INFLUENCE OF CEREAL BLENDS ON THE FERMENTATION KINETICS AND IRON AND ZINC BIOAVAILABILITY OF INJERA, A STAPLE IN ETHIOPIA

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Introduction. Complementary foods in developing countries are predominantly cereal based. Such complementary foods are associated with low iron and zinc bioavailability(1) because of their high content in chelating agents like phytates and polyphenols. However, fermentation of cereals may activate several enzymes like phytases, and thus can influence mineral bioavailability (2). The extent to which such enzymes are activated depends on the fermentation kinetics, which in turn, depends on the raw materials used (3). The staple in Ethiopia is injera, a traditional fermented pancake.

The objectives of this study were to: identify and characterize the most frequently consumed foods by young children in North Wollo, Ethiopia; determine the potential of injera fermentation in the degradation of phytates; and evaluate the effect of degrading phytates, polyphenols and fibers on the bioavailability/bioaccessibility of iron and zinc.

Methods. The food consumption of 76 young children (12-23 months) was evaluated using two 24h recalls conducted in two agro-ecologically distinct villages in the highlands (3500 m) and lowlands (1500 m) of Gobalafto district, North Wollo, Ethiopia (4). Household preparations of the most frequently consumed foods were observed and samples were collected from households for the analyses of minerals (Fe, Zn and Ca), phytates (IP6), fibers, and polyphenols. Phytase activity of raw cereals and injera flour blends were measured (5). Fermented pastes were analyzed for mono- and di-saccharides, lactate, acetate, ethanol and mannitol (5). In-vitro digestions were performed on untreated, fermented-cooked and enzyme treated injera flours. The relative weight of IP6, fibers, and polyphenols, in determining iron bioaccessibility was evaluated by using exogenous phytase, xylanase+cellulase and polyphenol oxidases.

Results. The most frequently consumed food was injera. Injera was mostly made from barley-wheat (BW) and wheat-red sorghum (WrS) blends in the highlands and from teff-white sorghum (TwS) blend in the lowlands. Despite similar processing, the difference in cereal blends influenced the fermentation kinetics and IP6 hydrolysis. Sourdough fermentations of WrS- and BW-injeras showed a two-step fermentation with lactic acid and alcoholic fermentation, while equimolar concentrations of lactic acid and ethanol were produced simultaneously in TwS-injera. WrS- and BW- injera fermentations resulted in complete IP6 degradation whereas only 28% IP6 degradations were observed in TwS injera (Fig. 1). Despite complete IP6 degradations, iron bioaccessibility and algorithm predicted absorption was not improved. The use of exogenous enzymes to hydrolyse fibers or oxidize polyphenols after dephytinization of flours resulted in significant increase in iron bioaccessibility ($P<0.05$).

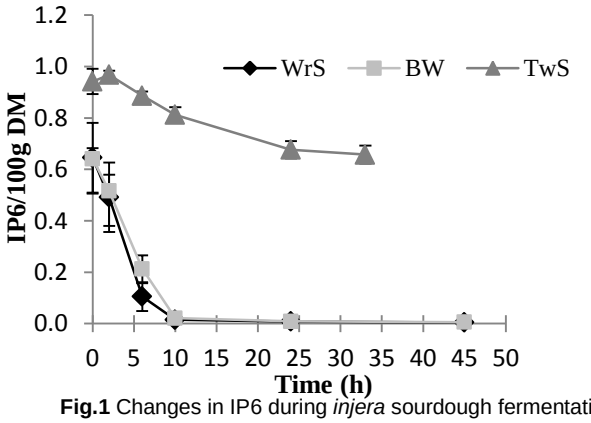

Fig.1 Changes in IP6 during *injera* sourdough fermentation
TwS: teff-white sorghum; WrS: wheat-red sorghum; BW: barley-wheat; Error bars represent the standard deviation of means

Conclusions. The cereal blends used for injera preparation, mainly determined by agro-ecological conditions, influenced the fermentation kinetics and IP6 hydrolysis. In injera, dephytinization alone did not increase iron bioaccessibility. However, dephytinization coupled with hydrolysis of fibers or oxidation of polyphenols led to greater iron bioaccessibility.

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