



UNIVERSITEIT VAN PRETORIA  
UNIVERSITY OF PRETORIA  
YUNIBESITHI YA PRETORIA

# **Vitamin A content and bio-availability of South African maize meal (as purchased and consumed)**

**Beulah Pretorius**

Thesis

**Ph.D Nutrition**

Study leader: Prof Dr Hettie C Schönfeldt

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# **Vitamin A content and bio-availability of South African maize meal (as purchased and consumed)**

by

**Beulah Pretorius**

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Pretoria

Study leader: Prof Dr Hettie C Schönfeldt

June 2011



**Dedicated to:**

**my husband, Gerard**

**and**

**three precious girls,**

**Somari, Elismi & Carina**



## DECLARATION

I, Beulah Pretorius, hereby declare that the thesis for the Ph.D Nutrition degree at the University of Pretoria, hereby submitted by me, has not previously been submitted for a degree at this or any other university and that it is my own work in design and execution and that all reference material contained herein has been duly acknowledged.

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BEULAH PRETORIUS

13 June 2011

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## ABSTRACT

# **Vitamin A content and bio-availability of South African maize meal (as purchased and consumed)**

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Study leader: Prof Dr Hettie C Schönfeldt

Faculty: Natural and Agricultural Science

Degree: Ph.D Nutrition

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In 2003 the Department of Health of South Africa embarked on a mandatory fortification programme of maize meal as part of the Integrated Nutrition Program (INP) to alleviate malnutrition. The aim of this study was two-fold: firstly, to determine the vitamin A content of South African fortified white maize meal as purchased and the maize porridge as traditionally prepared from it as consumed and secondly, to determine the relative efficacy of the daily consumption of maize meal in sustaining or improving vitamin A status.

Maize meal samples for analysis were purchased from various supermarkets and small retail outlets. A High Performance Liquid Chromatograph-Diode Array Detector system with a Reverse Phase C-18 column and isocratic elution was used for

separation and quantification of vitamin A. The highest mean vitamin A concentration measured in the maize meal was 261  $\mu\text{gRE}/100\text{g}$  and the lowest mean vitamin A concentration was  $<19 \mu\text{gRE}/100\text{g}$ . Pertaining to the regulations the final minimum level of vitamin A in fortified maize meal must not be less than 187.7  $\mu\text{gRE}/100\text{g}$ . The average retention of vitamin A in maize porridge as the difference in vitamin A concentration measured between raw maize meal and cooked porridge was calculated at 39.8%.

One of the considerations in a fortification program is the availability of certain micronutrients in the fortified foods, with the focus in this project on vitamin A. An animal model, namely chickens, closely relating the metabolism of vitamin A in humans was used. Chickens are very susceptible to vitamin A deficiencies with similar symptoms. Growth and vitamin A status was evaluated by the weight, feed conversion and liver retinol stores of chickens on five different maize based diets over a six week period.

No significant difference in vitamin A levels in the livers of birds on diets with fortified white maize meal, compared to the normal poultry diet consisting of yellow maize meal with added vitamin A was found. It can thus be concluded that the fortificant in the white maize meal is as bioavailable as the vitamin A in the premix used in poultry nutrition. The results of this study show that the vitamin A added as fortificant is absorbed and available to the body. Therefore, fortification of commonly eaten staple foods in the country can significantly improve the vitamin A intake of the population and will improve the overall micronutrient density of their diets.

Fortification should be set at levels to include losses incurred through packaging and during transportation, shelf losses and preparation losses. It is also important that the

vitamin A content of the product as purchased and consumed must be regularly monitored and regulated by government. Valid and reliable evaluation data are needed to evaluate a program's success, and to make timeous adjustments for optimal efficiency.

**Key words:** maize meal, porridge, vitamin A fortification, retention, staple foods, bioavailability

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# TABLE OF CONTENTS

<b>DECLARATION.....</b>	<b>i</b>
<b>ACKNOWLEDGEMENTS.....</b>	<b>ii</b>
<b>ABSTRACT.....</b>	<b>iii</b>
<b>LIST OF ACRONYMS AND ABBREVIATIONS.....</b>	<b>xi</b>
<b>LIST OF TABLES.....</b>	<b>xiii</b>
<b>LIST OF FIGURES.....</b>	<b>xv</b>
<b>LIST OF ADDENDA.....</b>	<b>xvii</b>
<b>CHAPTER 1: THE STUDY IN PERSPECTIVE.....</b>	<b>1</b>
1.1 <b>Background to the study.....</b>	<b>1</b>
1.2 <b>The South African context.....</b>	<b>3</b>
1.3 <b>Motivation for the study.....</b>	<b>4</b>
1.4 <b>Objective of the study.....</b>	<b>6</b>
1.5 <b>Presentation and structure of the thesis.....</b>	<b>7</b>
1.6 <b>References.....</b>	<b>9</b>
<b>CHAPTER 2: LITERATURE REVIEW.....</b>	<b>13</b>
2.1 <b>Introduction.....</b>	<b>13</b>
2.2 <b>Vitamin A and the isomers.....</b>	<b>15</b>
2.2.1      Sensitivity of vitamin A.....	15
2.3 <b>Vitamin A metabolism and deficiency.....</b>	<b>19</b>
2.3.1      The role of vitamin A in human metabolic processes .....	19
2.3.2      Bioavailability of vitamin A.....	20
2.3.3      Dietary requirements and toxicity.....	22

