Evaluation of nitrate, nitrite and saponins contents, total antioxidant potential, antioxidant capacity and activity in different products of beetroot: cereal bar, juice and chips.

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ABSTRACT

The beetroots of *Beta vulgaris* L. species is considered NO_3^- dietary and antioxidants source. However, the amount of these nutrients varies in relation to the administration form. This study aimed to develop a beetroot cereal bar (BB) and compare the NO_3^-, NO_2^- and saponins contents; potential, capacity and antioxidant activity to beetroot juice (BJ) and chips (BC). All ingredients used in the BJ, BC and BB formulations were obtained from the market from Rio de Janeiro, Brazil. The NO_3^-, NO_2^- contents and the total antioxidant potential (TAP) were analyzed by high-performance liquid chromatography. Saponins quantification was performed using spectrophotometry. The assessment of antioxidant capacity and activity was performed by the ferric reducing ability of plasma (FRAP), trolox equivalent antioxidant capacity (TEAC), oxygen radical antioxidant capacity (ORAC), 2.2-diphenyl-1-picrylhydrazyl radical scavenging assay (DPPH) and lipid peroxidation methods, respectively. BB showed the highest NO_3^- (16.6±0.1 mmol/100 g) and saponins (8648.3±1.85 mg/100g) contents when compared to BJ and BC. Significantly higher values in the antioxidant capacity analysis were observed in BB when compared with BJ and BC. BB also showed an ability to inhibit lipid peroxidation (86.0%) significantly higher than BJ (54.3%), BC (65.0%), butylated hydroxyanisole (BHA, 76.5%), α-tocopherol (34.3%) and similar to butylated hydroxytoluene (BHT, 86.4%) standards. All beetroot administration forms showed a high TAP. In conclusion, a new nutritional approach, BB, showed to have the highest contents of nutrients, potential, activity and total antioxidant capacity, these characteristics are important to improve the vascular health, endothelial function and exercise performance.

MATERIAL AND METHODS

The beetroot used in this study was Chenopodiaceae family and *Beta vulgaris* L. species. All ingredients used in the formulations of juices, bars and chips were obtained from the trade of Rio de Janeiro, RJ, Brazil. All beetroots were sanitized beforehand in a clean container, containing 1 tablespoon of bleach soup (200 ppm active chlorine) in 1 liter of water for 20 min. The BB was formulated containing a dry phase of 61% and a ligand phase of 39% (Arévalo-Pinedo et al., 2013[(1)]). Beetroot chips was formulated cutting vertically into slices 6-8 cm wide and 2-4 mm thickness and beetroot slices were deposited side by side on a baking sheet lined with parchment paper and the surfaces of the slices was painted with olive oil. The baking was carried to oven at 180°C for 20 min and then 150°C for 10 min. The chips were crushed by a portable grinder to obtain a homogeneous powder. BJ was formulated cutting into 4 cubes and liquefied it in centrifuge food.

Saponins were performed as previously described by Shiau et al., 2009[(3)], using a calibration curve prepared with a commercial mixture of saponins obtained from soybeans and performed using spectrophotometer. The analysis of NO_3^-, NO_2^- and TAP were performed as described by Baião et al. 2016[(4)] and Wantusiak et al., 2012[(5)] by HPLC. The antioxidant capacity and activity were performed FRAP, TEAC, ORAC, DPPH and lipid peroxidation methods and their results are expressed in mg or mmol/ 60g (dry weight and wet basis).

RESULTS

Table 1: Saponins, NO_3^- e NO_2^- contents in different products of beetroot

Nutritional information (60g of product)	Chips	Juice	Bar (BB)
Saponins (mg)	3842,8±45,8^c	1579,2±41,9^d	5289±26,7^a
NO_3^- (mg)	138±0,1^b	45±0,2^c	600±0,1^a
NO_2^- (mg)	0,071±0,1^b	0,009±0,1^c	0,092±0,1^a

* Values are expressed as mean± standard deviation (n= 3). Different letters denote significant difference (one-way ANOVA, post Bonferroni`s test; p <0.001).

