Retention of zinc in biofortified rice and maize during processing and cooking

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Introduction

Biofortification is considered a complementary strategy to reduce micronutrient deficiencies in low- and middle -income countries. Rice and maize are two stable crops commonly consumed in Latin America where zinc deficiency is common and biofortified rice and maize could potentially assist in reducing these deficiencies. Improved biofortified varieties contain higher levels of zinc, but not much is known about the effect on zinc retention or on phytate reduction when using these crops in common recipes. Also the biofortified maize contains a better protein profile with higher concentrations of tryptophan and lysine, which could be influenced during processing.

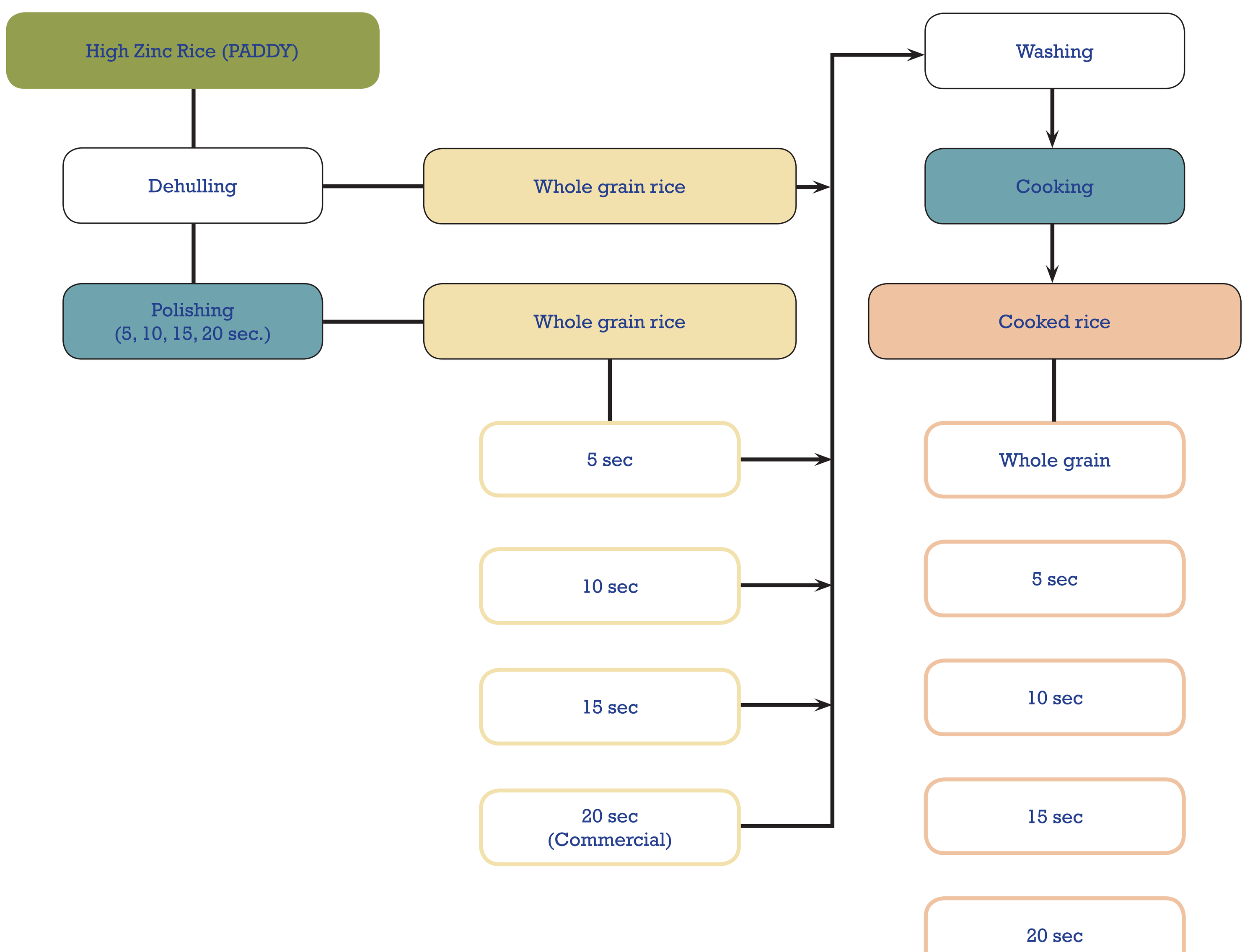

Figure 1. Flowchart of the preparation of rice.

