milk.  
c) It is a type of target fortification where fortifier and other modular components are added to human milk based on the recommendations by ESPGHAN.  

11) In the study by Alan et al at the estimated median amount of daily protein intake in the intervention group was:  
a) 3.4g/kg body weight/day  
b) 4.5g/kg body weight/day  
c) 4.8g/kg body weight/day  

12) Which one of the following statements is not true for the study by Alan et al?  
a) The estimated protein to energy ratio in the intervention group fell below the recommended ranges.  
b) Mother’s own milk was used exclusively.  
c) Statistically significant increases in daily growth indices for weight, length and head circumference were reported for infants in the intervention group.  

13) Which one of the following statements is not true for the study by Arslanoglu et al?  
a) Energy intake was significantly correlated with weight gain (g/kg body weight/day) and head circumference gain (mm/day).  
b) Protein intake was significantly correlated with weight gain (g/kg body weight/day) and head circumference gain (mm/day).  
c) Weight gain (g/kg body weight/day) and head circumference gain (mm/day) were significantly higher in the adjustable fortification group than in the standard fortification group.  

14) Which one of the following statements is not true for the study by Biasini et al?  
a) Target fortification was compared to standard fortification.  
b) Mother’s own milk was used exclusively.  
c) In a sub-group analysis of ELBW infant’s growth in length and head circumference was significantly better in the intervention group than in the control group.  

15) Which one of the following statements applies to the studies in Table II?  
a) Preterm infants had a birth weight of less than 1500g and gestational age of less than 32 weeks in all the studies.  
b) Weight gain was reported in g/kg/d in all but one study.  
c) In all of the studies, the volume when standard fortification was initiated was between 80mL/kg/d and 100mL/kg/day.  

16) Which one of the following statements is not true:  
a) In the studies cited in Table II, the most promising results were seen in terms of improved growth in head circumference and length, and primarily in the smaller, more immature preterm infants.  
b) Head circumference and length could be seen as indicators of growth in lean body mass.  
c) The aim of postnatal growth is not to lose more than 2SDS in head circumference and length from birth to discharge.  

17) Which one of the following statements is not true:  
a) Target fortification was tailored to the individual preterm infant’s need by analysis of maternal milk before fortification.  
b) Target fortification should be initiated for all infants with a birth weight below 1500g.  
c) In the study by Rochow et al, the target levels for macronutrients were defined based on the ESPGHAN recommendations and assumed an intake of 150mL/kg body weight/day.  

18) With regards to adverse effects, a Cochrane review on multi-component fortification of human milk came to the conclusion that:  
a) Increases in late-onset sepsisemia, NEC and electrolyte disturbances are often seen.  
b) It does not appear to be associated with adverse effects even though the limited total sample size and missing cases of the reviewed studies, should be considered.  
c) The increased intake of enteral protein is associated with clinically significant increases in both blood urea and pH levels.  

19) According to the published proceedings of a Consensus Development Conference (Mor et al):  
a) Standard fortification should be initiated for all infants with a birth weight below 1800g and individualized fortification for all infants with a birth weight below 1500g.  
b) Standard fortification should be initiated for all infants with a birth weight below 1800g and, if this does not lead to appropriate growth, target or adjustable fortification should be considered.  
c) Standard fortification should be initiated for all infants with a birth weight below 1500g and super fortification should be considered if growth is inadequate.  

20) Which one of the following statements would most likely apply to a resource-poor setting like South Africa?  
a) Standard fortification should be considered for all preterm infants with a birth weight of 1500g or less, as recommended by the ARP.  
b) Due to the high incidence of premature births, standard fortification should be considered at a higher birth weight than that recommended by Mor et al.  
c) Super fortification should be considered for all low birth weight infants.
South African indigenous fruits – Underutilized resource for boosting daily antioxidant intake among local indigent populations?

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Introduction

The dietary pattern of indigenous peoples of South Africa changed for the worse as a result of colonisation. Nutritionally superior indigenous crops have gradually been displaced by cash crops that do not serve poor rural communities well, placing rural children at a higher risk of malnutrition.8,9

In determining rural household dietary diversity, a study carried out in two districts of the Eastern Cape showed that sugar, tea, coffee, grains and potatoes were among the food groups most frequently consumed, while only 5% and 3% of households reported consuming vegetables and fruits, respectively.10 To counteract the effects of eating refined grains, a plant-centred diet has been strongly encouraged,4 as the post-prandial surge associated with such a high glycaemic index meal has negative health implications. However, the inflammatory responses triggered following digestion can be offset by the inclusion of “exotic” fruits. But to what extent could antioxidant intake be boosted through the ingestion of selected indigenous fruits? Ten indigenous South African fruits were evaluated for their antioxidant activity and compared with blueberry and cranberry. An Antioxidant Potency Composite Index was drawn up based on the results of three equally weighted assays, namely Total Phenolic Content (FCR), Trolox Equivalent Antioxidant Capacity (TEAC) and Total Antioxidant Capacity (H-ORAC, L-ORAC). The antioxidant potency rankings obtained were as follows: wild plum > wild olive > colpoon > blueberry > Christmas berry > crossberry > waterberry > cranberry > tortoise berry > bietou > num-num > sour fig. Blueberry and cranberry ranked 5th and 9th, respectively. It was shown that by introducing servings of as little as 25 g of wild plum, waterberry, num num or sour fig into the diet, the daily antioxidant intake can be boosted to within an acceptable range to support health. All of these freely available fruits are known and have been traditionally used by rural communities in South Africa.

Keywords: antioxidant capacity (AOC), antioxidant potency composite index, oxygen radical antioxidant capacity (ORAC), total phenolic content (TPC), trolox equivalent antioxidant capacity (TEAC)

Consuming more than seven portions of fruit and vegetables daily substantially lowers the risk of mortality from any cause, yet many South Africans living below the poverty line have a very low or even zero intake of fruit and vegetables. Advice on the importance of consuming a healthy, and at the same time affordable diet needs to be provided by suggesting alternatives among indigenous plants that are nutritionally superior to “exotic” fruits. But to what extent could antioxidant intake be boosted through the ingestion of selected indigenous fruits? Ten indigenous South African fruits were evaluated for their antioxidant activity and compared with blueberry and cranberry. An Antioxidant Potency Composite Index was drawn up based on the results of three equally weighted assays, namely Total Phenolic Content (FCR), Trolox Equivalent Antioxidant Capacity (TEAC) and Total Antioxidant Capacity (H-ORAC, L-ORAC). The antioxidant potency rankings obtained were as follows: wild plum > wild olive > colpoon > blueberry > Christmas berry > crossberry > waterberry > cranberry > tortoise berry > bietou > num-num > sour fig. Blueberry and cranberry ranked 5th and 9th, respectively. It was shown that by introducing servings of as little as 25 g of wild plum, waterberry, num num or sour fig into the diet, the daily antioxidant intake can be boosted to within an acceptable range to support health. All of these freely available fruits are known and have been traditionally used by rural communities in South Africa.

Availability issues due to absence of supermarkets in rural areas further limits healthy food choices, with fruit and vegetable intake among one adult rural group calculated at 133 g per day;15 however, even among the urban population, 25% of urban black adults consumed zero fruits and vegetables16 in a 24 h recall study. Similarly, only 16% of children sampled in a National Food Consumption Survey10 had consumed fruits or vegetables in the same period. Although locally-grown wild fruits, loquats and guavas were consumed, the number of respondents consuming such fruit was below 0.5%.

While some Greek island communities consume up to 1.2 kg of fruit and vegetables per day, the World Health Organisation (WHO) has advised that a minimal quantity of 600 g of fruit and vegetables should be consumed per day to achieve optimal health benefits.14 However, South African adults consume 115 g of vegetables and 91 g of fruit per day on average, with combined fruit and vegetable intake of rural adults reaching only 141 g per day.16 One South African study found that children aged between 1 and 5 years consumed, on average, 52 g of vegetables and 48 g of fruit per day,17 which is one third the recommended amount.

Another WHO funded study found that approximately 91–94 g of fruit is consumed (average per capita per day) by children aged between 1 and 5 years in South Africa. The diversity is limited to banana (26.1 g), banana (17 g), pear (10 g), orange (8.3 g) and grape (7.3 g).10,18
A measure of whether fruit and vegetable intake is adequate can be ascertained from the total antioxidant capacity consumed per day, as determined by the Oxygen Radical Antioxidant Capacity (ORAC) assay. From the South African ORAC database, the calculated average Total Antioxidant Capacity (TAC) consumed per capita (from the above five fruits consumed by children) is 1 600 μmol Trolox Equivalents (TE) per day. This compares with the average intake of ORAC in the United States, calculated as 1 500 μmol TE/day. A high intake is considered to be 6 000 μmol TE/day and above.

A study carried out by Cao et al. on participants consuming five fruits and vegetables per day determined their daily plasma ORAC to be around 1 670 μmol TE. Increasing the intake of fruits to ten a day increased the daily plasma ORAC to 3 300–3 500 μmol TE. However, the choice of seven fruits with low ORAC values would yield only 1 300 μmol TE, whereas the choice of seven fruits with high ORAC values could yield up to 6 000 μmol TE, with a cup of blueberries alone supplying 3 200 μmol TE.

A robust inverse association for consumption of more than seven portions of fruit and vegetables daily and all-cause, cancer and cardiovascular disease mortality reduction has been shown from the 2014 Health Survey for England study. Another study showed that increased consumption of fruit in childhood limits the incidence of cancer in adulthood. In addition, a strong case for the existence of a direct relationship between the level of consumption of antioxidants and the prevention of adverse health outcomes has been made in a recent review article by Prior. This is substantiated by the results released from recent clinical trials.

In view of the above, the question arises: What national interventions have been put in place to encourage higher household consumption of fruits and vegetables, particularly among children?

The growing of home gardens has been promoted in an attempt to overcome the twin hurdles of affordability and accessibility, and thereby increase household consumption of fruits and vegetables. At the same time the planting of endemic crops (generally better adapted to the harsh conditions of the South African climate, therefore requiring less input agriculturally), has been encouraged. As these crops are already known by the community, their acceptance is a given with the added bonus of their higher nutrient content.

In reviewing the outcomes of a Medical Research Council (MRC) intervention study involving home gardens, it was noted that this nutrition education program had empowered communities with the knowledge of what constitutes adequate vitamin A intake for healthy children, as well as how to produce vitamin A dense foods, such as orange-fleshed sweet potatoes and paw paws, in home gardens. As a result, children in these households had significantly increased energy and micronutrient intakes; however, as was pointed out, a wider range of nutrients is required for good health.

In 2007, the HealthKick programme, a nutrition education intervention, was initiated at several schools in the Western Cape. It involves both teachers and parents in planting a school vegetable garden, while teaching the children how to grow vegetables. By 2008, more than 6 500 schools across South Africa had set up food gardens.

Since 1975, by means of Arbour Day/Week, indigenous trees nominated for planting, especially in previously disadvantaged communities, have included wild olive (Olea europaea subsp. Africana), wild plum (Harpephyllum caffrum), waterberry (Syzygium cordatum) and crossberry (Grewia occidentalis). These are among the species bearing native fruits known and traditionally consumed by rural children in South Africa.

This exploratory study considers the extent to which local indigenous fruits could provide a source of phenolics and antioxidants, which can positively contribute to the nutritional status of South African children, despite their otherwise impoverished diet.

When food is scarce, wild resources take on an important role in the diet of people in rural areas. Of the 10 South African rural villages sampled, it was reported that families collected up to 104.2 kg ± 15.6 kg of wild fruits per year.

Eighty lesser-known fruits commonly utilised in the rural areas include the following varieties, six of which were used in this study: Carissa macrocarpa (num num), Carpobrotus edulis (sour fig), Doyoyalis calfire (kiwi-apple), Grewia flava (velvet raisin bush), Harpephyllum caffrum (wild plum), Nylandtia spinosa (tortoise berry), Olea africana (wild olive), and Syzygium cordatum (waterberry).

A study of indigenous edible plant use by contemporary Khoi-San, revealed that of the 58 indigenous edible plant species collected, over 40% were collected for their fruits, among them Osyris compressa (colpoon), Carissa bispinosa (num num), Carpobrotus edulis (sour fig) and Murdattia spinosa (tortoise berry), Chrysanthemoides monilifera (bietou), Grewia occidentalis (crossberry), Olea europaea (wild olive) and Chironia baccifera (Christmas berry).

