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Proceeding Paper

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 to immunocompetence. Bio-fortification is a feasible strategy from an environmental and economical point of view. It is considered the perfect strategy to combat human mineral malnourishment. Bio-fortified foods can be efficiently assimilated by humans. However, relevant information on the effect of an implemented diet with bio-fortified leafy vegetables on hematological and chemical parameters is 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 also vary within the same species. Therefore, the aim of the study was to assess the effects of bio-fortified lettuce with iodine on hematological 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 bio-fortified 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 bio-fortification improved whole-body homeostasis in healthy people. The measurement, after the consumption for 12 days with iodine bio-fortified curly endive crops, revealed an increase in iodine concentration in the urine samples and an increase in vitamin D, calcium and potassium concentrations in the blood samples. The intake of bio-fortified lettuce did not alter the blood-chemical parameters and the increased vitamin D levels suggested that bio-fortification with iodine could have an immunomodulatory function.

Keywords: immune system; vitamin D; bone remodeling; iodine; lettuce; bio-fortification; malnourishment; vegetables

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1. Introduction

Bio-fortification 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. However, for some minerals (calcium, iron, iodine), one can easily encounter deficiency syndromes with well-defined manifestations, especially in certain physiological conditions, such as pregnancy and lactation.

The World Food Program has implemented several food assistance programs to overcome nutritional deficiencies and provide health benefits. For example, salt iodization (iodine fortification) has been able to successfully 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 also vary within the same species [3]. Therefore, the aim of the study was to assess the effects of bio-fortified lettuce with iodine on hematological 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 years old were recruited for the study. The 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, which were as follows: the first group of ten people received bio-fortified curly endive for 12 days, and the second group of ten people ate a control lettuce of the same species without any supplementation.

The 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 groups (Figure 1).

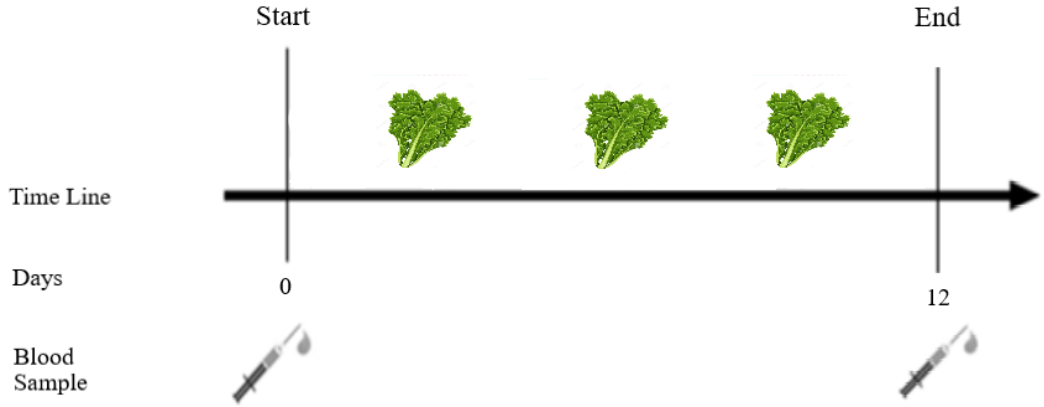

Figure 1. Schematic design of the study. The participants were supplemented with curly endive leaf bio-fortified for 12 days.

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 the hematological parameters, suggesting that the consumption of iodine-enriched lettuce for 12 days did not affect the participants. In addition, in the group that consumed bio-fortified lettuce, the blood concentration of vitamin D increased by 22.9%, compared to t0.

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

Table 1. *Cont.*

	Base (Mean ± SD)	**Supplementation (Mean ± SD)**
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
HHB (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 corpuscular hemoglobin concentration (MCHC); red blood cell distribution width (RDW); platelet (PLT).

In addition, urine analysis was carried out and there was an increase in the concentration of iodine in the group that consumed bio-fortified endive with iodine for 12 days.

4. Conclusions

The intake of bio-fortified curly endive improved whole-body homeostasis and did not bring any harm to healthy people, as it did not alter the blood-chemical parameters. In addition, the increased vitamin D levels ultimately suggested that bio-fortification with iodine could have an immunomodulatory function in healthy people, as plays an important role in maintaining a healthy immune system.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest. The research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

1. Olson, R.; Gavin-Smith, B.; Ferraboschi, C.; Kraemer, K. Food Fortification: The Advantages, Disadvantages and Lessons from Sight and Life Programs. *Nutrients* **2021**, *13*, 1118. [CrossRef] [PubMed]
2. Jha, A.B.; Warkentin, T.D. Biofortification of Pulse Crops: Status and Future Perspectives. *Plants* **2020**, *9*, 73. [CrossRef] [PubMed]
3. Buturi, C.V.; Mauro, R.P.; Fogliano, V.; Leonardi, C.; Giuffrida, F. Mineral Biofortification of Vegetables as a Tool to Improve Human Diet. *Foods* **2021**, *10*, 223. [CrossRef] [PubMed]