Methods

An advanced breeding line of upland rice was selected for its high zinc concentration and was grown at CIAT, Colombia in 2014. This whole grain rice was polished for 0, 5, 10, 15 and 20 seconds after which the rice was cooked, to study the effects of polishing on zinc and phytate concentration (see figure 1 for the process).

An advanced hybrid breeding line of maize was selected for its high zinc concentration and grown at CYMMIT, Mexico in 2014 and as a control maize regular maize was bought in Colombia. These 2 types of maize were used to prepare two types of tortillas (with and without nixtamalization) and also a toasted flour was prepared (see figure 2 for the process) that is used to make a drink called "pinol". Nixtamalization is commonly used in Central-America and is the process of cooking the maize in an alkaline solution to increase the softness of the maize for later preparation.

All utensils and cooking equipment was acid washed before preparation, as well as ultra-pure water was used to avoid any contamination with external zinc.

Zinc (by ICPMS), tryptophan and lysine were measured at CYMMIT Mexico for maize. For rice, zinc concentration (by ICPMS) and phytates (by LC) were measured at Flinders University in Australia. All analyses were measured in duplicate.

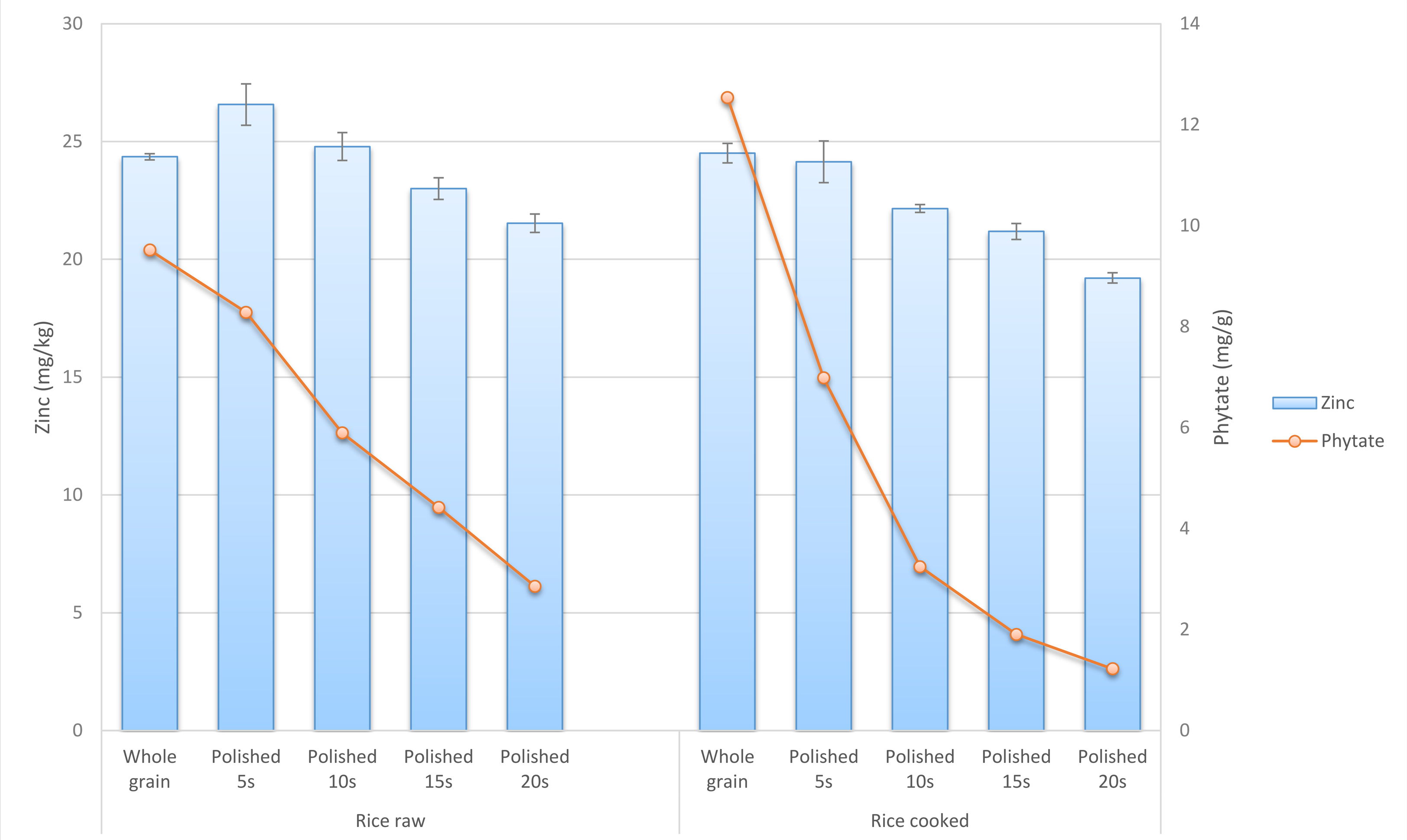

Figure 3. Concentration of zinc and phytates during processing of rice (in dry weight)

Objective

We studied the effect of polishing and cooking on zinc and phytate concentration in high zinc rice and the effect of preparing common recipes on zinc and tryptophan and lysine concentration in high zinc maize.

