BIOFORTIFICATION AND HUMAN HEALTH

Scientefic Review

N. S. Ali
Prof.
shawqiali@yahoo.com
College of Agric. – University Of Baghdad

ABSTRACT

Micronutrients deficiency can be consider as one of the yield "quantity and quality" limiting factor in arid calcareous lands and can be consider as the troubling component of hunger. Therefore, enriching food product through adding nutrient to food product or through increasing soil fertility and breeding crop for nutrient efficiency are alternatives available to improve food quality. However, poor people have no excess to food additives and can benefits from naturally enriched food products or what being called biofortification. The undergoing short review would discuss these concepts and their implementation and uses in Iraq.

Key words: Biofortification, Food enrichments', Food additives, Iron efficient plants.

مجلة العلوم الزراعية العراقية – 47: (عدد خاص): 144-147 /2016 علي

ألإغناء الحيوي وصحة الإنسان

مقالــــة مرجعيـــة

نورالدين شوقي علي
استاذ
shawqiali@yahoo.com
كلية الزراعة – جامعة بغداد

المستخلص

نقص المغذيات الصغرى يمكن عده احد عوامل النمو المحددة للإنتاج كماً ونوعاً في الاراضي الكلسية الجافة ويمكن ان يعد احد المكونات المزعجة للمجاعة. لذا إغناء المنتجات الغذائية بالمغذيات الصغرى صناعياً(كمواد مضافة) او بشكل طبيعي من خلال زيادة خصوبة التربة وتربية النباتات الكفوءة بهذه المغذيات تعد من البدائل لتحسين نوعية الغذاء. ومع هذا فإن الفقراء ليس لديهم المقدرة في الحصول على المنتجات الجاهزة الغنية بالمغذيات ولكن يمكنهم الاستفادة من المنتجات الغنية بشكل طبيعي او ما يطلق عليها بالأغذية الغنية حيوياً بشكل طبيعي. ولذا المراجعة القصيرة الحالية يناقش هذه المفاهيم ومدى استعمالها في العراق.

الكلمات المفتاحية: الإغناء الحيوي، إغناء الاغذية، مضافات الأطعمة، النباتات الكفوءة بالحديد.

Biofortification

In a modern world where the West is afflicted by the diseases of excess nutrition, much of the rest of the globe suffers at the hands of hunger. It ranks as the world's top health risk, taking the lives of more people annually than the combined effects of AIDs, malaria, and tuberculosis (15).A troubling component of hunger is micronutrient deficiency called "hidden hunger it stems from the lack of essential dietary vitamins and minerals such as iron, zinc, iodine, and vitamin A, causing a variety of diseases and other illness such as blindness, brain damage, and death (20). So the issue of having good quality foods (in terms of essential nutrients) is important as the importance of feeding hungry peoples (what the green revolution aimed to). Traditionally agronomist in general was looking mainly on productivity or yield per unit of area while nutritionist interests on nutritive value. Therefore we should be looking and tackling both issues all together at once and this it is what being termed or called "bio-enrichment" or "biofortification". Therefore, agricultural scientists and others who worked at the same field (plant breeders and plant nutritionists) ought to selectively breed crop plants that would be significantly higher in micronutrients than their predecessors, without negatively affecting crop yield. Most likely when someone apply zinc or iron to soil or plant or breed for more efficient plants uptake of these micronutrients in a goal to increase crop content of such crop, yield would be improved as well. Therefore, some researchers consider biofortification as "Marriage of Nutrition and Agriculture". The conclusion made by Morgan's, (15) is that: the success in controlling world hunger and decrease death percent will depend, in part, on holistic solutions such as biofortification". Biofortification can be defined as the naturally enrichment of crop with essential micronutrients mainly through breeding crops to increase their nutritional value. It involves the identification of varieties of a crop that naturally contain high densities of certain micronutrients or having the high ability to absorb nutrient (i.e. iron efficient plants). Plant breeders use these varieties to develop new, productive and biofortified crop lines for farmers to grow for consuming and marketing. The word Biofortification (natural enrichment) differs from ordinary fortification which means "the process of adding micronutrients (essential trace elements and vitamins) to food (artificial enrichment). Biofortification make plant food (eaten or edible parts) naturally more nutritious as the plants are growing without adding food additives when they are being processed (17). The biofortified food products will be more accessible to rural poor peoples, who rarely have access to commercially fortified foods (21). As such, biofortification is seen as an upcoming strategy for dealing with deficiencies of micronutrients in the developing world. Micronutrient fortification and biofortification are both food-based approaches, but the interventions are at very different stages: micronutrient fortification has been used with great success for decades (particularly in fortifying salt with iodine), while very few biofortified crops have been released. In the case of iron, WHO estimated that biofortification could help curing the 2 billion people suffering from iron deficiency-induced anemia (11). Biofortification represents one promising strategy to enhance the availability of vitamins and minerals for people whose diets are dominated by micronutrient-poor staple food crops.

