



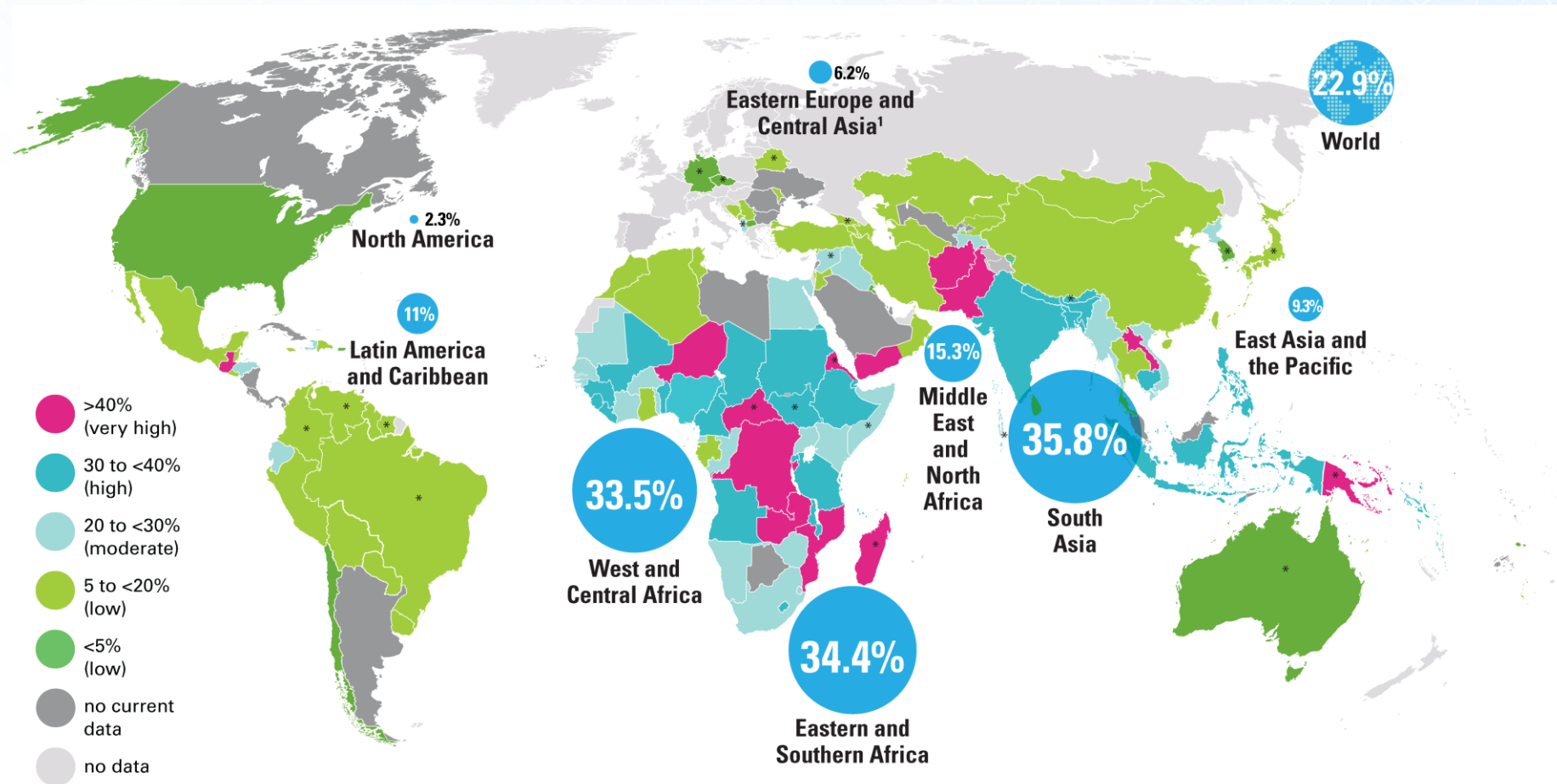
VARIABILITY IN IRON, ZINC AND PHYTIC ACID CONTENT IN A WORLDWIDE COLLECTION OF COMMERCIAL DURUM WHEAT

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Malnutrition

Those people do not have a sufficient amount of energy or fundamental nutrients and can not lead a healthy and active life

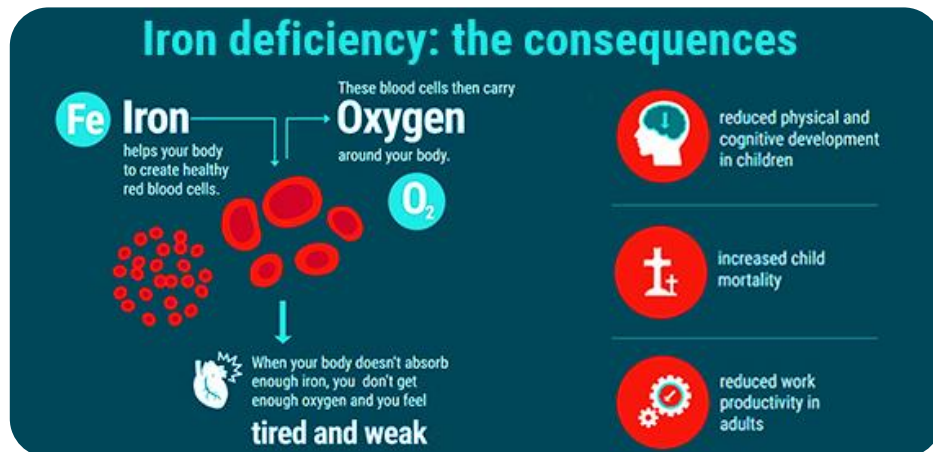
FAO. 2016.