The aim of this study was to assess, by comparative means, the potential health benefits that might accrue from the consumption of the following indigenous fruits: Syzygium cordatum (waterberry), Osyris compressa (colpoon), Harpephyllum caffrum (wild plum), Nylandtia spinosa (tortoise berry), Carissa macrocarpa (num num), Chironia baccifera (christmas berry), Chrysanthemoides monilifera (bietou), Grewia occidentalis (crossberry), Carpobrotus edulis (sour fig), and Olea europaea subsp. Africana (wild olive). The Afrikaans and Zulu names of these species are shown in Figure 1. For control purposes, two Northern Hemisphere berry species Vaccinium corymbosum (blueberry) and Vaccinium macrocarpon (cranberry) were included in the evaluation, as these have been extensively studied and recommended for their healthy properties.

The following phenolic/antioxidant determinations were carried out on these species: Total Phenolic Content (FCR method), Trolox Equivalent Antioxidant Capacity (TEAC), H-ORAC and L-ORAC, combined to give Total Antioxidant Capacity (TAC). The results were compared with the northern hemisphere “gold standards” of blueberry and cranberry; and a composite index Antioxidant Potency Composite Index (APCI) was drawn up to rank all the fruits in terms of their antioxidant potential.

**Choosing from a plethora of antioxidant capacity assays**

Our antioxidant defence system is a multi-pronged network involving prevention, interception and repair. Therefore, it becomes apparent that any assessment of antioxidant capacity would present a challenge due to the complexity of these biological systems. Adding to the complexity, it is possible for...
individual antioxidants to act by multiple mechanisms within a single system, including free radical chain breaking, oxygen scavenging, singlet oxygen quenching, metal chelation and inhibition of oxidative enzymes.40

Therefore, it is evident that natural antioxidants, being multifunctional, cannot be evaluated by means of one-dimensional methods only. As it is impossible for any single assay to accurately reflect all of the radical sources, as well as all of the antioxidants in a complex system, a valid evaluation demands the use of several assay methods which allows for the inclusion of different mechanisms of inhibition.41,42

In June 2004, at the First International Congress on Antioxidant Methods, Prior proposed43 that three methods be standardised for the measurement of Antioxidant Capacity (AOC) in natural products: Total Phenolic Content by the FCR method; TEAC; and ORAC<sub>fl</sub>, Jimenez-Alvarez44 selected the following assays: ORAC<sub>fl</sub> (hydrophilic and lipophilic); FRAP; and ICA (Iron Chelating Activity), as both iron and copper have been shown to be catalysts of lipid oxidation in foods.45 By this means, it was believed that all the relevant antioxidant mechanisms were being targeted, namely radical scavenging, reducing capacity, and metal chelating properties.

Some researchers have combined the results from multiple assays to arrive at a ranking that more accurately represents a sample’s overall antioxidant potency.46 In this case, three test results were combined into a single Antioxidant Potency Composite Index (APCI) by the following procedure: All three assays were equally weighted (TPC (FCR), TEAC, and TAC). An index value of 100 was assigned to the best score for each test.

Figure 1: The indigenous fruits with names given in the order Latin, Afrikaans, Zulu, and the family36–38.
The index score of the samples in each assay was calculated as follows:

Antioxidant Index score = \left( \frac{\text{Sample score}}{\text{Best score}} \right) \times 100

An average of all three assays for each sample was calculated giving an overall mean index value for APCI. A simple rank order is reported.

Materials & methods

Plant materials

The species studied are found on the campus of the Cape Peninsula University of Technology and at Kirstenbosch National Botanical gardens. Samples of approximately 200 g were collected for each fruit which were harvested when ripe (fully coloured and sweet). All samples were verified by Dr N. Louw in conjunction with SANBI. Syzygium cordatum (waterberry), Osyris compressa (colpoon), Harpephyllum caffrum (wild plum), Nylandia spinosa (tortoise berry), Carissa macrocarpa (num num), Chironia baccifera (Christmas berry), Chrysanthemoides monilifera (bietou), Grewia occidentalis (crossberry), Carposaurus edulis (sour fig) and Olea europaea subsp. Africana (wild olive) were collected and rinsed with deionised water, air dried, packed into Ziploc bags and purged with nitrogen before freezing at \(-18^\circ\text{C}\). *Vaccinium corymbosum* (blueberry) and *Vaccinium macrocarpon* (cranberry) were purchased in frozen form from a local supermarket.

Extraction methods

The method of Sellapan et al. \(^{47}\) was followed for the TPC and TEAC assays. Approximately 2 g of fruit was used. The skins were not removed; however, fruits were deseeded (except for bietou and sour fig fruits). For the ORAC assay, the extraction method of Prior et al. \(^{48}\) was followed.

Chemicals and apparatus

The following chemicals were used: acetonitrile, gallic acid, quercetin, caffeic acid, 4-dimethylaminocinnamaldehyde (DAC), Trolox (6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid), potassium persulphate (K\(_5\)S\(_2\)O\(_8\)), 2,2-diphenyl-1-picrylhydrazyl (DPPH), 3',6'-dihydroxy-spiro[sobenzofuran-1[H]-xanthen]-3-one (Fluorescein), 2,2'-azobis (2-amidino-propane) dihydrochloride (AAPH), ascorbic acid and butylated hydroxyltoluene were purchased from Sigma (South Africa). Folin Ciocalteu reagent and ABTS (2,2'-azinobis(3-ethylbenzothiazoline-6-sulfonate)) were purchased from Fluka Chemicals. Acetic acid (glacial), sodium carbonate, hydrochloric acid (32%), methanol, 95% ethanol, trisodium orthophosphate dodecahydrate, ammonium molybdate tetrahydrate and sulphuric acid, all of analytical reagent grade, were obtained from Merck (South Africa). Milli-Q water was used.

A Pharmacia LKB Ultraspec II E Spectrophotometer and a Sigma analytical plate reader (Fluoroskan Ascent, Thermo Electron Corporation, USA).

Methods

The methods used for the three assays are as follows: Total Phenolic Content (Folin Ciocalteu reagent); \(^{49}\) TEAC (ABTS') assay; \(^{50}\) and, ORAC. \(^{48}\)

Results & discussion

The findings obtained for the three assays for 10 indigenous fruits and 2 controls are presented in Table 1.

<table>
<thead>
<tr>
<th>Fruit Name</th>
<th>TPC (FCR)</th>
<th>TEAC Assay</th>
<th>H-ORAC</th>
<th>L-ORAC</th>
<th>TAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blueberry</td>
<td>6 080 ± 2.35</td>
<td>8.3 ± 0.4</td>
<td>84.30 ± 5.36</td>
<td>34.94 ± 2.65</td>
<td>119.24</td>
</tr>
<tr>
<td>Cranberry</td>
<td>282 ± 4.69</td>
<td>9.5 ± 0.1</td>
<td>34.23 ± 1.76</td>
<td>30.22 ± 4.45</td>
<td>64.45</td>
</tr>
<tr>
<td>Waterberry</td>
<td>342 ± 0.75</td>
<td>3.2 ± 0.1</td>
<td>77.04 ± 1.45</td>
<td>48.32 ± 2.24</td>
<td>125.36</td>
</tr>
<tr>
<td>Colpoon</td>
<td>3 581 ± 5.14</td>
<td>8.5 ± 0.2</td>
<td>323.39 ± 2.23</td>
<td>55.60 ± 1.94</td>
<td>378.99</td>
</tr>
<tr>
<td>Wild plum</td>
<td>5 193 ± 1.12</td>
<td>55.6 ± 1.8</td>
<td>125.90 ± 4.13</td>
<td>27.10 ± 2.51</td>
<td>153.00</td>
</tr>
</tbody>
</table>

The results for the Antioxidant Potency Composite index are presented in Chart 1.

Wild plum ranked first for the overall APCI, having obtained the highest ranking in the TEAC assay. The red fruits of wild plum are well known and commonly used for eating. Some trees bear sweet tasting fruit, while others bear fruit that is sour. While the commercial cultivation of wild plum has not been viable due to very small fruits (labour intensive) and the flesh being only 10% of the total weight, it has been suggested that the wild plum tree be used for home gardens, city and park landscaping so that the fruits may still be picked and enjoyed by “children and others.” \(^{51}\) A lemonade-type fruit juice and rosé wine has been made from the pulp, as well as jam and jelly.

Colpoon, in second place, had the highest TAC. Wild olive was ranked third in the APCI, with the third highest TAC; blueberry, ranking fourth, had the highest was TPC (FCR); whereas Christmas berry in fifth place had the second highest TAC. Wild olive, colpoon and Christmas berry would not be consumed as food due to their bitter taste but could be prepared rather as medicine, similar to European bitters. The Khoe are reported to have used the fruit and leaves of Christmas berry as a bitter tonic to treat stomach ulcers as well as diarrhoea.

Crossberry, ranked sixth, has been collected traditionally and dried to use as flavouring for milk. \(^{52}\) The fruits have been said to be eagerly eaten by humans for their sweet fruity taste.

Waterberry took seventh position, with cranberry in eighth position, yet waterberry scored double the ORAC points of cranberry. Waterberry was one of the three indigenous fruits containing anthocyanins. When fully ripe, it has a dark blue skin similar to blueberries and has a pleasant sweet, faintly resinous taste. It has been made into jellies and fermented to give alcoholic beverages.
Conclusion

As the results show, freely available indigenous fruits that have been traditionally used by rural peoples in South Africa have relatively high levels of antioxidant capacity and, therefore, constitute an untapped resource that deserves to be promoted more extensively in the community by health educators. As affordable, yet nutritionally superior alternatives to the relatively expensive “exotic” fruits, these could help in diversifying monotonous diets.55,56 As dietary diversity correlates strongly with longevity and a decreased risk of mortality,57 indigent groups need to be empowered to increase their intake of essential nutrients58 and polyphenols that have been implicated in chronic disease prevention. They can do this by tapping into our rich South African flora.

Acknowledgements

– The authors thank Dr N. Louw, Prof V. Hugo, Prof W. Gelderblom, Prof J. Marnewick, Mrs L. Marshall, Ms P. Snijman, Mr J. Kotze and Mr F. Rautenbach for intellectual and technical support; and, the Cape Peninsula University of Technology for financial support.

References


Table 2. The Trolox equivalent (units µmol TE) for certain indigenous fruits found in South Africa

<table>
<thead>
<tr>
<th>Indigenous fruit</th>
<th>µmol TE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colpoon</td>
<td>9475</td>
</tr>
<tr>
<td>Christmas berry</td>
<td>8559</td>
</tr>
<tr>
<td>Wild olive</td>
<td>8413</td>
</tr>
<tr>
<td>Crossberry</td>
<td>6284</td>
</tr>
<tr>
<td>Wild plum</td>
<td>3825</td>
</tr>
<tr>
<td>Waterberry</td>
<td>3134</td>
</tr>
<tr>
<td>Blueberry</td>
<td>2981</td>
</tr>
<tr>
<td>Cranberry</td>
<td>1611</td>
</tr>
<tr>
<td>Sour fig</td>
<td>1587</td>
</tr>
<tr>
<td>Num-num</td>
<td>1249</td>
</tr>
<tr>
<td>Bietou</td>
<td>1224</td>
</tr>
<tr>
<td>Tortoise berry</td>
<td>1199</td>
</tr>
</tbody>
</table>

Chart 1: Antioxidant Potency Composite Index for ten indigenous fruits and two controls, with the ranking order in brackets.

Tortoise berry was placed ninth in the sample rank order. It produces small red fruits, high in vitamin C, said to be a popular snack with children.53

Bietou ranked tenth overall. The Zulu traditionally add these berries to their porridge, which provides protection against the post-prandial surge associated with consumption of high glycaemic index foods.53 These small sweet black fruits have also been made into nourishing syrup or jam; the juice has also been taken in water or tea; and, combined with other herbs for blood strengthening or purification.

Num num, ranking eleventh, could be a very useful addition to any home garden as it flowers and fruits continuously throughout the year. Its thorny branches make a good hedge. The delicious sweet red fruits, rich in vitamin C, can also be made into jam. It has been suggested that this fruit should be promoted much more than it is at present.53

And finally, sour fig ranked twelfth. It is an easy-to-grow creeping succulent, producing fleshy fruit capsules which turn reddish brown when ripe. The fruit contains an edible sweet-sour gelatinous pulp with shiny brown seeds. It is already successfully commercialised, being sold in open markets as dried figs, or made into jam.