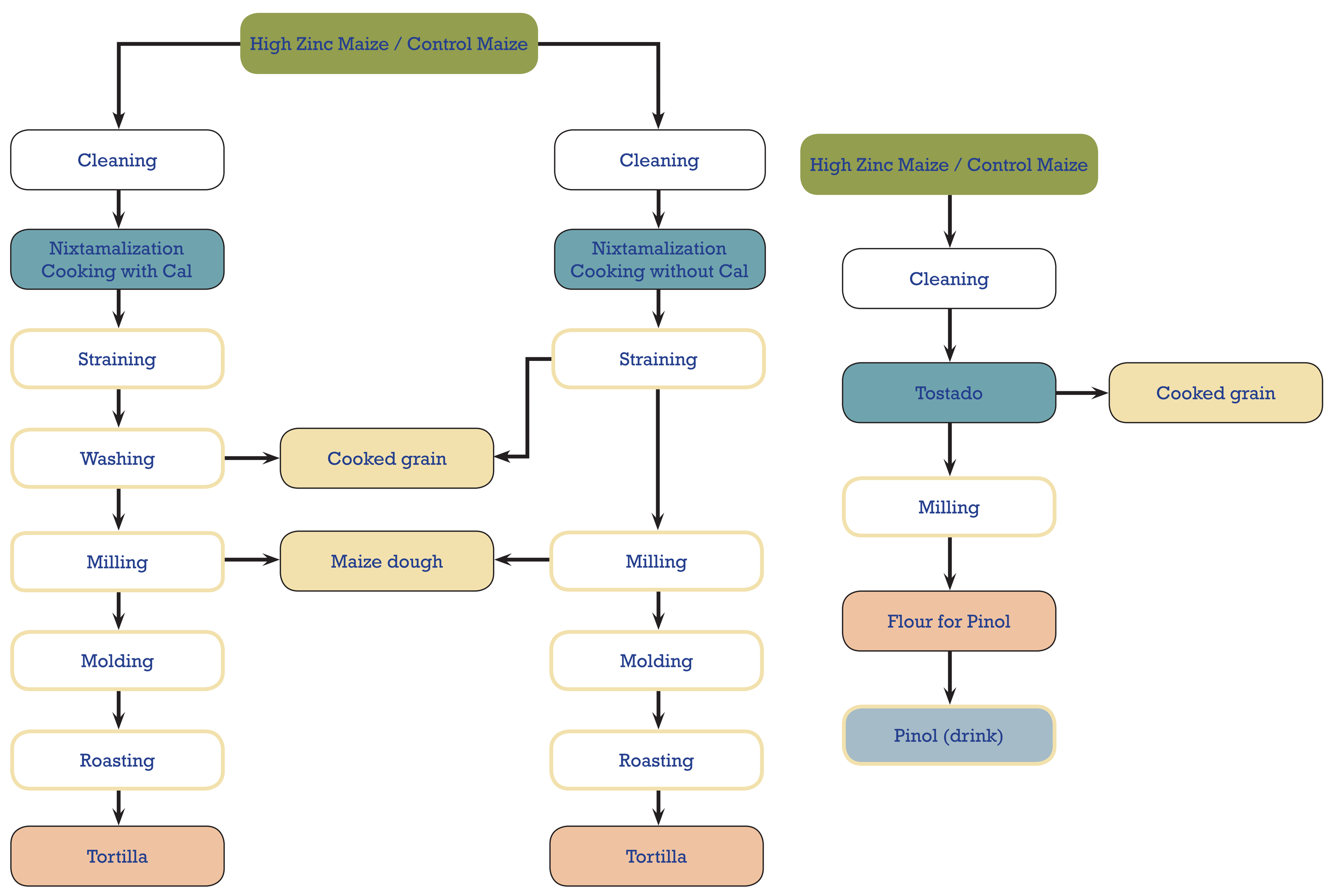

Figure 2. Flowchart of the preparation of maize.