Micronutrient Deficiencies:

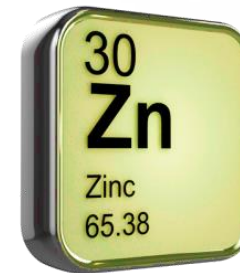


Low, medium, and high severity of the most common micronutrient deficiencies—vitamin A, iron, and zinc—among children under 5 prevalence data. Data from the WHO, image from HarvestPlus.



Approximately 2 billion people (30% world's population) are affected from micronutrient deficiencies (Hidden Hunger)

52% pregnant women
39% children under 5 years old





Biofortification of crops

enhancing micronutrient concentration in the edible part of the crops
by plant breeding,

*has been proposed as one of the most cost effective and environmentally safe
approaches to alleviate malnutrition*

In some developing countries is
one of the main sources of
calories and protein

Efforts have been focused



**is the main wheat species
cultivated
worldwide**

*particularly in
South Asian countries such as Bangladesh,
India and Pakistan
where Zn deficiency is a major problem.*

bulgur



pasta



injera



couscous



**Triticum turgidum L.
ssp. durum**

kitta

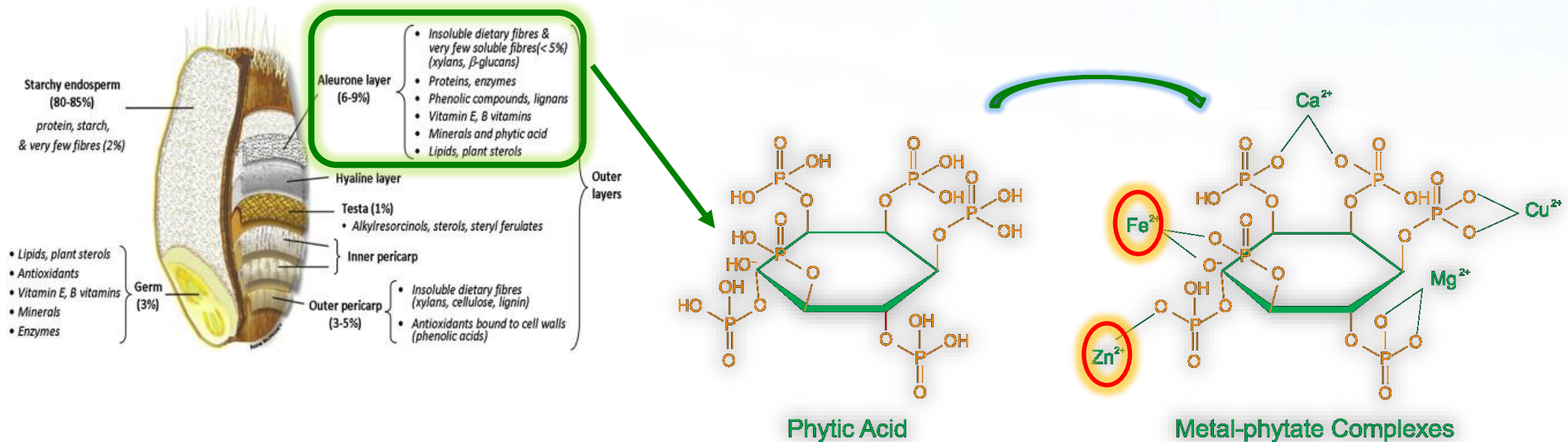


*CIMMYT works with HarvesPlus project to develop biofortified wheat
varieties with enhanced Fe and Zn concentration*



Disadvantage. Phytic Acid

Phytic acid (myoinositol-1,2,3,4,5,6-hexakisphosphate), as abundant in the aleurone layer as Fe and Zn, affects the bioavailability of minerals because of the possibility of strong chelation between the two ([Coudray et al., 2001](#)).



Chelates minerals forms insoluble salts which precludes their absorption in the gastrointestinal tract.

This study was undertaken with the following objectives:

- 1)** Describe the variability in grain of Fe, Zn and Phytic acid concentration in durum wheat cultivars
- 2)** Estimate the bioavailability of Zn and Fe in durum whole-meal flours
- 3)** Examine the environment effect on the nutritional quality traits

Plant materials, grain physical and micronutrients determination

46 durum wheat varieties (collection of durum wheat cultivars with worldwide commercial importance)

All genotypes were grown in Ciudad Obregón Sonora. 2014-2015 cropping season

Two environments:

- full irrigation (>500 mm)
- reduced irrigation (<300 mm)

Non-destructive energy-dispersive x-ray fluorescence spectrometry instrument (EDXRF)

- Grain Iron (mg/Kg)
- Grain Zinc (mg/Kg)



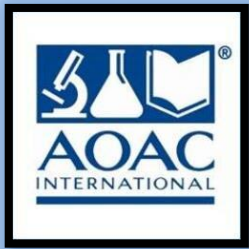
Grain physical parameters

- Test weight (Kg/hL)
- Thousand kernel weight (g)
- Grain protein content (12.5% moisture basis)



Phytic Acid Determination

In breeding programs, the analysis of a large number of samples has to be done in the shortest time possible with the lowest costs.