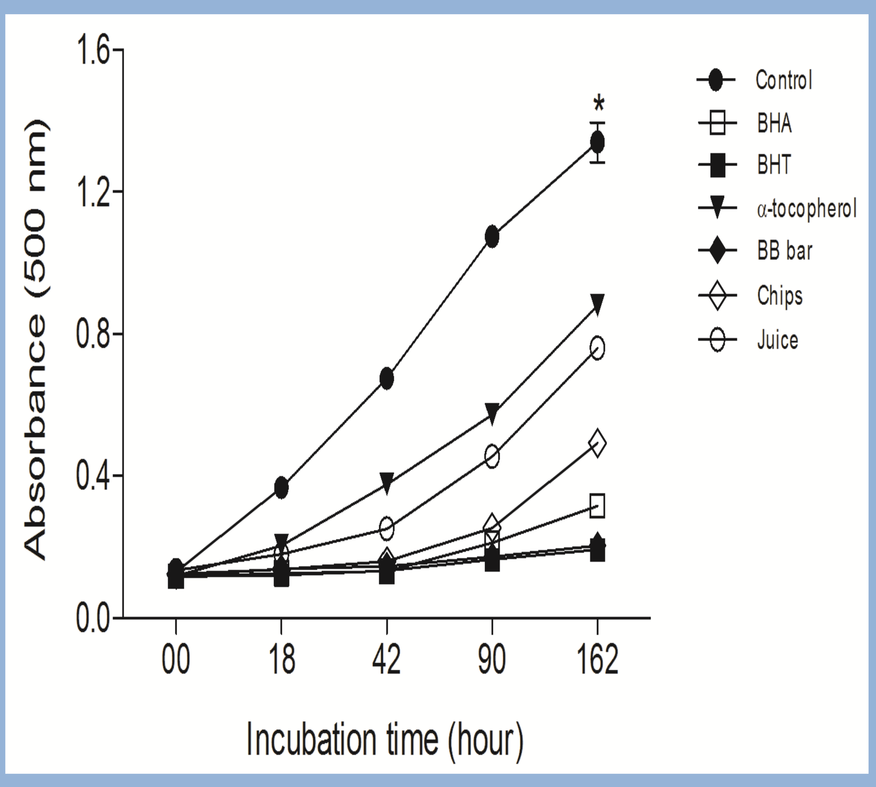

Figure 1. Inhibition of lipid peroxidation by control, BHA, BHT, α-tocopherol, BB bar, chips and juice.
The samples are at the same concentration (20 µg/ ml) in a system of auto-oxidation of linoleic acid. Values are expressed as mean± standard deviation (n = 3). The symbol *(p <0.05) denotes significant difference from BHA, BHT and BB Bar (one-way ANOVA, post Bonferroni`s test; p <0.001).

