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Could Bio-Fortification of Vegetables with Iodine Represent a Tool to Boost the Immune System? A Pilot Study on Human Health †

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Abstract: Nutrition is a major contributing factor for immunocompetence. Biofortification is a feasible strategy from the environmental and to the economical point of view. It is considering the perfect strategy to combat human mineral malnourishment. Biofortified foods can be efficiently assimilated by humans. However, relevant information on the effect of the implemented diet with biofortified leafy vegetables on haematological and chemical parameters are scarce. Vegetables are particularly rich sources of micronutrients and phytochemicals such as polyphenols and vitamins. Lettuce is considered to be a frequently consumed salad vegetable that is rich in phytonutrients. The concentration of bioactive compounds and antioxidant activity in lettuce may depend on variation and species, but they may vary within the same species. Therefore, the aim of the study was to assess the effects of biofortified lettuce with iodine on haematological parameters and in general on whole body homeostasis and specifically on iodine, glucose, lipid, hepatic, iron metabolism. A cohort of ten people was supplemented with curly endive leaf biofortified for 12 days. Blood samples were obtained at baseline (T0) and after 12 days (T2) of supplementation with curly endive leaf and were analyzed for hematochemical parameters. The results showed that curly endive biofortification improved the whole body homeostasis in healthy people. The measurement, after the consumption for 12 days with iodine biofortified curly endive crops, revealed an increase in Iodine concentration in urine samples, increase in vitamin D, calcium and Potassium concentration in blood samples. The intake of bio-fortified lettuce did not alter the blood-chemical parameters and increased vitamin D suggesting that biofortification with iodine could have an immunomodulatory function.

Keywords: immune system; vitamin D; bone remodeling; iodine; lettuce; biofortification; malnourishment; vegetables

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1. Introduction

Biofortification is the process by which food crops are grown to improve their nutritional value without changing their energy content [1]. If the diet of an individual is varied and balanced, the need for minerals is automatically met and it is therefore not necessary to enrich or fortify foods. For some (Calcium, Iron, Iodine), however, one can easily encounter deficiency syndromes, with well-defined manifestations, especially in certain physiological conditions, such as pregnancy and lactation. Several food assistance programs are in place in the World Food Program (WFP) to overcome nutritional deficiencies

and provide health benefits with nominal risk. For example, salt iodization (iodine fortification) has been successfully achieved to reduce the incidence of goiter [2]. The concentration of bioactive compounds and antioxidant activity in lettuce may depend on variation and species, but they may vary within the same species [3]. Therefore, the aim of the study was to assess the effects of biofortified lettuce with iodine on haematological parameters and in general on whole body homeostasis and specifically on iodine, glucose, lipid, hepatic, iron metabolism.

2. Methods

Twenty clinically healthy people between the ages of 18 and 60 were recruited for the study. Participants had a BMI between 18.5 and 28. People with chronic illnesses, pregnant or breastfeeding women, and those using drugs, vitamins and dietary supplements were excluded from the study.

People who met the inclusion criteria were enrolled and the subjects were randomized into two different groups: a first group of ten people received biofortified curly endive for 12 days, and a second group of ten people that ate a control lettuce of the same species without any supplementation.

Participants were asked not to change their eating habits and lifestyle during the study period.

Blood samples were obtained at baseline (T0) and after 12 days (T2) of supplementation with curly endive leaf and were analyzed for hematochemical parameters in both group (Figure 1).