The Human Need for Micronutrients

A healthy diet is considered to be one that satisfies human needs for energy and all essential nutrients, but such diet is unavailable for poor populations. Roughly one third of the world's population suffers from shortage in vitamins (particularly A and C) and minerals (zinc, iodine and iron), which result in health deterioration (12 and 15). Iron deficiency affects mental ability; it interferes with normal brain development and learning and in pregnant women is associated with increased risks in childbirth, causing more than 20 percent of maternal deaths in Asia and sub-Saharan Africa and more than 20 percent of the deaths in the first week of life (12, 20). Micronutrient deficiencies in particular affect poor rural populations in low and middle income countries. A familiar example of micronutrient deficiency is in a family who can only afford to eat cheap rice, but not the fruit, vegetables and meat that would provide a balanced diet. When people lack vital micronutrients, they can become weak, sick, and even die.

Biofortification issues in Iraq

Iron and Zinc as micronutrients holds very important role in the production of many crops especially in calcareous Iraqi soils (1, 8, and 9). However, studies on micronutrient still not as much as macronutrients and in particular N, P, and K. Besides, most of the conducted studies concentrated either on the chemical behavior of micronutrient in soil to understand the low availability and sometimes some attempts tried to increase their availability. Agronomists and horticulturists concentrated on the responses of crops (field crops or vegetables) and trees to application of micronutrients direct to soil or through foliar application (spraying on leaves) and of course looking for yield increment. The concept of biofortification never has been use except for the research in which going to be mentioned in this short review. Although and as mentioned above the main method of biofortification can be achieved through selection and breeding, biofortification can be done through increasing of iron availability in soil which can be considered as economic and sustainable management to cope with iron shortage in diet (22) or through selecting a more efficient genotype for iron together with some proper management (e. g. Biofertilizer application alone or with proper nitrogen source) to increase soil iron availability and iron uptake (6) or increase Zn availability through applying chelated source(e.g. Zn-DTPA of micronutrient) (2 and 8). Microorganisms found on the rhizosphere or applied through inoculation can have good role in improving iron availability and iron uptake (4 and 10).Crop plants differ in their ability to absorb iron and on their strategies for uptake and iron efficient plants can grow well even in soils with low available iron (4). The use of biofertilizers increased in the last decades due to the increase awareness in environment. Results of Ali *et al*., (6) from an experiment conducted during the autumn 2013 season on clay soil to study nitrogen and iron availability in soil and their uptake by two genotypes of maize (*Zea mays* L.) (Shahed and Fajer) plants (Chosen from another pre- trial with four genotypes, two levels of Fe-EDDHA and two sources of nitrogen (13)) as affected by mineral (0,100, and 200 kg N ha^{-1}) and bio nitrogen fertilizer (two rates of nitrogen biofertilizer (PGPB) (*Azotobacter chroococcum* and *Azosprillium brasiliensis*) (0, and 1kg bio to 50 Kg seeds) application, indicated that, biofertilization with 200 kg N ha^{-1} gave the best results in grain yield with high iron content. These results mainly due to the effect of N fertilizer and biofertilizer in decreasing soil pH, increasing Fe availability and then increasing Fe content in grains .Genotypes also had different contributions in this matter with some promising genotypes. The treatment of biofertilizer + 200 kg N ha^{-1} had an increment of 100% in Fe content in maize plants compared to unfertilized treatment(13). As related to Zinc, Ali and Al-Ameri (8) results from a field trial indicated that Zinc application as Zn-DTPA (10 kg Zn ha^{-1}) increased grain yield from 6.93 to 9.50 Mg ha^{-1} with an increment of 37.1%. Applying micronutrients in most cases affected by sorption-precipitation reactions in calcareous soils, therefore its availability decline within short time (2, 5, and 14). However, Chelated fertilizers such as Zn-DTPA can improve this bioavailability of Zn, and in turn contributes to the productivity and profitability of commercial crop production (5,8 and 9) especially with Iraqi soils which can be consider as among soils with low Zn availability and most crops especially cereals show Zn deficiency(18 and 19) . Applying Zn-DTPA (10 kg Zn ha^{-1}) increased Zn content in maize grains by 210% compared to control (0 kg Zn ha^{-1}) (2). This signifies the importance of Zn biofortification which is very important for human health.

REFERENCES

1. Al-Abidi, J. S. 1989.The status of trace elements of Iraqi soils. Abstracts of micronutrients workshop. Cairo 16/12/1989.