2.3.3.1	Definitions of Recommended Dietary Allowances, Recommended Safe Intake and Dietary Reference Intake .....	22
2.3.3.2	Toxicity .....	25
<b>2.4</b>	<b>Vitamin A deficiency.....</b>	<b>25</b>
2.4.1	Strategies for controlling vitamin A deficiency.....	28
<b>2.5</b>	<b>Fortification of staple foods with vitamin A.....</b>	<b>30</b>
2.5.1	Maize meal as vehicle for micronutrient fortification.....	31
2.5.2	Vitamin A as fortificant.....	31
2.5.3	Factors that affect nutrient delivery in fortification.....	32
2.5.3.1	Nutrient-nutrient interactions.....	33
2.5.3.2	Nutrient-matrix interactions.....	34
2.5.3.3	Moisture.....	34
2.5.3.4	Temperature.....	35
2.5.3.5	pH.....	35
2.5.3.6	Losses of added micronutrients.....	35
2.5.3.7	Premix and pre-blend considerations.....	36
2.5.3.8	Effect of further processing.....	36
2.5.3.9	Packaging.....	37
2.5.3.10	Effect of storage.....	39
2.5.3.11	Food preparation.....	39
2.5.4	Summary.....	40
<b>2.6</b>	<b>Sampling.....</b>	<b>41</b>
<b>2.7</b>	<b>Measuring the vitamin A content of South African fortified white maize.....</b>	<b>43</b>
2.7.1	Size of the test portion.....	43
2.7.2	Extraction procedures.....	43
2.7.3	Chromatography.....	44



2.7.4	Method Validation.....	44
<b>2.8</b>	<b>Studying the relative bioavailability of vitamin A in fortified maize meal.....</b>	<b>45</b>
2.8.1	Animal models in nutrition research.....	46
<b>2.9</b>	<b>Concluding Remarks.....</b>	<b>47</b>
<b>2.10</b>	<b>References.....</b>	<b>48</b>
 <b>CHAPTER 3: VITAMIN A CONTENT IN FORTIFIED WHITE MAIZE MEAL AS PURCHASED AND IN PORRIDGE AS CONSUMED IN SOUTH AFRICA.....</b>		
<b>3.1</b>	<b>Abstract.....</b>	<b>59</b>
<b>3.2</b>	<b>Introduction.....</b>	<b>60</b>
<b>3.3</b>	<b>Materials and Methods.....</b>	<b>62</b>
3.3.1	Samples.....	62
3.3.2	Preparation of porridge samples.....	63
3.3.3	Gravimetric determination of dry matter.....	64
3.3.4	Determination of total vitamin A as all-trans retinol.....	64
3.3.4.1	Chemicals and standards.....	64
3.3.4.2	Sample preparation.....	65
3.3.4.3	Saponification.....	65
3.3.4.4	Extraction and phase transfer.....	65
3.3.4.5	HPLC.....	66
3.3.4.6	Calculation.....	66
3.3.4.7	Method validation.....	66
3.3.5	Calculation of the retention of vitamin A in porridge.....	67
3.3.6	Statistical Analysis.....	68
<b>3.4</b>	<b>Results and Discussion.....</b>	<b>68</b>

3.4.1	Method performance.....	68
3.4.2	Vitamin A content of maize meal as purchased in supermarkets.....	69
3.4.3	Vitamin A concentration of maize porridge.....	71
<b>3.5</b>	<b>Conclusion.....</b>	<b>77</b>
<b>3.6</b>	<b>Acknowledgement.....</b>	<b>78</b>
<b>3.7</b>	<b>References.....</b>	<b>79</b>

**CHAPTER 4: EFFECT OF DIFFERENT MAIZE MEAL DIETS ON THE GROWTH  
AND VITAMIN A STATUS OF CHICKENS..... 84**

<b>4.1</b>	<b>Introduction.....</b>	<b>84</b>
<b>4.2</b>	<b>Materials and Methods.....</b>	<b>86</b>
4.2.1	Husbandry and rearing of broilers.....	86
4.2.2	Measurements and observations.....	89
4.2.2.1	Birds.....	89
4.2.2.2	Feed.....	89
4.2.2.3	Feed conversion ratio.....	89
4.2.2.4	Mortality.....	89
4.2.2.5	Livers.....	89
4.2.3	Vitamin A analysis.....	90
4.2.4	Statistical analysis.....	90
<b>4.3</b>	<b>Results and Discussion.....</b>	<b>90</b>
4.3.1	Feed .....	90
4.3.2	Body weight.....	95
4.3.3	Feed conversion ratio.....	97
4.3.4	Mortality.....	99
4.3.5	Livers.....	99
<b>4.4</b>	<b>Conclusion.....</b>	<b>103</b>



