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Effect of agronomically biofortified zinc flour on zinc and selenium status in resource poor settings; a randomised control trial

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Zinc deficiency affects around 17 % people globally and over 40 % of the Pakistani population. Strategies, including dietary supplementation and fortification at the food processing stage have been applied to address this issue, however there are limitations of accessibility and affordability for low-income and vulnerable people. An alternative approach is to intervene at agricultural production stage through biofortification to achieve greater concentrations of bioavailable vitamins or elements in the edible portion of crops[1]. Biofortification can be realized through crop breeding and/or application of element-enriched fertilisers, known as "agronomic biofortification", which is particularly important in Pakistan where soil zinc content is low. The aim of this randomised control parallel-group pilot trial was to examine the impact of consuming flour made from selectively bred and agronomically biofortified wheat grain (zincol/NR-421, HarvestPlus) on zinc and selenium status using plasma zinc and selenium concentrations as biomarkers of status.

Male (n = 10) and female (n = 10) participants from 10 families living in a resource poor community were randomized into control (n = 10) and intervention arm (n = 10) based on whether the participants were provided with flour made from zincol/NR-421 wheat (35 ppm Zn) or locally available control wheat (25 ppm Zn) for a period of 4 weeks. Plasma zinc and selenium concentration (Jobin-Yvon JY-24 Atomic Emission Spectrophotometer; ICA, Middlesex, UK), haemoglobin, haematocrit (HCT), mean corpuscular volume (Abbott® Cell-Dyn Emerald haemotology analyzer), and 24-hour dietary recall (Windiet 2005 software) were measured before and after the intervention.

Plasma zinc levels increased from a mean (SD) value of 681·3(100·9) µg/L at baseline to 793·9(103·9) µg/L in the intervention group in contrast to the control group (pre-intervention; 821·4(165·6) µg/L to post-intervention; 684·1(130·6) µg/L). Intervention with zincol-NR/421 resulted in a significantly higher mean change in plasma zinc (ΔZn) ($p = 0{\cdot}023$) which was significantly associated with BMI (R^2% 50·67 %, $p = 0{\cdot}048$) and plasma HCT (R^2% 60·34 %, $p = 0{\cdot}023$) only in the intervention group. Among haematological parameters, HCT was significantly higher in males compared to females in control ($p = 0{\cdot}009$) and intervention ($p = 0{\cdot}002$) groups before intervention. Similarly, mean plasma selenium concentrations showed a higher increase in the intervention arm compared to the control arm at the end of the intervention (89·98(9·21) µg/L vs. 103·95(13·21) µg/L, $p = 0{\cdot}021$, 2 sample t-test). Change in plasma selenium (ΔSe) in the two groups was not significantly different ($p = 0{\cdot}321$). However, ΔSe was significantly associated with height (R^2% 70·29 %, $p = 0{\cdot}009$), BMI (R^2% 55·05 %, $p = 0{\cdot}035$) and plasma HCT (R^2% 53·23 %, $p = 0{\cdot}040$) only in the intervention group. ΔZn was significantly associated with post-intervention total caloric intake, proteins (g), carbohydrate (g), and dietary fibre intake (g) only in the intervention group. In conclusion, crop breeding coupled with agronomic biofortification of wheat with zinc may be an effective way to address zinc deficiency in resource poor settings with beneficial effects on plasma Selenium.

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1. Olsen LI and Palmgren MG (2014) *Frontiers in PLand Sci* **5**, 1–6.