From a TAC or ORAC perspective, the contribution to ORAC from fruits in the diet may come from a high consumption of low ranking fruits or from high ranking fruits that are consumed in small amounts.54 By adding as little as 25 g of certain indigenous fruits (excluding seeds) to the average diet consumed in South Africa, increases in Trolox Equivalents (units µmol TE) per day could be achieved (shown in Table 2).

As seen from the values in Table 2, these indigenous fruits compare favourably with blueberry and cranberry.


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11) According to a 2011 study, on average, the increased cost of a nutrient dense diversified diet may be:
   a) 69%
   b) 9%
   c) 6%

12) A valid evaluation of natural antioxidants requires the use of the following methods:
   a) 1-dimensional methods
   b) A single radical source
   c) Several assay methods

13) The Total Antioxidant Capacity TAC value (µmol TE/day) consumed by children eating ~100 g fruits and vegetables is:
   a) 6.000
   b) 1.600
   c) 1.300

14) The recommended consumption of Oxygen Radical Antioxidant Capacity (ORAC) (µmol TE/day):
   a) 1.600
   b) 3.500
   c) 6.000

15) The overall antioxidant potency of a fruit or vegetable is best described by the following measure:
   a) Total Phenolic Content
   b) Antioxidant Potency Composite Index
   c) Trolox Equivalent Antioxidant Capacity

16) Anthocyanins are valuable flavonoid components of fruits. These are indicated by the following colouration:
   a) Green
   b) Blue
   c) Yellow

17) In the APC Index of a selection of South African indigenous fruits Wild Plum ranked:
   a) 4th
   b) 8th
   c) 1st

18) Which of the indigenous fruits in this study are used mostly for medicinal purposes due to their bitter flavour?
   a) Sour fig, crossberry and tortoise berry
   b) Bietou, wild plum and waterberry
   c) Wild olive, Colpoon and Christmas berry

19) Which of the indigenous fruits studied are also rich in vitamin C?
   a) Wild olive
   b) Colpoon
   c) Num num and tortoise berry

20) The post-prandial surge following a high GI meal such as mielie porridge has been offset by including in the meal:
   a) Bietou berries
   b) Sugar
   c) Potatoes
Colon cancer and the consumption of red and processed meat: an association that is medium, rare or well done?

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In 2015, the International Agency for Research on Cancer (IARC) indicated that red meat is a probable cause of colon cancer, while processed meat was classified as carcinogenic. The 2010 indicators of lifetime risk for developing colorectal cancer among South African (SA) males and females was 1:114 and 1:182 respectively, while its prevalence as a newly diagnosed cancer was seventh for males and sixth for females. SA consumers have increased their meat expenditure over the past decade as a result of class mobility. This has resulted in an increase in the proportion of middle-class consumers. Although the consumption of red meat has increased, it has been surpassed by chicken. Due to a lack of national food consumption data regarding processed meat, it is not clear what local consumption trends are. The 2015 Consumer Price Index (CPI) documented a significant urban food price increase for chicken, cheaper cuts of beef and polony. However, when comparing urban food prices, a processed meat like polony is 27% cheaper per kilogram than whole chicken. Hence it is possible that the relative affordability of processed meat could contribute to its consumption among many South Africans (SA) and in so doing, could contribute to colon cancer risk. In relation to the above, it is important for future SA public health recommendations to take cognisance of the World Cancer Research Fund and American Institute for Cancer Research recommendations of limiting red meat consumption to less than 500 g/week and avoiding processed meat.

Keywords: colon cancer, colorectal cancer, haem iron, processed meat, red meat

Introduction
In October 2015, the International Agency for Research on Cancer (IARC), the cancer agency of the World Health Organisation (WHO), issued a press release after the consumption of red and processed meat was evaluated for its carcinogenicity.1 This was based on a comprehensive review of epidemiological studies1-2 by the IARC Monographs Programme.1-2 Reviewed data included 800 studies from numerous countries and several continents with diverse ethnicities and diets, including 14 cohort studies. For the evaluation, prospective cohort studies conducted in the general population were weighted more than other study designs. Additional evidence was provided by high-quality population-based case-control studies.2 Based on the above evaluation, red meat was classified as probably carcinogenic to humans (Group 2A) as there was limited evidence that consuming red meat was responsible for causing colon cancer in humans, but with strong mechanistic evidence supporting a carcinogenic effect. Although this association was mainly observed for colorectal cancer, associations were also found for pancreatic and prostate cancer. Processed meat was classified as carcinogenic to humans (Group 1), as there was sufficient evidence in humans that consuming processed meat causes colorectal cancer (IARC 2015).1,2

Hence, for the purpose of this review, the focus will be on investigating the incidence of colorectal cancer among South Africans (SA) as well as their red and processed meat consumption patterns. An interpretation of the IARC classification of carcinogens will follow, as well as the definition of red and processed meat. Current recommendations regarding the consumption of red and processed meat and the cooking methods associated with an increased risk of carcinogenicity will be reviewed, followed by a discussion of the compounds and mechanisms proposed to be responsible for carcinogenesis. This will be followed by assessing the feasibility of promoting a vegetarian diet in order to prevent colon cancer.

Incidence of colorectal cancer among South Africans
The 2010 statistics regarding the incidence of colorectal cancer among SAs issued by the National Cancer Registry, documented the lifetime risk for developing colorectal cancer among males and females as 1:114 and 1:182 respectively. The highest race- and gender-specific lifetime risk was documented for coloured females (1:94), followed by white females (1:94), coloured males (1:68) and Asian males (1:58).3 Colorectal cancer was the seventh most prevalent newly histologically diagnosed cancer among South African (SA) males, followed by sixth position for females. Among Asian males and females, colorectal cancer was the second most commonly histologically diagnosed cancer, accounting for 13.6% and 7.39% of total cancers respectively. It accounted for only 3.8% and 2.5% of confirmed cancers amongst black males and females. White females had a higher percentage of newly diagnosed colorectal cancers than males at 5.2% versus 4.8%. Stefan4 explains that the variation in the above race-specific colorectal cancer statistics can be attributed to diversity in terms of genetics, diet, culture, lifestyle and exercise habits. It is therefore not surprising that a comparison of colon cancer risk between healthy middle aged African Americans (65:100 000) and rural SAs (< 5:100 000) found the stronger association in the former to be related to a higher intake of animal protein and fat, as well as a lower fibre consumption.5 Although the above statistics seem modest, they could be important for future public health messages when reflecting on increasing urbanisation, acculturation and the adoption Westernised eating habits by many SAs.
South African red and processed meat consumption patterns

The Global Agricultural Information Network (GAIN) Report stated that, over the past two decades, steady economic growth and an increase in the average income of SAs has resulted in a rapid increase in meat consumption patterns. Although mention of beef, poultry, pork and lamb consumption is made within this report, processed meat was not referred to. The increase in meat consumption can be accounted for by class mobility, a phenomenon related to an increase in the proportion of SAs being classified as middle-class consumers. However, the increase in red meat consumption can be described as moderate when compared with that of chicken. The latter trend was echoed by a report on SA food consumption studies to determine the mean intake of foods most commonly consumed. Findings were that amongst 1- to 9-year-olds, chicken was the tenth most commonly consumed, whereas among those 10 years of age and older, it was the ninth most commonly consumed.

Processed meat consumption was not referred to in the above report. However, a study that investigated fast food consumption among black 17-year-olds in Soweto, which formed part of the Birth to Twenty cohort, reported that children and adolescents living in urban areas (including townships and settlements) are increasingly exposed to the influences of a Western lifestyle as a result of urbanisation and the resultant nutrition transition. Hence, townships have an increasingly large variety of commercial and informal food vendors that sell fast-food items such as a quarter, which proved to be most popular amongst the above cohort. The ingredients of a quarter included white bread, fried chips, a slice of cheese and a variety of processed meats such as polony, Russians (a spiced processed meat sausage), sausage, viennas (a processed meat sausage), mangola, white liver and special. The latter three are all fatty processed meats. Other processed meats consumed by the cohort included sausage rolls, boerewors (sausage) rolls, hot dogs and hamburgers. These findings are of importance, as Popkin explained how available evidence suggests that developing countries like SA have been undergoing transition at a more rapid rate over the past decade or so compared with high-income developed countries. In addition, in townships like Soweto it is likely that fast food makes a significant contribution to total energy intake. It can therefore be postulated that where fast foods contain processed meats, their use could be related to the fact that the 2015 urban Consumer Price Index (CPI) indicated that processed meats like polony (R36.43/kg), are more affordable per kilogram than whole chicken (R49.85/kg), hence making them a preferred component of fast foods.

Table 1: Classification of carcinogenic agents and their description

<table>
<thead>
<tr>
<th>Agent</th>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>Carcinogenic to humans</td>
<td>Sufficient evidence of carcinogenicity in humans</td>
</tr>
<tr>
<td>Group 2A</td>
<td>Probably carcinogenic to humans</td>
<td>Limited evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in experimental animals, as well as strong evidence that the carcinogenesis is mediated by a mechanism that also operates in humans</td>
</tr>
</tbody>
</table>

Table 2: Colon cancer and associated carcinogenic agents

<table>
<thead>
<tr>
<th>Cancer site</th>
<th>Carcinogenic agents with sufficient evidence in humans (Group 1)</th>
<th>Agents with limited evidence in humans (Group 2A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colon</td>
<td>Alcoholic beverages, Smoking, X-radiation, gamma radiation, Processed meat consumption</td>
<td>Asbestos, Schistosoma japonicum, Red meat consumption</td>
</tr>
</tbody>
</table>

Classification and interpretation of carcinogenicity

The classification of carcinogenic agents used by the IARC monographs is depicted in Table 1 and is based on scientific judgement that reflects the strength of evidence derived from studies in humans and experimental animals, as well as mechanistic and other relevant data. The Group 1 classification of processed meat and its carcinogenicity in relation to the development of colon cancer is used when there is sufficient, convincing evidence of carcinogenicity in humans, thus implying that there is convincing evidence based on epidemiologic studies that show the development of cancer in exposed humans.

The Group 2A classification of red meat and the use of the term ‘limited’ relates to limited evidence from epidemiologic studies showing positive associations between red meat consumption and the development of colon cancer. In addition, strong mechanistic evidence for this relationship and the development of colon cancer is present. However, other explanations for the observation including chance, bias or confounding factors cannot be ruled out.

When assessing colon cancer risk and the associated carcinogens with sufficient evidence in humans versus those with limited evidence (Table 2), processed meat is strongly associated with colon cancer, while the consumption of red meat is based on limited evidence.

The reason why processed meat was classified along with smoking and the consumption of alcohol does not imply that they are equally carcinogenic. It merely describes the strength of scientific evidence regarding the carcinogen, rather than assessing the level of risk. Burden of disease is a quantitative measure of population health outcome using information on...
Table 3: Classification of red meat and processed meat

<table>
<thead>
<tr>
<th>Red meat</th>
<th>Processed meat including salting, curing and smoking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef</td>
<td>Bacon</td>
</tr>
<tr>
<td>Goat</td>
<td>Beef patties</td>
</tr>
<tr>
<td>Lamb</td>
<td>Biltong</td>
</tr>
<tr>
<td>Mutton</td>
<td>Braaiwleis (smoking occurs when cooking meat over a charcoal or wood fire when the dripping of fat and meat juices onto the fire causes flames and smoke)</td>
</tr>
<tr>
<td>Pork</td>
<td>Canned meat</td>
</tr>
<tr>
<td>Horse</td>
<td>Corned beef</td>
</tr>
<tr>
<td>Veal</td>
<td>Frankfurters</td>
</tr>
<tr>
<td></td>
<td>Ham</td>
</tr>
<tr>
<td></td>
<td>Hot dogs</td>
</tr>
<tr>
<td></td>
<td>Meat-based preparations and sauces made from meat drippings</td>
</tr>
<tr>
<td></td>
<td>Polony</td>
</tr>
<tr>
<td></td>
<td>Russians</td>
</tr>
<tr>
<td></td>
<td>Salami</td>
</tr>
<tr>
<td></td>
<td>Sausages</td>
</tr>
<tr>
<td></td>
<td>Smoked chicken</td>
</tr>
<tr>
<td></td>
<td>White liver</td>
</tr>
</tbody>
</table>

mortality and morbidity as well as recovery in the population.\textsuperscript{17} According to the most recent estimates of the Global Burden of Disease Project, globally 34 000 annual cancer deaths can be attributed to diets high in processed meat. Although red meat has not yet been established as a carcinogen, should the reported associations be proven to be causal, it is estimated that diets high in red meat could be responsible for 50 000 global deaths annually. In contrast, about one million annual global deaths are caused by smoking, 600 000 are due to the consumption of alcohol, and more than 200 000 can be attributed to air pollution.\textsuperscript{15}

The above association between red and processed meat and the development of colon cancer was reported in a press release issued by the IARC.\textsuperscript{1} Subsequently the WHO indicated that due to numerous queries, expressions of concern and requests for clarification resulting from the press release, a question-and-answer document was being released,\textsuperscript{16} based on the paper published by the IARC Monograph Working Group in Lancet Oncology.\textsuperscript{2} When reviewing the Q&A issued by the WHO,\textsuperscript{16} it became evident which aspects of the IARC report generated the most questions and queries. Hence, an in-depth discussion of some of these aspects will follow.