4.5	<b>Acknowledgement.....</b>	<b>105</b>
4.6	<b>References.....</b>	<b>106</b>
<b>CHAPTER 5:</b>	<b>SIGNIFICANCE OF THE STUDY, CONCLUSIONS AND</b>	
	<b>RECOMMENDATIONS.....</b>	<b>110</b>
5.1	<b>Introduction.....</b>	<b>110</b>
5.2	<b>Significance of the study.....</b>	<b>111</b>
5.2.1	Vitamin A content in fortified maize meal as purchased and in porridge as consumed in South Africa.....	111
5.2.2	Effect of different maize meal diets on the growth and vitamin A status of chickens.....	113
5.3	<b>Concluding remarks.....</b>	<b>114</b>
5.4	<b>Limitations of the study.....</b>	<b>116</b>
5.5	<b>Recommendations.....</b>	<b>117</b>
5.6	<b>References.....</b>	<b>120</b>

## LIST OF ACRONYMS AND ABBREVIATIONS

<b>AI</b>	Adequate Intake
<b>ANOVA</b>	Analysis of Variance
<b>AOAC</b>	Association of Analytical Chemists
<b>ARC</b>	Agricultural Research Council
<b>AUC</b>	Area Under the Curve
<b>BHT</b>	Butylated Hydroxytoluene
<b>CE</b>	Capillary Electrophoresis
<b>CEN</b>	European Committee for Standardisation
<b>CV</b>	Coefficient of Variation
<b>DALY</b>	Disability Life Year
<b>DM</b>	Dry Matter
<b>DRI</b>	Dietary Reference Intake
<b>EAR</b>	Estimated Average Requirement
<b>FAO</b>	Food and Agricultural Organisation
<b>FCR</b>	Feed Conversion Ratio
<b>FCS</b>	Food Control System
<b>FFP</b>	Food Fortification Program
<b>GC</b>	Gas Chromatograph
<b>HPLC</b>	High Performance Liquid Chromatograph
<b>ICN</b>	International Congress on Nutrition
<b>INP</b>	Integrated Nutrition Program
<b>IOM</b>	Institute of Medicine
<b>ISO</b>	International Standards Organisation
<b>IU</b>	International Units

<b>IVACG</b>	International Vitamin A Consultative Group
<b>LC</b>	Liquid Chromatography
<b>LLE</b>	Liquid Liquid Extraction
<b>LOD</b>	Limit of Detection
<b>MDGs</b>	Millennium Development Goals
<b>LOQ</b>	Limit of Quantification
<b>NFCS</b>	National Food Consumption Survey
<b>NFCS-FB</b>	National Food Consumption Survey Fortification Baseline Study
<b>NHLS</b>	National Health Laboratory Services
<b>PCA</b>	Principal Component Analysis
<b>PDA</b>	Photo Diode Array
<b>RAE</b>	Retinol Activity Equivalent
<b>RDA</b>	Recommended Dietary Allowance
<b>RE</b>	Retinol Activity
<b>RP</b>	Reverse Phase
<b>RSI</b>	Recommended Safe Intake
<b>SANAS</b>	South African National Accreditation Services
<b>SAVCG</b>	South African Vitamin A Consultative Group
<b>SD</b>	Standard Deviation
<b>SPE</b>	Solid Phase Extraction
<b>TRM</b>	Treatment
<b>UNICEF</b>	United Nations Children Fund
<b>UL</b>	Upper Limit
<b>VAD</b>	Vitamin A Deficiency
<b>WHO</b>	World Health Organisation