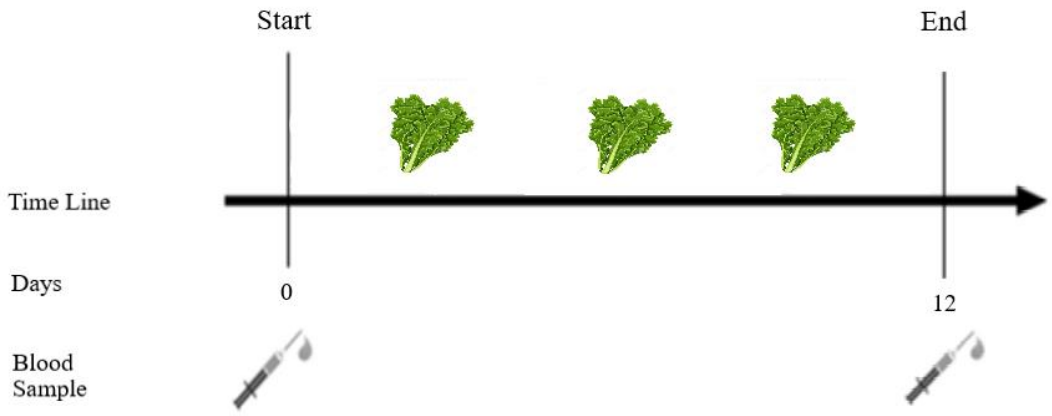

Figure 1. Schematic design of the study: The partecipants were supplemented with curly endive leaf biofortified for 12 days.

3. Results and Discussion

The results for the hematological parameters analyzed before and after 12 days of supplementation are listed in Table 1. The results showed no changes in hematological parameters suggesting that the consumption of iodine enriched lettuce for 12 days did not affect them. In addition, in the group that took bio-fortified lettuce, the blood concentration of vitamin D increased by 22.9% compared to t0. The assumption of iodine biofortified curly endive for 12 days shows an increase in Iodine concentration in urine samples and an increase in vitamin D.

Table 1. hematological parameters.

	BASE (MEAN ± SD)	**SUPPLEMENTATION (MEAN ± SD)**
WBC ($10^3/\mu L$)	6.19625 ± 2.307	6.233 ± 2.265
NEUTROPHILS (%)	57.2125 ± 5.480	54.62 ± 5.250
LYMPHOCYTES (%)	31.425 ± 6.036	33.64 ± 5.192
MONOCYTES (%)	7.45 ± 1.879	8.150 ± 1.505
EOSINOPHILS (%)	2.438 ± 1.350	2.360 ± 0.970
BASOPHILS (%)	0.600 ± 0.321	0.600 ± 0.245
NEUTROPHILS ($10^3/\mu L$)	3.623 ± 1.569	3.481 ± 1.579
LYMPHOCYTES ($10^3/\mu L$)	1.868 ± 0.542	2.022 ± 0.506
MONOCYTES ($10^3/\mu L$)	0.515 ± 0.234	0.543 ± 0.208
EOSINOPHILS $10^3/\mu L$	0.151 ± 0.109	0.150 ± 0.086
BASOPHILS ($10^3/\mu L$)	0.040 ± 0.030	0.037 ± 0.019
RBC ($10^6/\mu L$)	5.204 ± 0.565	4.966 ± 0.632
HGB (g/dL)	13.475 ± 1.998	13.320 ± 1.949
HEMATOCRIT (%)	40.338 ± 3.811	39.120 ± 4.820
MCV (fL)	78.163 ± 9.887	79.480 ± 10.749
MCH (pg)	29.020 ± 1.303	29.514 ± 1.406
MCHC (g/dL)	33.288 ± 2.064	33.990 ± 1.082
RDW (%)	14.188 ± 1.772	13.900 ± 1.450
RDW (fL)	38.800 ± 5.006	38.950 ± 5.119
PLT ($10^3/\mu L$)	268.333 ± 41.259	241.375 ± 29.631

Values are presented as mean and SD. RBC, red blood cells; HGB, hemoglobin; HCT, hematocrit; WBC, white blood cells; mean cell volume (MCV); Mean Corpuscular Hemoglobin (MCH); Mean Corpuscolar Hemoglobin Concentration (MCHC); Red blood cell Distribution Width (RDW); Platelet (PLT).

4. Conclusions

The intake of bio-fortified curly endive improved the whole body homeostasis, did not bring any harm to healthy people as it did not alter blood-chemical parameters and ultimately increased vitamin D suggesting that bio-fortification with iodine could have an immunomodulatory function in healthy people.

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