**Definition of red and processed meat**

When referring to red and processed meat, the meat and meat products listed in Table 3 can be used for clarification purposes.\textsuperscript{2,15,18}

Processed meats such as polony, Russians and white liver referred to in the Sowetan Birth to Twenty Cohort\textsuperscript{4} are presumed to be consumed by many SAs. Although they did not feature in the international classification of processed meat,\textsuperscript{2,15,18,20} when reviewing the South African National Standards (SANS) on processed meat products\textsuperscript{21} it is evident that these products can be included in the classification.

**Amount of meat consumed in relation to colorectal cancer risk**

An increase in colorectal cancer risk was generally associated with the amount of processed meat consumed. A meta-analysis of data from 10 studies estimated that for every 50 grams of processed meat consumed on a daily basis, the risk of colorectal cancer increased by 18%.\textsuperscript{1,15,18,22} It was also found that colon cancer risk increased in a linear fashion with an increase in the consumption of red and processed meat, i.e. total meat intake, up to approximately 140 g/day. Beyond this level, the increase in risk was less prominent. In studies that analysed risk in relation to total meat intake (red and/or processed meat), colorectal cancer risk increased up to 22% with intakes ranging from 20 g/day to 140 g/day, after which the increase became stable.\textsuperscript{18} Results generated by the European Prospective Investigation into Cancer and Nutrition (EPIC) study found a 35% increase in colon cancer risk when more than 160 g/day of red and processed meat was consumed, compared with less than 20 g/day.\textsuperscript{23}

The cancer risk associated with the consumption of red meat is more difficult to estimate as available evidence linking the consumption of red meat to colon cancer is not as strong. However, should the association between the consumption of red meat and colorectal cancer prove to be causal, it is suggested that the risk of developing colorectal cancer could be increased by 17% for every 100 g portion consumed on a daily basis.\textsuperscript{12,18,22}

As the increase in cancer risk in the IARC report was related to the amount of meat consumed, available data did not permit a conclusion regarding the existence of a safe level.\textsuperscript{15}

**Mechanism associated with carcinogenicity**

Although there is a lack of clarity regarding the mechanism involved in colon carcinogenesis, evidence points towards certain compounds found in meat itself as well as in processed meat.\textsuperscript{21} Red meat consists of compounds such as haem iron (HI) that facilitates the endogenous formation of N-nitroso compounds (NOCs) such as nitrosylated haeme iron,\textsuperscript{24,30} catalysing its formation from natural precursors in the gastrointestinal tract (GI).\textsuperscript{2,18,25} as well as through lipid peroxidation in the GI.\textsuperscript{2,18} In addition, HI can induce oxidative stress,\textsuperscript{26} colonocyte proliferation through the lipid–peroxidation pathway\textsuperscript{27,20,28} and induce the production of genotoxic free radicals in the colonic stream.\textsuperscript{28}

The carcinogenic compounds that form during processing and cooking include NOCs and polycyclic aromatic hydrocarbons (PAHs).\textsuperscript{2,15,26,29} NOCs are introduced exogenously from nitrates.
and nitrites added during the preservation process\textsuperscript{20,29} but can also be formed endogenously\textsuperscript{20,26,29} as alluded to previously. In processed meat, HI is nitrosylated because curing salt contains nitrate or nitrite. There is evidence that nitrosylated HI promotes carcinogenesis at doses that are five to six times lower than non-nitrosylated HI.\textsuperscript{14}

Cooking red or processed meat at high temperatures such as during pan frying or direct grilling over an open flame produces mutagens such as PAHs and heterocyclic aromatic amines (HAAs).\textsuperscript{2,15,20,28,30} HAs are genotoxic and the extent to which HAAs’ conversion to genotoxic metabolites occurs as a result of amino acids and creatinine reacting at high cooking temperatures is higher in humans than in experimental animals such as rodents.\textsuperscript{2} HAAs become DNA alkylating agents, inducing DNA mutations after activation by various metabolizing enzymes.\textsuperscript{20} The intestinal microbiota adapts to meat intake and HAAs. As a result, HAAs might be more genotoxic in those with a high meat intake. However, the majority of studies investigating meat and phenotype interactions are not convincing. It is probable, though, that heat-induced mutagens found on the surface of well-done red meat can cause colon cancer in those with a genetic predisposition.\textsuperscript{26}

NOCs, PAHs and HAAs are considered to be genotoxic by acting directly on DNA, causing point mutations, deletions and insertions.\textsuperscript{15} However, there is little direct evidence that this occurs following meat consumption.\textsuperscript{2} A high consumption of HI (but not other forms of iron), NOCs, HAAs and PAHs has been associated with an increased risk of colorectal tumours, albeit with a few exceptions.\textsuperscript{15,29} Genetic variations in NOCs’ and HAAs’ metabolism may alter the relationship between the consumption of red meat and the risk of developing colon cancer.\textsuperscript{15} However, there is substantial supporting mechanistic evidence regarding HI, NOCs and HAAs being involved in colon carcinogenesis.\textsuperscript{15,21,22} A high consumption of red meat (300–420 g/day) increased levels of DNA adducts, presumed to be derived from NOCs, in exfoliated colonocytes or rectal biopsies.\textsuperscript{21,22}

Impact of cooking methods on carcinogenicity

Although high-temperature cooking methods generate compounds that may contribute to carcinogenic risk, their role in carcinogenesis is not yet fully understood.\textsuperscript{11} What is known is that consuming well done cooked meat increases the bacterial mutagenicity of human urine.\textsuperscript{2,23} Despite the fact that cooking improves the digestibility and palatability of meat,\textsuperscript{2} carcinogenic compounds are produced when meat is heated beyond 100°C (205°F), when it is cooked directly over an open flame such as barbecuing, grilling or over a hot surface such as pan frying.\textsuperscript{2,26,27} These cooking methods are associated with producing the largest amounts of carcinogens that include PAHs and HAAs,\textsuperscript{2,15,20,29,34,35} with levels varying according to meat type, temperature, cooking time and method.\textsuperscript{16,27} As a result, the consumption of well-done grilled meat (heated to 71.1°C/160°F or higher) has been reported to be associated with the highest risk of colorectal cancer.\textsuperscript{16} Insufficient data resulted in the IARC Working Group being unable to conclude whether the cooking method of meat affects cancer risk.\textsuperscript{15} A possible reason why studies investigating carcinogen formation during the cooking of meat was inconclusive could be related to interactions with genetic polymorphisms such as the acetylator phenotypes, as well as difficulties in assessing dietary carcinogen intake.\textsuperscript{44} When comparing the burden of disease estimate attributed to red meat consumption prepared according to different cooking methods, the cooking method that led to the largest health loss due to colorectal cancer was barbecuing/ grilling, followed by pan frying.\textsuperscript{29}

Current public health recommendations to reduce the risk of colon cancer

The evaluation conducted by the IARC reinforces a previous recommendation by the WHO that those who eat red meat should consume processed meat in moderation to reduce the risk of colorectal cancer. Other dietary guidelines also recommend limiting the consumption of red or processed meat but are predominantly focused on reducing the intake of fat and sodium as risk factors for cardiovascular disease and obesity. Hence, recommendations that address cancer risk could consider the introduction of a guideline that promotes a reduction in the consumption of red or processed meat until updated guidelines specifically related to cancer prevention have been developed.\textsuperscript{15}

The World Cancer Research Fund (WCRF) and American Institute for Cancer Research (AICR) recommendations are to limit the consumption of red meat to less than 500 g/week and to avoid processed meat (0 g/week). However, the choice of these limits was not clearly substantiated in the report.\textsuperscript{29} The 4th European Code against Cancer Working Group developed recommendations in order to reduce cancer risk. The guideline related to consuming a healthy diet includes a recommendation stating: ‘avoid processed meat; limit red meat and any foods high in salt.”\textsuperscript{26}

The Food-based Dietary Guideline for SA that refers to the consumption of meat\textsuperscript{27} recommends that no more than 560 g of red meat should be consumed on a weekly basis. This equates to a daily intake of 80–90 g. However, there are no guidelines or recommendations regarding the consumption of processed meat.

Avoidance of red and processed meat

Due to the relationship between the consumption of processed meat, and in certain studies a combination of red and processed meat referred to as total meat intake,\textsuperscript{16,23} and the development of colon cancer, the question that arises is: Should vegetarian diets not be actively promoted as part of public health messages that promote health? In shaping this decision, consideration should be given to the fact that vegetarian diets versus those that include meat have different health-related advantages and disadvantages. The IARC evaluation did not directly compare the health risks associated with following a vegetarian diet compared with eating meat. In addition, a comparison of this nature is difficult because vegetarians can differ from non-vegetarians in ways other than just the consumption of meat.\textsuperscript{15} However, data from the Adventist Health Study showed that non-vegetarians had an increased risk for colorectal cancer when compared with vegetarians.\textsuperscript{38} It should, however, be remembered that red meat is a source of high biological value protein and micronutrients such as vitamin B6, B12, iron (free iron and haem iron), selenium and zinc.\textsuperscript{1,2,15,20} In addition, the nature and content of fat in red meat varies according to breed, age, gender, feed and the cut of meat.\textsuperscript{2} To facilitate optimal health, non-vegetarian consumers should be educated to choose lean cuts of meat and consume them in moderate amounts as per the eighth Food-based Dietary Guideline of SA: ‘Fish, chicken, lean meat and eggs can be eaten daily.”\textsuperscript{27}

Conclusion

A recent review by the IARC that investigated the relationship between consuming red and processed meat and the development of colon cancer sparked renewed global interest when red meat was labelled as a probable cause, while processed meat was classified as carcinogenic. Although the factors that
contribute to the development of cancer are multifactorial, the local incidence of colon cancer as well as meat consumption patterns should be assessed on a regular basis as a transitional developing country like South Africa which is characterised by urbanisation, nutrition transition and the adoption of a Westernised lifestyle. Another factor that could affect the eating habits of SAs is food prices. As processed meats are generally more affordable than red meat and chicken, local food-based dietary guidelines should also be reviewed on a regular basis to ensure that they are evidence based and in line with the changing eating habits of SAs.

References
38. Fraser GE. Associations between diet and cancer, ischemic heart disease, and all-cause mortality in non-Hispanic white California Seventh-day Adventists. Am J Clin Nutr. 1999;70 Supp IS328–88. Received: 12-01-2016 Accepted: 07-05-2016
Dispensing patterns of prescription-only antiobesity preparations in South Africa

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Abstract (Full text available online at www.tandfonline.com/ojcn)

Objectives: The aim of the study was to investigate the dispensing patterns of prescription-only antiobesity preparations in South Africa (classified as Anatomical Therapeutic Chemical (ATC) group A08).

Design: Retrospective, cross-sectional drug utilisation study using electronic dispensing records.

Setting: Private sector community or retail pharmacies in South Africa.

Subjects: Patients who received one or more antiobesity medications in ATC group A08 in 2013.

Outcome measures: Number of patients by age and gender, prescribing frequency and cost of antiobesity prescriptions, and trends observed.

