LENTIL (*LENS CULINARIS L.*) INTRASPECIFIC NUTRITIONAL VARIABILITY AND DEVELOPMENT OF A LENTIL-BASED SNACK

Rafaela A.F. Geraldo [1]; Marta Nunes da Silva [2]; Carla Sancho dos Santos [2]; Elisabete Pinto [3]; Marta Wilton Vasconcelos [3]

[1]PhD student. , R. Diogo Botelho 1327, 4169-005, Porto, Portugal . Universidade Católica Portuguesa, CBQF - Centro de Biotecnologia e Química Fina, Laboratório Associado, Escola Superior de Biotecnologia; [2]Researcher. R. Diogo Botelho 1327, 4169-005, Porto, Portugal . Universidade Católica Portuguesa, CBQF - Centro de Biotecnologia e Química Fina, Laboratório Associado, Escola Superior de Biotecnologia; [3]Professor. R. Diogo Botelho 1327, 4169-005, Porto, Portugal . Universidade Católica Portuguesa, CBQF - Centro de Biotecnologia e Química Fina, Laboratório Associado, Escola Superior de Biotecnologia

Keywords: Lentil; Mineral; Protein

INTRODUCTION

Lentils (*Lens culinaris L.*) are among the oldest crops cultivated by humans. They are excellent sources of minerals, protein/amino acids, fatty acids, fibers, carbohydrates, and phytochemicals. Compared to other legumes, lentils have a faster preparation time, low phytic acid content, high arginine, and total phenolic content of antioxidant flavonoids. Besides, their low glycemic index helps avoid peaks in blood glucose, improving metabolic control. Although lentils have these benefits, their consumption in Portugal is lower than desirable, highlighting the need for greater promotion of this legume and the development of new value-added lentil-based snacks.

METHODS

Four *Lens culinaris L*. genotypes with representative seed hull colors were used. The green lentil CDC Kermit (LK) was provided by the University of Saskatchewan, Canada, and was used for its high polyphenol levels. The other three were obtained commercially and were named "Brown" (LB), "Green" (LG), and "Red" (LR).

Mineral concentration analyses

Seed samples were analyzed for seven minerals [potassium (K), phosphorus (P), magnesium (Mg), calcium (Ca), iron (Fe), zinc (Zn), and manganese (Mn)] following the procedure described by Santos et al. (2020).

Protein percentage

The percentage of protein was determined using the Dumas Nitrogen Analyzer (Dumatec 8000 Nitrogen/Protein Analyzer) after previous seed pulverization.

Development of a lentil-based snack

Several trials were performed to optimize a muffin formulation with different amounts of lentil flour (100, 50, and 25 %) mixed with oatmeal flour. The best formulation was obtained with 50 % of each flour. The control muffin was composed of 100 % of oatmeal flour.

Statistical analyses

Mean comparisons were performed by ANOVA ($p < 0.05$) on GraphPad Software (GraphPad Holdings, LLC, California, USA).

RESULTS AND DISCUSSION

(a) Mineral concentration analysis

No significant differences were observed in P, Mg, and Ca concentrations between genotypes, while K concentration was higher in LG and LR (Table 1). In terms of micronutrients, LG had the highest concentration

of Fe and Mn, while LB was the variety with the highest Zn (Table 1). The mineral concentration obtained is in the range of values in studies carried out with different lentil varieties (Benayad and Aboussaleh, 2021).

(b) Protein percentage

The percentage of protein varied significantly between genotypes (Table 1). The varieties LB and LR had about 10 % highest protein (Table 1), although all varieties presented values between 19-22 %. This highlights the importance of this legume as an excellent alternative protein source. These results are according to the literature (Hamid et al., 2019).

Table 1-Mineral concentration and protein percentage of genotypes "Kermit" (LK), "Brown" (LB), "Green" (LG), and "Red" (LR). Values represent mean ± SEM. Different letters indicate significant differences ($p < 0.05$)

	LK	LB	LG	LR
Potassium (K) $mg.g^{-1}$	10.52 ± 0.04^{ab}	9.44 ± 0.02^{b}	11.92 ± 0.41^{a}	11.94 ± 0.02^{a}
Phosphor (P) $mg.g^{-1}$	3.89 ± 0.04	4.71 ± 0.03	5.78 ± 0.13	5.56 ± 0.08
Magnesium (Mg) $mg.g^{-1}$	1.35 ± 0.03	1.31 ± 0.02	1.51 ± 0.06	1.10 ± 0.03
Calcium (Ca) $mg.g^{-1}$	0.70 ± 0.01	0.93 ± 0.01	0.80 ± 0.02	0.35 ± 0.00
Iron (Fe) $\mu g.g^{-1}$	82.96 ± 1.64^{b}	100.91 ± 2.01^{a}	102.22 ± 2.06^{a}	75.19 ± 0.98^{c}
Zinc (Zn) $\mu g.g^{-1}$	43.42 ± 0.12^{d}	64.99 ± 0.14^{a}	52.03 ± 0.78^{c}	60.63 ± 0.88^{b}
Manganese (Mn) $\mu g.g^{-1}$	12.12 ± 0.17^{b}	16.87 ± 0.12^{a}	17.15 ± 0.28^{a}	15.11 ± 0.11^{a}
Protein %	19.72 ± 0.15^{b}	21.89 ± 0.14^{a}	19.16 ± 0.11^{c}	21.53 ± 0.04^{a}

(c) Development of a lentil-based snack

Muffins were developed with lentil/oatmeal flour and oatmeal flour (control) (Figure 1).

Figure 1- Muffins made with lentil/oatmeal flour (left) and oatmeal flour (right).

CONCLUSIONS

Considering the nutritional profile of the different lentil genotypes analyzed, it is possible to choose the appropriate, with better quality, for new food product development.

In a way to incorporate these lentil qualities into the human diet, we developed a snack in which commercial oatmeal flour was partially substituted with lentil flour, promoting the use of this legume grain.

REFERENCES

Benayad, A. and Aboussaleh, Y. (2021) Mineral Composition of Lentils: Physiological Functions, Antinutritional Effects, and Bioavailability Enhancement. *Journal of Food Quality*, 2021.

Hamid, K, Maya, S., Mike, N., Cristina, MV., Juana, F., and Albert, V. (2019) Seed Protein of Lentils: Current Status, Progress, and Food Applications. *Foods*. 8(9):391.

Santos, C.S., Silva, B., Valente, L. M. P., Gruber, S. and Vasconcelos, M. (2020) The Effect of Sprouting in Lentil (Lens culinaris) Nutritional and Microbiological Profile. *Foods*. 9(4): 400

Financial Support

This work was supported by European Union's Horizon 2020 Research and Innovation Program through RADIANT, Grant Agreement #101000622, and by FCT (Portugal) through PhD scholarship 2021.05683.BD. We would also like to thank the scientific collaboration under FCT project UIDB/50016/2020 and the University of Saskatchewan for providing lentil CDC Kermit.