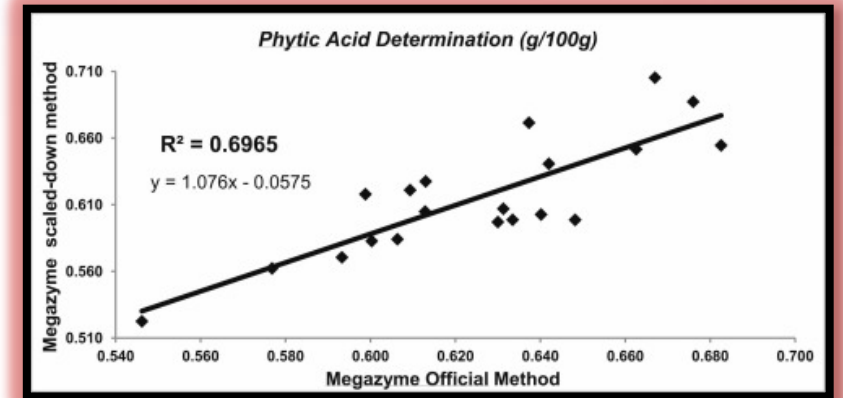
AOAC Official Method of analysis 17th ed. 32, 57-58



24h / **15 samples** / duplicated
Cost: 6.9 dollar



24h / **25 samples** / duplicated
Cost: 1.4 dollar



A.M. Magallanes-Lopez et al.
Food Chemistry 237 (2017) 499-505

RESULTS

Comparison between traits means and ranges for full irrigation and reduced irrigation environments

	Full Irrigation		Reduced Irrigation	
	Mean	Range	Mean	Range
Grain Yield (t/ha)	5.1	2.8-6.1	2.6	1.1-3.2
TW (kg/hL)	81.6	74.5-84.0	82.2	78.9-84.4
TKW (g)	45.2	31.6-57.7	44.3	34.1-53.3
GPRO (%)	13.0	11.3-15.8	14.2	12.8-18.2
FeC (mg/kg)	31.3	25.7-39.1	33.6	30.2-40.5
ZnC (mg/kg)	37.2	31.8-48.8	30.9	24.8-44.7
Phytic Acid (%)	0.747	0.654-0.945	0.604	0.483-0.919

PEARSON CORRELATION

	Grain Yield	TW	TKW	GPRO	FeC	ZnC
Full Irrigation						
Grain Yield	1					
TW	0.58**	1				
TKW	0.24*	0.46**	1			
GPRO	-0.39**	-0.47**	0.05	1		
FeC	0.17	0.11	0.47**	0.29**	1	
ZnC	-0.29**	-0.41**	0.10	0.67**	0.35**	1
Phytic Acid	-0.55**	-0.62**	-0.10	0.73**	0.09	0.71**
Reduced Irrigation						
Grain Yield	1					
TW	0.46**	1				
TKW	0.20	0.25*	1			
GPRO	-0.60**	-0.49**	-0.03	1		
FeC	-0.34**	0.14	0.17	0.65**	1	
ZnC	-0.52**	-0.41**	-0.03	0.73**	0.62**	1
Phytic Acid	-0.39**	-0.38**	0.0	0.80**	0.64**	0.77**

Molar Ratio.

In fact, phytic acid:micronutrients molar ratios are used to estimate the potential bioavailability of the micronutrients.

	Full Irrigation		Reduced Irrigation	
	Mean	Range	Mean	Range
Phy:Fe	20.4	16.3-29.6	15.2	12.1-20.4
Phy:Zn	20.2	17.4-23.6	19.2	16.9-22.1

*The literature about durum wheat grain
Phy:Fe is scarce or nonexistent*

For Phy:Fe, the molar ratio should be <1 or preferably <0.4 to significantly improve Fe absorption (Hurrell & Egli, 2010).

For Phy:Zn there is more information available

Phy:Zn molar ratios <5, between 5 and 15 and >15 have been associated with high, moderate and low zinc bioavailability, corresponding to approximately 50%, 30% and 15% of total zinc, respectively (Gibson, 2006).

Conclusions

- The concentration of micronutrients and the molar ratios revealed are not adequate to meet the daily requirements of humans in countries where durum wheat represents the main source of calories.
- This study revealed more information which will be useful for devising an appropriate durum wheat breeding strategy focused in nutritional quality.
- Due to the impact and the need that exists in the bioavailability of micronutrients, it is necessary:
 - continue working on the proposal of more sensitive and reliable methodologies
 - decrease the amount of phytic acid

[illegible]