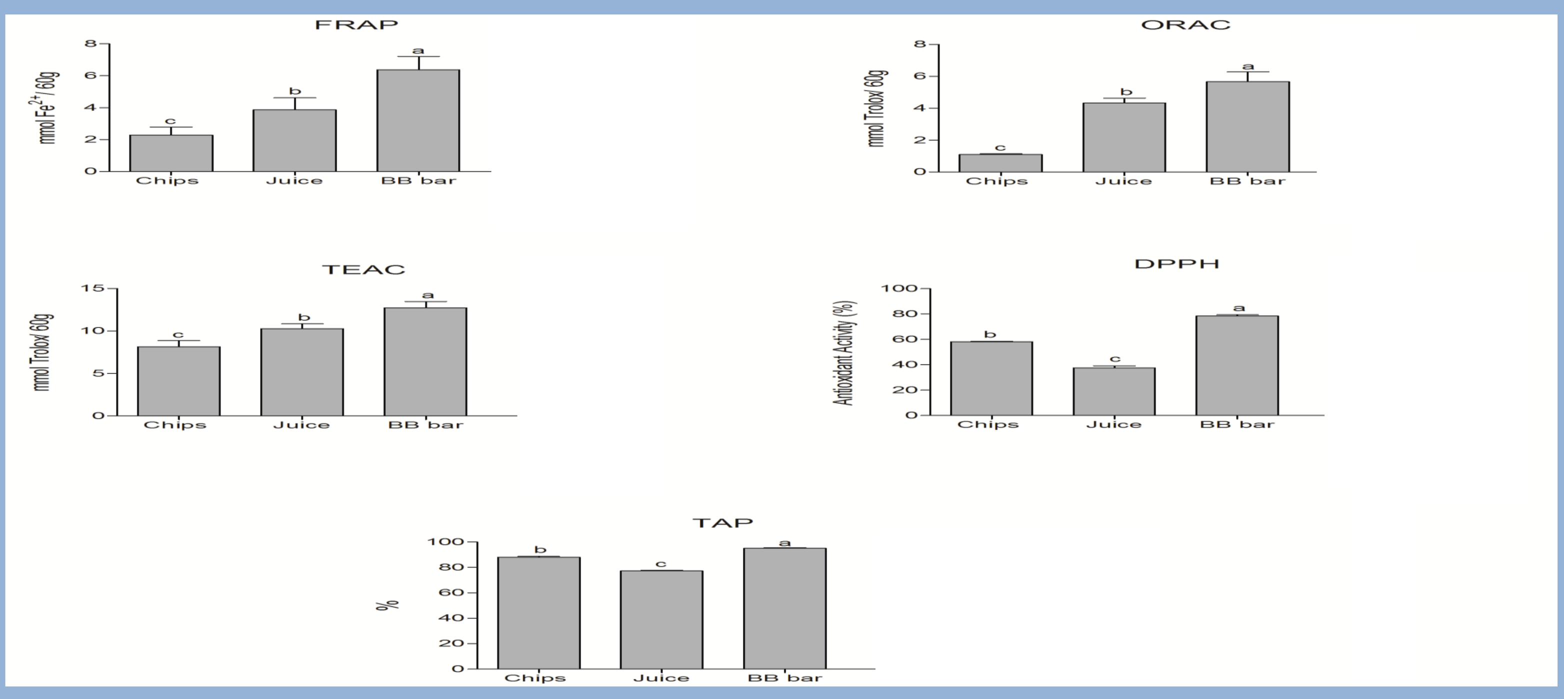

Figure 2. Antioxidant capacity and activity (FRAP, ORAC, TEAC, DPPH and TAP) in beetroot juice, chips and BB bar.

* Values are expressed as mean± standard deviation (n= 3). Different letters denote significant difference (one-way ANOVA, post Bonferroni`s test; p <0.001).

CONCLUSIONS

The higher saponins and NO_3^- contents were observed in the BB bar when compared with other forms of beetroot administration.

The BB bar had the highest antioxidant capacity (FRAP, TEAC, ORAC and DPPH), TAP and antioxidant activity (performed by emulsion beetroot samples in a solution containing linoleic acid) compared with juice and chips.

The results clearly indicated that the concentrated sugar beetroot (in bar form) has a antioxidant capacity and activity and effective.

Furthermore, inhibition of lipid peroxidation BB cereal bar was similar to the BHT standard, a potent antioxidant agent used as an additive and preservative. Some studies have shown that the antioxidant capacity of a food depends on its content of phenolic compounds.

In conclusion, a new nutritional approach, BB, showed to have the highest contents of nutrients, potential, activity and total antioxidant capacity, these characteristics are important to improve the vascular health, endothelial function and exercise performance.

REFERENCES

1. Arévalo-Pinedo A, Arévalo ZDS, Beserra NS, Zuniga ADG, Coelho AFS, Pinedo RA. Desenvolvimento de barra de cereais à base de farinha de amêndoa de babaçu (*Orbygnia speciosa*). Revista Brasileira de Produtos Agroindustriais. 2013: 15(4); 405-411.
2. Association of Official Analytical Chemists (2000). Official methods of analysis (17th ed.). Gaithersburg: AOAC International.
3. Shiau IL, Shih TL, Wang YN, Chen HT, et al. Quantification for saponin from Soapberry (Sapindus mukorossi Gaertn) in cleaning products by a Chromatographic and two colorimetric assays. J Fac Agr. 2009;54(1):215–221.
4. Baião DS, Conte-Junior CA, Paschoalin VMF, Alvares TS. Quantitative and Comparative Contents of Nitrate and Nitrite in Beta vulgaris L. by Reversed-Phase High-Performance Liquid Chromatography-Fluorescence. Food Anal Methods. 2016a:1-7.
5. Wantusiak PM, Głód BK. Application of UV detection in HPLC in the total antioxidant potential assay. Central European Journal of Chemistry. 2012;10(6):1786-1790.