Results

Zinc concentration in rice was 24 mg/kg (sd 0.13) in whole grain rice and reduced linearly with milling time to 22 mg/kg (sd 0.39) after 20s polishing and to 19 mg/kg (sd 0.22) after cooking (retention 79%). Phytate concentration reduced from 9.5 mg/g (sd=1.3) in whole grain rice to 2.9 mg/g (sd=0.1) after 20s polishing and to 1.2 mg/g (sd=0.1) after cooking (13% retention). See figure 3 for the results on rice.

Zinc concentration in biofortified maize was 36 mg/kg in uncooked maize and 14 mg/kg in conventional maize. Processing into tortilla or toasted flour did not reduce zinc concentration and nixtamalization added 2 mg of zinc. See figure 4 for the results on maize.

Conclusions

Foods made of biofortified rice and maize have high zinc retention and therefore have the potential to reduce zinc deficiency in humans.

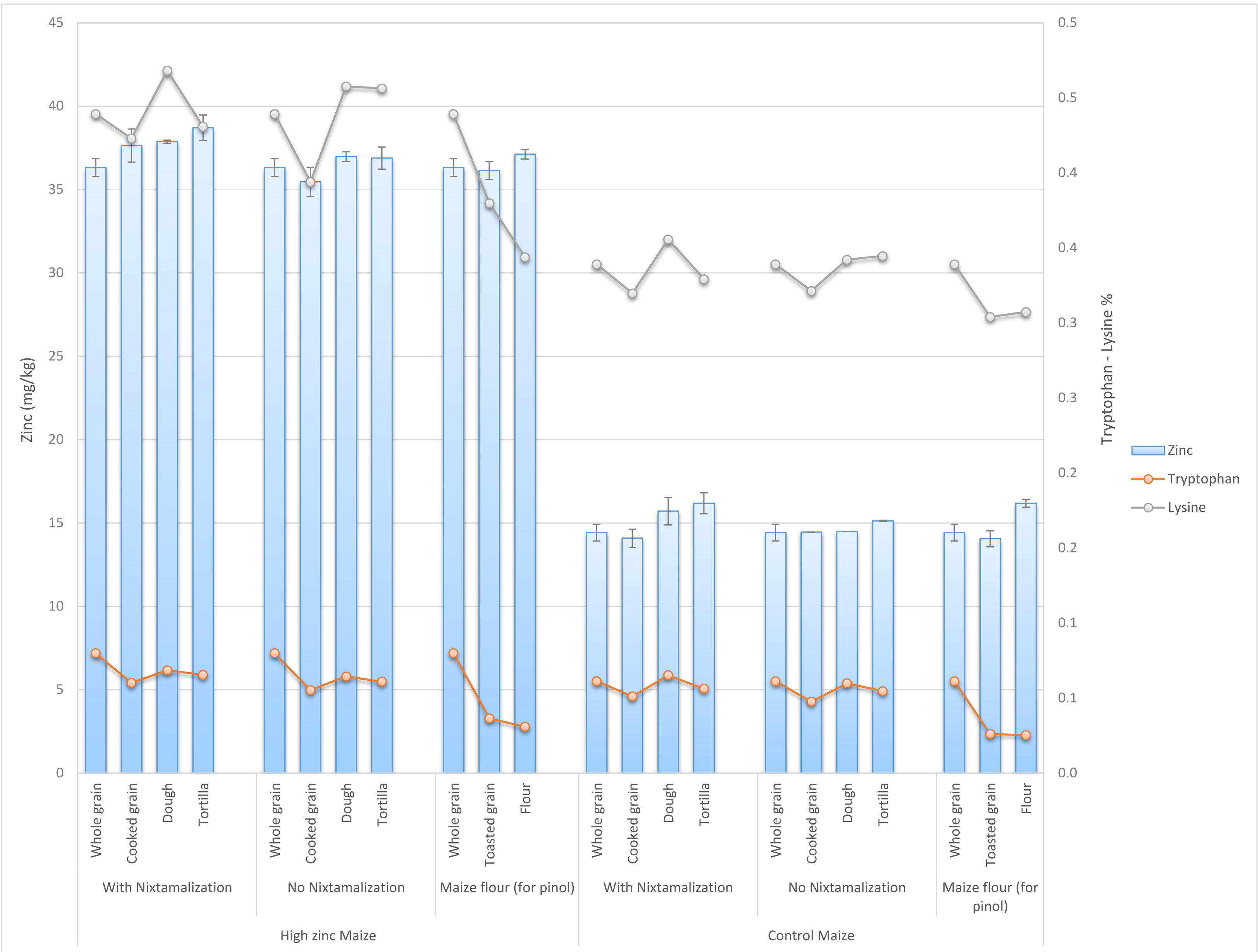

Figure 4. Concentration of zinc, tryptophan and lysine during processing of maize (in dry weight)

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