2. Al-Ameri, B. H. A.2013. Behavior, Availability and FUE of Zn-DTPA and Boric Acid in Soil and Their Effect on Maize Productivity. PhD Dissertation, College of Agriculture, University of Baghdad.

3. Al-Ameri, B. H. A., N. S. Ali and A. H. Afaj. 2014. Sorption of Zn and B on

calcareous alluvial soil from the middle of Iraq. Iraqi J. of Science and Technology, 5(1):52-59.
4. Alamiri, A. A.2011. Effect of Iron, Zinc and Bicarbonate on Growth and Yield of Wheat Varieties as Related to Some Enzymic Antioxidants. PhD Dissertation, College of Agriculture, University of Baghdad.
5. Al-Hadethi, A. A.; G. Alqwaz; and R. S. Abbas. 2008 .Effect of zinc fertilization on yield component of two wheat cultivars. Al-Anbar J. of Agric. Sci.6 (1):20-28.
6.Ali, N. S, W. F. Hassan and F. O. Janno. 2015. Soil iron and nitrogen availability and their uptake by maize plants as related to mineral and bio nitrogen fertilizers application. Agric. Biol. J. N. Am., 6(5): 118-122.
7. Ali, N. S.; J. K. Al-uqali and B. H. Al-Ameri. 2002.Solubility and precipitation of some zinc fertilizer in calcareous soils. Basra Journal of Agricultural Sciences 15(2):-127-138.2002.
8. Ali, N. S. and B. H. A. Al-Ameri .2015. Agronomic efficiency of Zn-DTPA and Boric acid fertilizers applied to calcareous Iraqi soil. The Iraqi J. of Agric. Sci. 46(6):1117-1122.
9. Ali, N. S.; J. K. Al-Uqali and B. H. Al-Ameri. 2001.Efficiency of some zinc fertilizer in some calcareous soils. Iraqi J. of Agric. Sciences .32:197-206.
10. Al-Obaidi, Z. H. H. 2013. Effect of Salicylic Acid and PGPB on Enzymic and Non Enzymic Antioxidant and Growth and Yield of Maize Grown Under NaCl Stress. PhD Dissertation, College of Agriculture, University of Baghdad.
11. De Benoist, McLean, Egli, Cogswell 2008. Worldwide prevalence of anemia 1993–2005 (PDF). WHO Library Cataloguing-in-Publication Data. ISBN 978 92 4 159665 7.
12. Haddad L., E. Achadi, M. Bendech, A. Ahuja, K. B. Zulfiqar .M. Blossner, E. Borghi, E. Colecraft, M. de Onis, K. Eriksen, J. Fanzo, R. Flores-Ayala, P. Fracassi, E. Kimani-Murage,E. Koukoubou, J. Krasevec, H. Newby, R. Nugent, S. Oenema, Y. Martin-Prevel, J.R. Je. Requejo, T. Shyam, E. Udomkesmalee, and K S. Reddy. 2015. The global nutrition report 2014: Actions and accountability to accelerate the worlds progress on nutrition. The Journal of Nutrition: 1-9. American Soc. Nutrition.
13. Hassan, W. F. 2015. The effect of Mineral and Bio Nitrogen Fertilizers Application on Iron Availability for Maize Genotypes. PhD Dissertation, College of Agriculture, University of Baghdad.
14. Lindsay, W. L. 1991. Inorganic Equilibria Affecting Micronutrients in Soil. In Micronutrients in Agriculture. 2nd edition. J.J. Mortvedt, F.R. Cox L.M. Shuman and R.M. Welch. pp. 89-112. Soil Soc. Amer. Book Series No. 4. Madison, Wisconsin, USA.
15. Morgan, J. 2013. Biofortification lasting solutions to micronutrient malnutrition and world hunger. CSA News January 2013:4-9.
16. Rachel Kyte.2015. Getting Nutritious Foods to People .The Second Global Conference on Biofortification. March 2014 POLICY BRIEF No. 1 |February 2015.
17.Rebecca Bailey, ‘Biofortifying’ one of the world's primary foods, Retrieved on July 22, 2008.
18. Sillanpaa, M. 1982. Micronutrients and the Nutrient Status of Soils: A Global Study, FAO Soils Bulletin No. 48, FAO, Rome.
19. Sillanpaa, M. 1990. Micronutrient Assessment at Country Level: An International Study. FAO Soils Bulletin No. 63, FAO, Rome.
20.WHO. 2007. Micronutrients deficiency, iron deficiency anemia. Geneva, WHO.
21. Yassir Islam, 2007. Growing goodness. *Developments*, 38: 36-37.
22. Zuo, Y. and F. Zhang. 2001. Soil and crop management strategies to prevent iron deficiency in crops. Plant and Soil.339:83-95.