Results: A total of 27 703 patients were prescribed 52 555 products for antiobesity medication during 2013. The average age of patients was 41.71 (SD = 11.37) years, with male patients older than female patients (46.09 and 40.02 years, respectively). More females (72.19%) were dispensed antiobesity products, and females received their prescriptions at a younger average age than male patients. Five active ingredients were dispensed. Phentermine was prescribed the most, accounting for 92.44% of all the antiobesity prescriptions, followed by orlistat (6.08%), phendimetrazine (1.36%), D-norpseudoephedrine (0.06%) and diethylpropionic (0.05%). Most patients (79.44%) received only short-term therapy (one or two prescriptions for an antiobesity product during the year). A small percentage (0.30%) of young patients (18 years and younger) received antiobesity products, despite the fact that the safety of these products in children has not been proven.

Conclusions: Most antiobesity preparations were prescribed to females. Phentermine was the most commonly dispensed active ingredient, followed by orlistat. Further studies on patient outcomes and the cost-effectiveness of these products should be conducted.

Keywords: antiobesity medicine, dispensing patterns, drug utilisation review, DUR, pharmacy

Dispensing of vitamin products by retail pharmacies in South Africa: Implications for dietitians

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Abstract (Full text available online at www.tandfonline.com/ojcn)

Objective: The objective of this study was to analyse the dispensing patterns of vitamins (Anatomical Therapeutic Chemical (ATC) group A11) over a one-year period in a group of community pharmacies in South Africa.

Design and setting: A retrospective drug utilisation study was conducted on community pharmacy electronic dispensing records in South Africa recorded in 2013.

Outcome measures: All products for ATC subgroup A11 were extracted and analysed.

Results: A total of 164 233 vitamin products were dispensed to 84 805 patients (62.64% female patients). Males received on average 2.09 (SD = 2.63) vitamin products per year, compared to 1.84 (SD = 2.13) products for females. Ergocalciferol (A11CC01) was the most often dispensed (37.48% of all vitamin products), followed by plain Vitamin B-complex products (A11EA00) accounting for 32.77%. Ergocalciferol (vitamin D2) is only available on prescription (50 000 IU tablets or 50 000 IU/ml only drops) in South Africa. Tablets were the preferred dosage form (62.84% of products). Most injections were for Vitamin B1 or Vitamin B combination products.

Conclusion: Ergocalciferol and injectable vitamins have recently been rescheduled to prescription-only; it is probable that this has impacted on the usage of these products. It is important to monitor future vitamin supplementation behaviour in community pharmacies since pharmacies are selling many of these products and pharmacists can, by counselling patients, determine the reasons for the use of these products. Furthermore, should dietitians and nutritionists choose to work with this captive audience, supplementation patterns can be monitored to develop and implement appropriate awareness campaigns. Further studies to explore these baseline results are recommended.

Keywords: dispensing patterns, drug utilisation study, ergocalciferol, retail pharmacies, vitamins
Nutrition-related cancer prevention knowledge of undergraduate students at the University of Ibadan, Nigeria

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Abstract (Full text available online at www.tandfonline.com/ojcn)

Objective: This study assessed the nutrition-related cancer prevention knowledge and dietary pattern of undergraduate students.

Design: A cross-sectional study design was employed.

Setting: The University of Ibadan campus, Ibadan, Oyo state, Nigeria.

Participants: A systematic random sampling of 367 undergraduate students was done. Method: A pretested self-administered questionnaire assessed the nutrition-related cancer prevention knowledge of the participants based on WCRF/AICR guidelines. A food frequency questionnaire was used to evaluate the dietary pattern. Weight, height, waist and hip circumferences, body mass index and waist:hip ratio were measured and computed based on standard procedures.

Results: Less than half (49%) had good nutrition-related knowledge of cancer prevention. About 30.0–40.0% frequently consumed legumes/nuts, vegetables and fruits respectively. About 75.0% frequently consumed processed cereals and grains (white rice, white bread and noodles). Above 20.0% were overweight, while 3.8% were obese. Less than 75.0% had low risk of abdominal obesity while 25.5% had high risk of abdominal obesity. Nutrition knowledge of cancer prevention was associated with the frequency of consumption of processed cereals and grains ($\chi^2 = 13.724; p = 0.000$), legumes/nuts ($\chi^2 = 17.268; p = 0.000$), meat ($\chi^2 = 22.972; p = 0.000$), fish ($\chi^2 = 23.017; p = 0.000$), pastry snacks ($\chi^2 = 36.159; p = 0.000$) and sugary drinks ($\chi^2 = 6.432; p = 0.011$). There was no significant difference in knowledge of cancer prevention and the frequency of consumption of roots and tubers, milk, vegetables, and fruits. A higher risk of abdominal obesity was associated with infrequent consumption of legumes/nuts ($\chi^2 = 7.001; p = 0.008$) in the males, and with vegetables ($\chi^2 = 6.771; p = 0.009$) and fruits ($\chi^2 = 4.205; p = 0.040$) intakes in the females.

Conclusion: Nutrition-related knowledge of cancer prevention was low, and the respondents also had a poor dietary pattern. The high risk of abdominal obesity may be a pointer to the larger young adult population, emphasising a need for targeted intervention.

Keywords: adolescents and young adult health, cancer prevention, nutrition knowledge
Eradicating malnutrition in Cameroon

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Despite the numerous interventions for the amelioration of socio-economic status and food security in Africa, the output still does not show any significant effect, leaving people to wonder if it will ever be possible to eradicate poverty and malnutrition in that part of the world. Malnutrition can effectively be eradicated but it will all depend on the strategies put in place as well as the monitoring systems, coordination and resources available for their proper functioning. In Cameroon, the situation keeps deteriorating with an estimated 229 000 cases of malnourished children (34% being severe cases) noted at the start of 2015, compared to 186 000 cases noted in 2014 (29% being severe cases). It was also noted that 8 out of 10 cases of malnutrition came from the North and Far North regions of Cameroon with more than half of the remainder coming from the East region of the country.1

Malnutrition is a term used to describe health disorders due to the inappropriate intake of food nutrients, either insufficient or are too many, which causes health problems and can increase morbidity and/or mortality.2 Malnutrition is a broad term that refers to both under-nourishment and over-nourishment, higher rates of which affect the developing and developed countries, respectively. Symptoms of malnutrition include fatigue, dizziness, weight loss and increased vulnerability to infection. Malnutrition can be moderate or severe presenting with underweight, wasting and stunting, and can cause irreversible physical or mental disability especially in children.3 The World Food Program defines malnutrition as “a state in which the physical function of an individual is impaired to the point where he or she can no longer maintain adequate bodily processes such as growth, pregnancy, lactation, physical work, and resisting and recovering from disease.”

Many factors are linked to malnutrition in Cameroon with the most important being the problem of food availability. This is coupled with the problem of accessibility, affordability and transformation especially in the northern and eastern parts of the country, marked by the entry of refugees and other internally displaced persons due to transnational instability. Poor nutritional habits, on the other hand, ironically make malnourished persons out of those having plenty. The situation worsens in pregnant and breastfeeding women, thus affecting the nutritional status of their babies.4,5

Primarily, malnutrition can be successfully addressed by putting in place and actively monitoring strategies and projects to reduce poverty as well as ensure food availability and security. The economy of Cameroon is predominantly agricultural with a great diversity of foods across the various regions of the country. This is due to the four climatic zones in the country, which also influence food availability thus the problem of nutrient equilibration, especially in the northern and eastern parts of the country.4 The Agriculture-Nutrition Advantage project funded by the USAID and implemented in some strategic sub-Saharan countries from 2001 to 2004 showed a remarkable degree of success. Here, the aim was creating a network of leaders and advocates to act in collaboration and promote the fight against poverty and hunger by linking agriculture to nutrition, thus bringing together the resources from the diverse nutritional climate zones in the country, taking into consideration the gender implications. The strategy aimed at bringing together aspects like cultivation, livestock, food processing, food availability in households and markets, affordability of prices, balanced dietary intake and health.2 Implementing the above initiative in Cameroon will demand a lot of political will from the government and other stake holders. Despite this, it can be achieved in a more practical context by putting in place policies that promote agriculture. Strategies like subventions and available agricultural loans at affordable interest rates can prove to be very important in promoting mass cultivation. This may be coupled with provision of knowledge on the technical know-how for the amelioration of mass cultivation. The amelioration of the agricultural output from the above initiative will only show its impact if the produced foods reach the needy persons, therefore the equilibration of nutritional status across climate zones will only be made possible if an effective transportation network linking all those regions of the country (including farm to market roads) is constructed, as well as putting in place food preservation mechanisms that will ensure quick and safe transportation. This will lead to a good level of collaboration and exchange increasing the availability of multiple and balanced dietary intakes for the population.

In keeping responsible and healthy living and nutritional habits, the large scale implementation of communication for behavioral change targeting issues like diversification and balancing of dietary intake, adequate nutrition of babies as well as mothers, personal hygiene and food security is required.6 Nutrition can also be included in all the levels of the country’s education system. Systemic infections, especially those concerning the digestive system, should be diagnosed and treated early so as to reduce its influence on the severity of malnutrition. Periodic treatment of intestinal infestation accompanied with food supplementation programs, especially in children, can be very effective.9

Bearing in mind that Cameroon needs a strong labour force to be able to achieve economic emergence, due consideration should be afforded to the consequences linked to overpopulation especially when the children are not fended for. Family planning interventions, through adequate birth spacing, have been shown to reduce risk for low birth weight and stunting and to decrease infant and maternal mortality.10 As birth weights increase in a population, nutritional status improves and mortality decreases. As children’s nutritional status improves, so do their cognitive development and performance in school, leading to higher educational attainment and improved earning capacity in adulthood.
In Cameroon, a good number of the above numerated areas of interventions are currently being adopted to solve the problem of food security and malnutrition, like communication for behavioral change, promotion of family planning, mass treatment of intestinal parasites and related programs. However, these interventions have been influenced negatively by a number of internal and external factors at all levels, which include the problem of durable funding, insufficient qualified human resources, globalisation (through trade policies unfavourable to local production), mismanagement of resources and insufficient coordination of the already implemented nutrition programs.\textsuperscript{11} Also, the participation of the community at all levels of the programs, from planning through to implementation, is still very precarious, negatively affecting the outcome of the interventions.\textsuperscript{11} This leads to problems of scaling, effectiveness and durability of the interventions adopted by the government. For a better functioning of these interventions, all the setbacks should be identified and solved. This will be made possible through the promotion of operational research in the domains of agriculture, nutrition and food security.

The appropriate implementation of a nutrition strategy and surveillance to address the enumerated setbacks is an absolute imperative in the struggle to tackle malnutrition in Cameroon in accordance to the recommendations of the World Health Organisation. So far, the government has elaborated on its nutrition policies and has put in place nutrition programs to reduce poverty and hunger as well as to promote research in the domain of nutrition, though much is still left undone. An optimally-nourished person is a healthy person and a healthy person is a productive person, thus nutrition should be given great attention in Cameroon’s drift towards becoming an emerging country.

References

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Case Study: An unusual case of Wernicke’s encephalopathy - Thiamin deficiency in advanced gastric adenocarcinoma

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Introduction

Wernicke’s encephalopathy (WE) is a neurological syndrome most commonly found in patients suffering from alcohol abuse. It is less frequently diagnosed in non-alcoholic patients. In non-alcoholic patients WE might develop due to the exclusion of upper portions of the gastrointestinal tract (e.g. after gastrectomy, gastrojejunostomy, gastric bypass surgery) or secondary to intractable vomiting, inadequate dietary intake or malabsorption. 1,2 Other described conditions in which WE may develop include HIV/AIDS, several types of malignancy (inoperable gastric cancer, leukaemia and lymphoma), prolonged periods of malnutrition (anorexia), hyperemesis gravidarum, thyroid conditions, post organ transplant as well as patients receiving dialysis and long-term dependency on parenteral nutrition (PN).1-3,4

WE is caused by thiamin (vitamin B1) deficiency.1,2 This micronutrient, a water-soluble vitamin, is absorbed primarily in the duodenum, acts as a co-factor in carbohydrate metabolism, and is important in neuron cell function.3 The human body cannot synthesize thiamin and regular dietary intake of thiamin is essential.3 Symptoms of a thiamin deficiency or WE include the classic triad of ophthalmoplegia/nystagmus, ataxia and encephalopathy/confusion,1-3 although these clinical symptoms occur in only 16–25% of patients.3,4,5 Early onset of a thiamin deficiency includes general symptoms of illness such as headaches, irritability, fatigue and abdominal discomfort.1 Prophylactic thiamin supplementation forms part of the standard nutritional management of patients at risk of developing refeeding syndrome (RFS).6,7 RFS, also a regularly underdiagnosed condition,4 is characterized by the potentially fatal shift in fluids and electrolytes (decrease in phosphate, potassium and magnesium), as well as thiamin deficiency which could possibly contribute to WE.4,6,7 These findings emphasize the importance for medical doctors as well as dietitians to be aware of the signs and symptoms of thiamin deficiency, particularly in cases with a non-alcoholic aetiology.