## LIST OF TABLES

<b>Table 2.1:</b>	Sensitivity of vitamin A compared to other vitamins.....	<b>17</b>
<b>Table 2.2:</b>	Commercially available forms of vitamin A, their characteristics and their main applications.....	<b>18</b>
<b>Table 2.3:</b>	FAO estimated mean requirement and safe level of intake for vitamin A.....	<b>23</b>
<b>Table 2.4:</b>	Dietary Reference Intakes (DRIs) for Vitamin A by life stage group.....	<b>24</b>
<b>Table 3.1:</b>	Limit of Detection (LOD), Limit of Quantification (LOQ) and Precision.....	<b>69</b>
<b>Table 3.2:</b>	Vitamin A content ( $\mu\text{gRE}/100\text{g}$ dry matter) of maize meal and maize porridge samples of seven different brands.....	<b>72</b>
<b>Table 3.3:</b>	Pearson Correlation matrix between retinol content and dry matter of the raw maize meal and retinol content and dry matter of the cooked maize porridge.....	<b>73</b>
<b>Table 3.4:</b>	Vitamin A content ( $\mu\text{gRE}/100\text{ g}$ ) of maize meal and maize porridge samples of seven different brands and the contribution towards the Recommended Daily Allowances (RDAs) and Recommended Safe Intake (RSI) for 1-9 year old children.....	<b>76</b>
<b>Table 4.1:</b>	Diet formulation for broiler starter and grower diets.....	<b>87</b>
<b>Table 4.2:</b>	Source of vitamin A per treatment.....	<b>87</b>
<b>Table 4.3:</b>	Comparison of the vitamin A concentration ( $\text{mg}/100\text{g}$ ) between the different treatments for the starter and grower diets.....	<b>91</b>





<b>Table 4.4:</b>	Comparison of the vitamin A concentration (mg/100g) over time for the starter and grower diets.....	<b>92</b>
<b>Table 4.5:</b>	Comparison of the vitamin A concentration (mg/100g) between the different treatments for the starter and grower diets over time.....	<b>93</b>
<b>Table 4.6:</b>	Cumulative Feed Intake for the chickens during a six week period on five different treatments.....	<b>94</b>
<b>Table 4.7:</b>	Body weight of the chickens during a six week period on five different treatments.....	<b>96</b>
<b>Table 4.8:</b>	Feed Conversion Ratio (FCR) for the chickens during a six week period on five different treatments.....	<b>98</b>
<b>Table 4.9:</b>	Percentage mortalities during the trail period at day 21 and 42.....	<b>99</b>
<b>Table 4.10:</b>	Average liver vitamin A (mg/100g) per week (comparing treatments within a week) of chickens on five different dietary treatments.....	<b>101</b>
<b>Table 4.11:</b>	Area under the curve (AUC) and relative absorption of vitamin A in chickens on five different diets over a six week period	<b>102</b>

## LIST OF FIGURES

<b>Figure 2.1:</b>	Chemical structures of different retinoids. All- <i>trans</i> -retinol is by definition vitamin A.....	<b>16</b>
<b>Figure 2.2:</b>	Prevalence of Vitamin A Deficiency in 6-71 month old children in South-Africa in 1994 as determined by the SAVACG study.....	<b>26</b>
<b>Figure 2.3:</b>	Disease burden (DALY's) in 2000 attributable to undernutrition and diet-related risks and physical inactivity.....	<b>27</b>
<b>Figure 2.4:</b>	Balance between the supply of nutrients and requirements.....	<b>29</b>
<b>Figure 2.5:</b>	Physical and chemical factors influencing the stability of nutrients....	<b>33</b>
<b>Figure 2.6:</b>	Sun-drying of hammer-milled maize meal in a rural village near Giyani.....	<b>37</b>
<b>Figure 2.7:</b>	Examples of maize meal packaging (25kg and 12,5kg in polyethylene bags and 1kg in a paper bag) as presented to consumers.....	<b>38</b>
<b>Figure 2.8:</b>	Examples of maize porridge cooked from white maize meal.....	<b>40</b>
<b>Figure 3.1:</b>	Different maize meal brands sampled during the study.....	<b>63</b>
<b>Figure 3.2:</b>	Mean vitamin A concentration ( $\mu\text{gRE}/100\text{g}$ ) of different brands of maize meal as purchased in supermarkets in the Tshwane-metropolis.....	<b>70</b>
<b>Figure 3.3:</b>	PCA Biplot of retinol and dry matter (DM) in maize meal (raw) and maize porridge (cooked).....	<b>74</b>
<b>Figure 4.1:</b>	Chickens feeding in the different pens during the feeding trial.....	<b>88</b>
<b>Figure 4.2:</b>	The treatment-diet effect from the starter diets to the grower diets....	<b>91</b>



<b>Figure 4.3:</b>	Means of body weight (grams) per week of broiler chickens on five different dietary treatments.....	<b>97</b>
<b>Figure 4.4:</b>	Means of liver weight (grams) per week of broiler chickens on five different dietary treatments.....	<b>100</b>
<b>Figure 4.5:</b>	Means of AUC per week of broiler chickens on five different dietary treatments.....	<b>102</b>



## LIST OF ADDENDA

<b>Addendum A:</b>	Nutrient content of South African white maize meal (unfortified)	<b>58</b>
<b>Addendum B:</b>	A list of brands of maize meal samples analysed in the study	<b>83</b>
<b>Addendum C:</b>	Proof of approval for the study from the Irene Animal Ethics Committee.....	<b>109</b>