Case Report

A 32-year-old female was referred to the upper gastrointestinal surgical unit at Groote Schuur Hospital with a one-year history of loss of appetite, poor oral intake, intermittent postprandial vomiting and significant loss of weight. Collateral history elucidated an acute deterioration in cognitive and muscle function over the preceding month. An initial gastroscopy by the referring hospital had shown severe gastritis, a prepyloric mass and gastric outlet obstruction (GOO). An abdominal ultrasound reported an abnormally thickened appearance of the gastric mucosa. Repeat gastric biopsies were consistent with a diffuse-type gastric adenocarcinoma involving most of the distal stomach and pylorus. Staging computed tomography (CT) revealed a locally unresectable diffuse gastric cancer.

Anthropometry

The patient was unable to stand, and therefore the relevant anthropometric measurements were estimated. A body mass index (BMI) of 19 kg/m² and height of 1.72 m were estimated, resulting in an estimated current body weight of 56 kg. An ideal body weight of 65 kg, at BMI of 22 kg/m², was calculated. The patient had visible temporal and deltoid wasting, with 5–10% weight loss over the preceding 6–12 months.

Biochemistry

The biochemical workup included a full blood count, serum urea, creatinine, electrolytes, calcium, magnesium, phosphate and albumin, as well as liver function tests. The relevant serial blood values are shown in Table 1. The patient had ongoing borderline hypokalaemia due to increased losses from prolonged vomiting. Serum creatinine levels reflect muscle mass as creatinine is mostly derived from the breakdown of endogenous sources, and less affected by catabolic states than urea levels.4 Thus, the decreased creatinine levels in the patient reflected her low muscle mass, corresponding with the quadriparhesis (see clinical assessment) and muscle wasting. Urea,
on the other hand, is derived from either dietary protein sources or endogenous protein sources and its formation is influenced by protein intake, increased catabolism (either due to starvation or an acute phase response), as well as the absorption of protein from blood in the gastrointestinal lumen. The hypophosphatemia on day 1 was not an indication of RFS since nutritional intervention only commenced on that day, but was rather a result of increased losses and poor dietary intake. Hypomagnesemia may be attributed to poor absorption, or rather diminished nutrient delivery due to GOO, as the absorption site for magnesium is in the small intestine and colon. Hypoalbuminemia is an indicator of the catabolic state due to the adenocarcinoma.

Clinical

On arrival at our centre, the patient was bedridden and aphasic with a flaccid, areflexic quadriaparesis, bilateral cranial nerve VI palsies, nystagmus, ptosis and encephalopathy. General wasting and fatigue with thin and weakened extremities were observed. The patient was apyrexial with stable vitals. According to collateral family history, she suffered from severe depression which was never formally diagnosed or treated, but had been fully independent and functional up until one month prior to presentation. A subsequent CT brain scan excluded metastatic disease. Psychiatry and neurology were consulted on day 1 and 4 respectively, and a subsequent diagnosis of WE due to severe thiamin deficiency was made on clinical grounds. A magnetic resonance imaging (MRI) of the brain showed no characteristic findings of WE or any other permanent lesions.

Table 1: Relevant cumulative biochemistry during hospital stay

<table>
<thead>
<tr>
<th></th>
<th>Normal values</th>
<th>Prior to admission</th>
<th>Admission</th>
<th>Day1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Day 8</th>
<th>Day 11</th>
<th>Day 18</th>
<th>Day 21</th>
<th>Day 27</th>
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</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>135–147 mmol/l</td>
<td>141</td>
<td>139</td>
<td>141</td>
<td>140</td>
<td>138</td>
<td>137</td>
<td>141</td>
<td>138</td>
<td>139</td>
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</tr>
<tr>
<td>Potassium</td>
<td>3.3–5.3 mmol/l</td>
<td>2.4</td>
<td>H</td>
<td>3.0</td>
<td>3.6</td>
<td>3.9</td>
<td>3.1</td>
<td>3.5</td>
<td>3.4</td>
<td>3.2</td>
<td>2.7</td>
<td>2.8</td>
</tr>
<tr>
<td>Urea</td>
<td>2.6–7.0 mmol/l</td>
<td>3.0</td>
<td>3.4</td>
<td>4.6</td>
<td>5.1</td>
<td>3.9</td>
<td>4.6</td>
<td>3.6</td>
<td>3.4</td>
<td>6.4</td>
<td>9.8</td>
<td></td>
</tr>
<tr>
<td>Creatinine</td>
<td>60–120 µmol/L</td>
<td>30</td>
<td>39</td>
<td>39</td>
<td>30</td>
<td>23</td>
<td>22</td>
<td>21</td>
<td>35</td>
<td>22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Haemoglobin</td>
<td>14.3–18.3 g/dL</td>
<td>10.6</td>
<td>13.7</td>
<td>11.8</td>
<td>9.7</td>
<td>10.1</td>
<td>9.0</td>
<td>7.9</td>
<td>8.7</td>
<td>10.0</td>
<td>9.3</td>
<td>9.1</td>
</tr>
<tr>
<td>WBC</td>
<td>4–10 x 10^9/L</td>
<td>2.74</td>
<td>4.05</td>
<td>2.64</td>
<td>2.52</td>
<td>2.63</td>
<td>2.86</td>
<td>2.50</td>
<td>3.26</td>
<td>3.90</td>
<td>6.56</td>
<td>16.4</td>
</tr>
<tr>
<td>Calcium (corrected)</td>
<td>2.05–2.56 mmol/l</td>
<td>2.0</td>
<td>1.9</td>
<td>1.9</td>
<td>2.1</td>
<td>2.2</td>
<td>2.05</td>
<td>2.2</td>
<td>2.4</td>
<td>2.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnesium</td>
<td>0.65–1.1 mmol/l</td>
<td>0.7</td>
<td>0.79</td>
<td>0.60</td>
<td>0.64</td>
<td>0.63</td>
<td>0.87</td>
<td>0.54</td>
<td>0.75</td>
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<tr>
<td>Phosphate</td>
<td>0.8–1.4 mmol/l</td>
<td>0.84</td>
<td>0.68</td>
<td>0.8</td>
<td>1.02</td>
<td>1.56</td>
<td>1.14</td>
<td>1.15</td>
<td>0.62</td>
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<tr>
<td>Albumin</td>
<td>35–52 g/L</td>
<td>27</td>
<td>29</td>
<td>32</td>
<td>30</td>
<td>28</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALT</td>
<td>5–40 U/L</td>
<td>37</td>
<td></td>
<td>42</td>
<td>9</td>
<td>&lt;5</td>
<td>8</td>
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<td></td>
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<tr>
<td>AST</td>
<td>5–40 U/L</td>
<td>20</td>
<td></td>
<td>35</td>
<td>16</td>
<td>12</td>
<td>17</td>
<td></td>
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<tr>
<td>ALP</td>
<td>40–120 U/L</td>
<td>48</td>
<td></td>
<td>93</td>
<td>85</td>
<td>74</td>
<td>130</td>
<td></td>
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</tr>
<tr>
<td>GGT</td>
<td>0–60 U/L</td>
<td>30</td>
<td></td>
<td>121</td>
<td>67</td>
<td>42</td>
<td>45</td>
<td></td>
<td></td>
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<tr>
<td>Vitamin B12</td>
<td>145–569</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>380</td>
<td></td>
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<tr>
<td>TSH</td>
<td>0.27–4.20 mIU/L</td>
<td></td>
<td></td>
<td>2.84</td>
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</table>

*H: Haemolysed; WBC: White blood count; ALT: Alanine transaminase; AST: Aspartate transaminase; ALP: Alkaline phosphate; GGT: Gamma glutamyl transpeptidase; TSH: Thyroid stimulating hormone

Dietary

The patient was identified as being at risk of developing RFS due to her prolonged inadequate intake and increased weight and nutrient losses. She was kept nil per os due to complete GOO, and total parenteral nutrition (PN) was initiated. An indication for PN according to European Society for Clinical Nutrition and Metabolism (ESPEN) in unresectable cancer patients includes supportive or supplementary PN, if a patient is likely to suffer from starvation prior to tumour spread, although, in most cases, the nutritional benefit is outweighed by the risk of infection, sepsis and or PN-associated liver disease with prolonged administration. Thus PN support in advanced cancer is not standard practice.

PN support was commenced according to the National Institute for Health and Care Excellence (NICE) guidelines for the management and prevention of RFS. The guidelines (Figure 1) recommend slow commencement of nutrition at 10 kcal/kg/day with an increase of 5 kcal/kg/day based on biochemical monitoring, along with intravenous (IV) thiamin supplementation and prophylactic IV phosphate, potassium and magnesium supplementation. Regular repeat blood as well as glycaemic monitoring was strictly adhered to.

The patient’s initial energy needs were calculated at 15 kcal/kg/day (based on estimated actual weight) due to the 330 kcal (5.8 kcal/kg/day based on estimated actual weight) that was already being received from the 5% Dextrose IV infusion @ 63 ml/hour since admission. The patient was prescribed an all-in-one PN bag, started at 60 ml/hour via central venous access. Additional IV micronutrient...
solution (containing one ampule Soluvit® and one ampule Additrace® in 200 ml saline, given over 4 hours) was administered to reach daily micronutrient requirements as the whole PN bag was not used. Normal saline IV fluids with 40 mmol KPO4 (42 ml/hour) was commenced to provide total fluids up to 40 ml/kg/day, based on estimated actual weight.

On diagnosis of gastric adenocarcinoma, the patient’s goal energy and protein were adjusted to disease specific recommendations according to the ESPEN guidelines on PN: non-surgical oncology of 25–30 kcal/kg/day and protein recommendations at a minimum of 1 g/kg/day with a target range of 1.2–2 g/kg/day.10 For prevention of further weight loss and/or weight gain, a total energy intake up to 40 kcal/kg/day is recommended.12 This resulted in 1680–2240 kcal/day (based on estimated current weight) and 78–130 g/day protein (based on ideal body weight). Her fluid requirement was continued at 40 ml/kg/day to maintain her fluid balance.

**Medical management**

The patient was initially prescribed Pantoprazole®, Clexane®, Perfarlan®, Stemetil®, and Morphine®. Prophylactic IV potassium phosphate (KPO4) and IV thiamin supplementation (200 mg immediately prior to initiation of PN and continuing 100 mg daily for 10 days) was started according to the NICE guidelines (Figure 1).11,12

![Figure 1. NICE guidelines for the management of refeeding syndrome](image)

<table>
<thead>
<tr>
<th>NICE* GUIDELINES FOR REFEEDING SYNDROME</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DAY 1:</strong> 10 kcal/kg/day 5 kcal/kg/day (BMI &lt; 14 kg/m² or nil per os for &gt; 15 days)</td>
</tr>
<tr>
<td><strong>Day 2 to 4:</strong> Increase by 5 kcal/kg/day Poor to no tolerance - keep to low feeding regimen or stop</td>
</tr>
<tr>
<td><strong>Day 5 to 7:</strong> 20–30 kcal/kg/day</td>
</tr>
<tr>
<td><strong>Day 8 to 10:</strong> 30 kcal/kg/day or increase to full requirements</td>
</tr>
</tbody>
</table>

Prophylactic supplementation:

- Phosphate: 0.5–0.8 mmol/kg/day
- Potassium: 1–3 mmol/kg/day
- Magnesium: 0.3–0.4 mmol/kg/day
- Sodium: restrict < 1 mmol/kg/day
- IV Thiamine and B-complex: 30 minutes prior to feeding till day 3 or 200 mg once when feeding commences and 100 mg daily for 10 days
- Fluid balance: maintain at a zero balance

*NICE: National Institute for Health and Care Excellence

IV thiamin supplementation was adjusted according to WE protocols on day 4 (Figure 2). It is inadvisable to prolong infusion for more than 30 minutes as it can be painful at the infusion site.4

**Figure 2. Neurology protocols for the management of Wernicke’s encephalopathy as recommended by literature**

| European Federation of the Neurological Societies (EFNS): |
| 200 mg Thiamine IV in 100 ml of normal saline or 5% glucose over 30 minutes three times a day until symptoms resolve |
| Royal College of Physicians: Evidence based on alcoholics |
| 500 mg Thiamine IV three times a day for three days followed by 250 mg IV daily for 5 days or until clinical improvement is no longer noted |

By day 10, the patient’s cognitive state improved and she was orientated to person, place and time, nystagmus resolved and she gained 3 out of 5 power in her upper limbs, although her lower limb weakness persisted. Occupational therapy was consulted and provided bilateral ankle foot orthosis (AFO) splints for foot drop.

**Nutritional Management**

The patient was started on PN according to the NICE guidelines for the management of RFS (Table 2). The patient tolerated the feeding regimen well and reached maximum requirements by day 4. Prophylactic supplementation of IV thiamin as well as KPO4 was continued and, on day 4, magnesium was also added due to deficient levels. Thiamin supplementation was adjusted on day 5 and the patient volunteered an increase in appetite, although she still had nil oral tolerance.

On day 22, an uncovered 120 x 20 mm duodenal self-expanding metal stent (SEMS) was placed endoscopically, but failed to expand due to the severity of her gastric outlet stenosis and external compression from the tumor (Figure 3). As a last resort to establish an enteral feeding route, the patient was booked for a palliative open gastrojejunostomy. On commencement of her laparotomy, however, the procedure was abandoned due to the severity of her gastric outlet stenosis and external compression. After extensive counselling with all family members, the patient was identified for palliative care and PN was weaned and stopped on day 27.

<p>| Table 2. Nutritional management of the patient – progress of parenteral nutrition provided |</p>
<table>
<thead>
<tr>
<th>Day</th>
<th>Rate (mL/h)</th>
<th>Total Energy (kcal/kg/day)</th>
<th>Protein (g/kg/day)</th>
<th>Dextrose (mg/kg/day)</th>
<th>Lipids (g/kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>60</td>
<td>15</td>
<td>1.2</td>
<td>1.9</td>
<td>0.9</td>
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<tr>
<td>2</td>
<td>60</td>
<td>20</td>
<td>1.2</td>
<td>3.1</td>
<td>0.9</td>
</tr>
<tr>
<td>3</td>
<td>62</td>
<td>25</td>
<td>3.1</td>
<td>3.1</td>
<td>0.9</td>
</tr>
<tr>
<td>4–27</td>
<td>66</td>
<td>35</td>
<td>3.1</td>
<td>3.1</td>
<td>0.9</td>
</tr>
</tbody>
</table>

![Table 2](image)
levels and, indirectly, from erythrocyte transketolase activity; the latter is not used to diagnose WE, but rather as a biomarker of an existing deficiency. The additional biomarkers were not used or tested in this patient as the clinical symptoms adequately justified the initiation of thiamin treatment.

In cancer patients, factors that contribute to the development of thiamin deficiency include the consumption of thiamin by fast-growing neoplastic cells, occlusion or bypassing of the duodenal absorptive surface, poor dietary intake related to lack of appetite and nausea, significant malabsorption, and the use of specific types of chemotherapy. This patient did not receive chemotherapy as the cancer was already too advanced on diagnosis, but rather developed a deficiency due to the fast growing tumour, prolonged poor intake and oral intolerance due to GOO.

Thiamin is a vital substrate in the anaerobic metabolism of carbohydrates, converting pyruvate to acetyl-CoA in the kreb cycle to produce adenosine triphosphate (ATP) or suitable energy that is transported to the brain. Decreased carbohydrate metabolism and poor glucose delivery to the brain lead to poor synaptic transmission, altered DNA synthesis and neurotoxicity due to increased lactic acid and reactive oxygen species. Decreased blood-brain barrier permeability due to the failed osmotic gradient has also been reported as a contributory factor. Standard practice in patients who present with symptoms of confusion and delirium include dextrose IV infusion, that could lead to WE with prolonged infusion. Large volumes of glucose rapidly deplete already deficient stores of thiamin in a malnourished patient, inhibiting glycolysis that result in WE. Hypomagnesaemia also inhibits the metabolism of glucose to ATP, as magnesium is a co-factor that enables thiamin to bind to thiamine-dependant enzymes. Recommendations include glycemic monitoring and early thiamin supplementation when a malnourished patient reaches normal glycemic levels. PN is often required in these patients to deliver adequate nutrition; however, WE can also be caused by PN administration due to the increased influx of carbohydrates due to refeeding syndrome.

Thiamin body stores are depleted within two to three weeks of inadequate intake/provision and/or increased losses that may lead to brain lesions. Thiamin supplementation can prevent or reverse early neurological symptoms in the initial two to three week stage of reversible biochemical lesions. In this case the patient’s neurological symptoms were partially reversed with high-dose thiamin supplementation, irrespective of the advanced stage of cancer. A lack of or delay in thiamin replacement can lead to irreversible structural lesions in the brain, permanent neurological sequelae and death. More research is needed to determine the optimal dosage for thiamin supplementation in treating WE. Side effects of parenteral thiamin supplementation include pruritus and sweating.

**Conclusion**

Lack of awareness of the manifestation and clinical symptoms that present in non-alcoholic thiamin deficiency or WE increase the
SASPEN Case Study: An unusual case of Wernicke’s encephalopathy

Fatality of the syndrome.1-6,17,18 Gastric adenocarcinoma patients’ life expectancy after diagnosis has been extended by improved treatment methods,1,2 although all these patients suffer from poor nutritional intake and absorption that could lead to nutrient deficiencies. WE or thiamin deficiency should be considered in gastric adenocarcinoma presenting with prolonged inadequate intake and increased losses in order to ensure early supplementation and prevention of permanent neurological damage or death.

References
SASPEN has been busy on the various media platforms this past quarter. We were delighted to reach 1000 likes on our Facebook page and would like to thank you for your interaction on the page.

SASPEN took part in several awareness campaigns which started off with participation in ASPEN’s Malnutrition Awareness Week™. This event took place during the week of 26–30 September 2016 and SASPEN participated through social media involvement. Visit www.nutritioncare.org for more information on this campaign as well as access to useful malnutrition resources.

National Nutrition Week takes place yearly from 9–15 October. The United Nation’s Food and Agriculture Organization (FAO) and the United Nations (UN) declared 2016 the International Year of Pulses aimed at promoting pulses as nutritious seeds for a sustainable future. National Nutrition Week joined in this effort with the theme of this year’s campaign being “Love your beans – eat dry beans, peas and lentils”. This initiative fitted in with the South African Food Based Dietary Guidelines to eat dry beans, split peas, lentils and soya regularly. SASPEN participated through creating awareness on the social media platforms. Visit www.nationalweek.co.za for interesting statistics, key messages and recipes. The FAO and UN website www.iyp2016.org also contains resources regarding pulses.


SASPEN had the privilege of participating in a slot dedicated to nutrition in developing countries at the 38th European Society for Clinical Nutrition and Metabolism (ESPEN) congress held in Copenhagen, Denmark, from 17–20 September 2016. Professor Renee Blaauw from Stellenbosch University and past president of SASPEN, did an excellent presentation on “The double burden of Malnutrition”. This is the first year that this slot was allocated on the program and we hope to see this in the years to come at the ESPEN congress. The congress was also attended by the current SASPEN President, Christina Nieuwoudt, and current Scientific Secretary, Anna-Lena du Toit. Both successfully completed the three required Life Long Learning (LLL) modules to be eligible for the LLL trainer program. SASPEN hopes to be able to provide the LLL locally in the near future.

In previous SASPEN news bulletins there has been mention of the “nutritionDay” initiative. South Africa has never participated in this initiative and this year SASPEN and ENASA endeavoured to facilitate the participation of local centres. However, due to challenges related to ethics approval, there will be no participation this year. SASPEN and ENASA would like to get involved next year and the first step would be to identify centres that would be interested in participating. To learn more about “nutritionDay” please visit www.nutritionday.org. If you are interested in participating, please contact a SASPEN representative. There will be further communication through our social media platforms for “nutritionDay” 2017.

SASPEN values your input and would like to hear about your initiatives. Please like us on Facebook, follow us on Twitter and join us on LinkedIn. You can visit our webpage on www.saspen.com or download our SASPEN application on your smart devices.
NSSA awards at the Nutrition Congress 2016

Several awards were handed out by the NSSA at the Nutrition Congress 2016, held in Somerset West from 3–5 September 2016.

The Nutrition Society Award
Johann Jerling received the Nutrition Society Award in recognition of his contribution to nutrition research in South Africa over the years. Prof Jerling focused his research on the major area of fibrinogen and haemostasis and the influence of glycaemic control. The work on haemostasis has been translational in nature and the studies involving ethnicity and diet related factors influencing haemostasis, fibrinogen and plasminogen activating factor have provided insights into the mechanisms involved in cardiovascular risk. He has also been a participating member in the PURE (Prospective Urban Rural Epidemiology) study, which has been published in a number of very prestigious International Journals, including The Lancet. He is also well known nationally and internationally for his role in building capacity in Nutrition Leadership in Africa through activities in the African Nutrition Leadership Programme (ANLP).

NSSA Senior Scientist Awards
The Nutrition Award, given to a senior scientist for the best oral presentation on nutrition research, was presented to Edelweiss Wentzel-Viljoen for her paper on Evaluation of a mass-media public awareness campaign to reduce discretionary salt use in South Africa. Salomé Kruger received the second prize for her paper on Agreement between body mass index and percentage body fat categories in black South African women.

NSSA Junior Scientist Awards
The Nutrition Award, given to a junior scientist for the best oral presentation on nutrition research, was presented to Marinka van der Hoeven for her paper on Consumption of locally produced foods in South Africa: a qualitative inquiry of women’s perceptions. Mariaan Wicks received the second prize for her paper on Comparing food classification of various nutrient profiling models to the opinions of South Africans dietitians.

William Fox Memorial Prize
The NSSA William Fox Memorial Prize for the Best Poster Presentation was presented to Friede Wenhold for her poster on The accuracy of bean bags as portion size estimation aids for different food types among elderly.

The theme of National Nutrition Week this year was ““Love your beans - eat dry beans, peas and lentils”. ADSA extends a warm thanks to all nutrition professionals around the country who contributed to various activities during National Nutrition Week.

On Wednesday 12 October, ADSA hosted a Twitter talk focusing on the theme. The hash tag for the talk was #LovePulses in alignment with the hashtag used by the International Year of the Pulses campaign. Partners that actively participated in the Twitter talk included the Consumer Education Project (CEP) of Milk SA (56), The Heart & Stroke Foundation South Africa (2 477) and ADSA. ADSA spokespersons also took part in TV and radio interviews around the country. For more information, go to the NNW 2016 website: http://nutritionweek.co.za/NNW2016/.

ICD 2016

It was with much excitement and great pride that ADSA president Maryke Gallagher, accompanied by past ADSA president Claire Julsing-Strydom, attended the International Confederation of Dietetics Associations congress in Granada, Spain this past September. Not only was it an opportunity for ADSA to learn from and engage with colleagues from around the world, but we got to showcase and present our own beautiful country, South Africa. Cape Town is the host for ICD 2020. Sustainability was the theme for the congress and one of the quotes on the first day that we found to be so valuable to set the scene for the days that would follow, were those of Mahatma Gandhi: “The world has enough for everyone’s need, but not enough for everyone’s greed.” One of the key messages from this conference was that nutritionist-dietitians will need to play a key role in shifting people’s eating patterns to provide food for the future while preserving the planet. ADSA looks forward to hosting an equally memorable event in Cape Town in September 2020.

ADSA Bursary 2017

ADSA is pleased to announce that applications for the ADSA Bursary 2017 are open. The closing date for the bursary is 16 December 2016. Students who are in or have completed first year dietetics are eligible to apply. To apply, fill in the application form (obtainable from your university or via the ADSA website at http://www.adsa.org.za/Members/BursariesAwards.aspx). Include in your application a motivation letter for why you should be chosen for support to study dietetics. Please send the completed form and supporting documents as PDF documents via email to andrew@vdw.co.za.

Goodbye, 2016!

We wish all SAJCN readers a happy and healthy 2017.

Stay in touch with ADSA and help us spread the word that optimal nutrition is essential for all South Africans:

- www.facebook.com/ADSAorgza
- www.twitter.com/ADSA
- Blog: http://nutritionconfidence.wordpress.com
- Website: http://www.adsa.org.za
- Email: info@adsa.co.za or adsacomms@gmail.com
Best you eat some beans

Beans have certainly played a big part in the International Year of Pulses this year. A pulse is a plant-based protein that is basically a powerhouse of nutrients. Pulses are very high in protein and fibre and are low in fat.

One pulse which should not be overlooked is the white kidney bean. The name comes from its convex shape that resembles the kidney. White kidney beans are among the best foods for helping you lose weight due to their low fat, high fibre content, which leaves you feeling full for longer and keeps food cravings at bay. They are well known for their texture and their ability to absorb flavours. These beans also contain essential nutrients such as minerals, vitamins and proteins.

All beans are a great choice for diabetics and people with high cholesterol and hypertension. Beans are also high in antioxidants, which makes them an all-round awesome food to add to your daily diet.

Below is a very tasty mussel and bean salad. Celebrate IYP 2016 with this fancy yet easy pulse recipe.

---

**Mussel and Bean Salad**

**Ingredients:**

- 830 g white kidney beans, drained
- 2 onions, chopped
- 2 tomatoes, peeled and crushed
- 1 kg mussels
- 2 cups (500 ml) white wine (preferably sauvignon)
- 1 branch thyme
- 1 garlic clove, finely chopped

**Sauce:**

- 3 tablespoons (45 ml) cooking sherry
- 1 tablespoon (15 ml) Dijon mustard
- 4 tablespoons (50 ml) olive oil
- 1 pinch paprika
- Sea salt and freshly ground black pepper, to taste

**Method:**

Wash mussels thoroughly, trimming as necessary.

Combine in a pot with white wine, half the onion, garlic and thyme. Cook uncovered on a high heat until mussel shells have opened.

Remove and shell mussels. Strain cooking broth and set aside.

In a large salad bowl, mix mussels, beans, remaining onion and tomatoes. Bring cooking juice back to a boil and let it reduce until it reaches a syrupy consistency. Set aside to cool.

Mix remaining ingredients and cooking broth in a separate bowl. Gently add the sauce to the salad. Refrigerate for half an hour before serving for best taste.

Try this excellent combination: Mix the reduced mussel juice with one cup of mayonnaise, one pinch of curry and a little a bit of lemon juice. Bon appetit!
Aspartame: Blog science has no place in nutrition

As professionals, nutritionists and dieticians should be in the forefront of critical examination of foods and food ingredients. But part of the professional responsibility is also to educate the consumer.

One of the major "scare stories" making the rounds on the internet in recent years has been the attacks on the sweetener Aspartame. Such scare stories have no basis in any research, and all professionals in the food industry should take care to categorically reject such incorrect information and "blog science".

Aspartame is a relatively easy ingredient to defend, due both to its composition and to how the quantities of these components relate to other common foods.

Amino acids make up 93% of aspartame. Amino acids, as protein building blocks, are obviously not "dangerous" in any way, so only those completely ignorant about nutrition would attack them as "dangerous". (The internet is full of such attacks.)

Phenylalanine is the most commonly attacked, but of course it is (1) an essential amino acid (we would die without it) and (2) it is found in virtually any food containing protein—milk, meat, legumes, nuts. To give a comparison on consumption of this amino acid:

<table>
<thead>
<tr>
<th>Phenylalanine consumption via servings:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Glass (200ml) Milk</td>
</tr>
<tr>
<td>1 x 150g Steak</td>
</tr>
<tr>
<td>1 egg (50g)</td>
</tr>
<tr>
<td>1 Snack (50g) Almonds</td>
</tr>
<tr>
<td>1 x 330ml &quot;Diet&quot; Carbonated Drink</td>
</tr>
</tbody>
</table>

*Note: 100% use of aspartame as sole sweetener is extremely rare in the food industry, as there are so many advantages to using blends of sweeteners. The usual phenylalanine content in a tin of CSD is only about 30mg

Therefore, it is readily obvious that we can discard any "danger" of phenylalanine consumption via aspartame.

The same type of calculation and common sense applies, of course, to aspartic acid, the other amino acid in aspartame. The body is fully capable of excreting any "excess" amino acids, and in any case any "excess" would clearly not be ingested via aspartame, due to its intense sweetness and so very limited use level.

That leaves only the methyl ester bond that links the two amino acids together. This, as is correctly pointed out, is converted to "methanol" when metabolised. The "blog science" then attacks this "poison in aspartame", but again this is utter ignorance. Unfortunately for the bloggers, another common methyl ester is pectin, which of course is found in virtually all fruits, vegetables, jams, etc. The human body is quite used to daily and frequent consumption of foods containing methanol. Comparative values of other foods deemed "very healthy" or "normal" show this:

<table>
<thead>
<tr>
<th>Typical methanol metabolism from:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 glass (220ml) Tomato Juice</td>
</tr>
<tr>
<td>1 glass (220ml) Grape Juice</td>
</tr>
<tr>
<td>1 Banana (115g)</td>
</tr>
<tr>
<td>1x330ml &quot;Diet&quot; carbonated drink</td>
</tr>
</tbody>
</table>

Now that the only three components that make up aspartame have been shown to be innocuous, professionals must state that aspartame is, as an ingredient, 100% safe to use.

So let us at least then move this discussion on to lifestyle, "sweet tooth" and behavioural issues, not "safety" issues.

There are no "safety issues" with use of aspartame.

References & Further Reading:
1. Phenylalanine content in foods, see especially an extensive chart by food category: Food Data Chart - Phenylalanine. apjcn.nhri.org.tw 2. Methanol: interesting analysis from: Aspartame, a sweet-tasting dipeptide. D. Eric Walters, Dept. of Biochemistry and Molecular Biology, Finch University of Health Sciences/The Chicago Medical School 3. Aspartame - School of Chemistry. www.chm.bris.ac.uk/motm/aspartame/ 4. A recent study by Ajinomoto found high levels of methanol in certain brands of aspartame, but again this is utter ignorance. Unfortunately for the bloggers, another common methyl ester is pectin, which of course is found in virtually all fruits, vegetables, jams, etc. The human body is quite used to daily and frequent consumption of foods containing methanol.

Typical methanol metabolism from:

- 1 glass (220ml) Tomato Juice: 85mg
- 1 glass (220ml) Grape Juice: 46mg
- 1 Banana (115g): 21mg
- 1x330ml "Diet" carbonated drink: 9mg (sweetened with a blend of sweeteners)

There are no "safety issues" with use of aspartame.
DELITE FOODS has been manufacturing an extensive range of LOW CARB/ SUGAR FREE foods since 1990 and has become well-known for quality under the TANTALIZE banner.

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With sugar removed, Jellies become Protein Snacks (good for all Banting fans). Compare this to traditional jellies which are packed with unnecessary sugar. Our Jellies can be snacks on their own or made with fresh fruit—all the better for fibre, vitamins and satisfying hunger in a positive way.

Other products include Sugar Free Syrups (to add to e.g. plain yoghurt or to make sugar free flavoured milks), MILKY MIX: a high cocoa Hot Chocolate/Drinking Chocolate, Liquid Sweeteners for coffee, tea and baking (including a Stevia version), Xylitol-Stevia sachets, Jams and much more...

All the products can be viewed and purchased on-line at www.delitefoods.co.za

BUYING ONLINE MAKES HEALTHY EATING AFFORDABLE!
November 2016, JOHANNESBURG: At a convocation ceremony held in Kempton Park, Johannesburg, more than 170 Healthcare professionals received their Post Graduate certificates in Paediatric Nutrition from Boston University School of Medicine (BUSM). The convocation ceremony was officiated by Dr. Clifford Lo - an Adjunct Professor of Nutrition at Harvard Medical School and Dr. Ali Dhansay - the Director of Nutritional Intervention Research Unit.

The Post Grad Programme in Paediatric Nutrition - a global academic programme which has been developed to help keep healthcare professionals up-to-date on evolving science - is a partnership between Nestlé Nutrition Institute, BUSM and MedInscribe.

Speaking at the graduation ceremony, Pindelwa Mda, Regional Business Head of Nutrition at Nestlé South Africa said: “As Nestlé Nutrition Institute Africa (NNIA), we sponsored this educational programme with an endeavour to contribute to improving the nutritional status of African Children one step at a time.”

“Proper nutrition in the first 1000 days has been recognised globally to have a profound impact on a child’s ability to grow, learn and thrive and has a lasting impact on long term health. This is a rapidly evolving area where new scientific advances are occurring at a rapid pace” Mda added.

The programme offers a unique opportunity to strengthen healthcare professionals’ knowledge and practice in paediatric nutrition by familiarising them with evidence-based guidelines and recommendations through a series of online learning modules, delivered in various formats including text, video and audio. The final stage of education is presented in a series of live meetings delivered in various locations worldwide.

Since the launch of the programme in March 2016, close to 4500 healthcare professionals from 63 countries have joined the programme. The majority of applications have been submitted from Africa, Asia and the Middle East where typically the burden of nutritional challenges in children is higher and access to education about nutrition is limited.
Lorisian 150plus Food Intolerance test, distributed by OptiWay™, identifies 158 specific foods and drinks a patient may be intolerant to.

Conditions reported by patients include:

- **Gastrointestinal**: e.g. IBS, Bloating etc. (80%)
- **Respiratory**: e.g. Asthma, Sinusitis, Rhinitis (72%)
- **Neurological**: e.g. Migraine, Headaches, ME (78%)
- **Dermatological**: e.g. Eczema, Acne, Psoriasis (76%)
- **Musculoskeletal**: e.g. Arthritis, Joint Aches & Pains (64%)
- **Psychological**: e.g. Depression, Anxiety (81%)
- **Others**: e.g. Lethargy, General feeling of Malaise (79%)

The University of York conducted an independent patient survey (2007), involving 5286 patients who eliminated their trigger foods after being tested for food intolerance food-specific IgG testing. The results were divided into groups and summarised below:

<table>
<thead>
<tr>
<th>Main Condition Reported</th>
<th>% of people who reported a benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gastrointestinal</td>
<td>80%</td>
</tr>
<tr>
<td>e.g. IBS, Bloating etc.</td>
<td></td>
</tr>
<tr>
<td>Respiratory</td>
<td>72%</td>
</tr>
<tr>
<td>e.g. Asthma, Sinusitis, Rhinitis</td>
<td></td>
</tr>
<tr>
<td>Neurological</td>
<td>78%</td>
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<td>e.g. Migraine, Headaches, ME</td>
<td></td>
</tr>
<tr>
<td>Dermatological</td>
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</tr>
<tr>
<td>e.g. Eczema, Acne, Psoriasis</td>
<td></td>
</tr>
<tr>
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<tr>
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<td>e.g. Depression, Anxiety</td>
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</tr>
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<td>Others</td>
<td>79%</td>
</tr>
<tr>
<td>e.g. Lethargy, General feeling of Malaise</td>
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</tr>
</tbody>
</table>

**Why make Lorisian 150plus Food Intolerance tests part of your practice?**

**Supported by years of research:**
- Lorisian 150plus is offered from Europe’s leading Food Intolerance test provider.
- Has multiple scientific papers published specifically about its performance.
- Lorisian 150plus was developed by one of the world’s leading laboratories specialising in food intolerance testing, established in 1982.

**Simple and minimally invasive:**
- Via a simple finger prick, a blood sample is collected on a wand and sent for laboratory analysis in the UK.
- With a single sample taken, 158 specific food and drink intolerances are tested for.
- Within receipt of sample by the lab, a color coded results and patient support pack is sent back to the practitioner, for consultation with the patient.

**Convenient in-practice use:**
- OptiWay™ offers the Lorisian 150plus food intolerance test to medical practitioners and dieticians for use on-site.
- Training and support is available directly via our partner laboratory in the U.K. through online webinars, and on-site via OptiWay™ support staff.

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- Snack Replacement Shake
- Source of Vitamin C
- Sweetened with Xylitol
- Low-GI
- Suitable for diabetics when used as part of a balanced eating plan

Each 25 g (single serving) contains:

<table>
<thead>
<tr>
<th></th>
<th>HIGH</th>
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<th>MED</th>
<th>LOW</th>
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Weight Loss Support
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Xylitol looks and tastes just like regular table sugar, contains less calories than sugar and measure 8 on the Glycaemic Index which indicates that it is low-GI.

- Low-GI
- Great tasting sugar alternative
- Suitable for diabetics when used as part of a balanced eating plan

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