New alternatives to milk from pulses: digestibility and bioactivity

Duarte C.M.[1], Mota J.[1], Assunção R.[2], Martins C.[2], Ribeiro A.[1], Lima A.[1], Raymundo A.[1], Nunes C.[1], Boavida-Ferreira R.[1], Sousa I.[1]

[1]LEAF–Linking Landscape, Environment, Agriculture and Food, Higher Institute of Agronomy, Universidade de Lisboa, Tapada da Ajuda, Lisboa, Portugal

[2]Food and Nutrition Department, National Institute of Health Doutor Ricardo Jorge, Lisboa, Portugal

Background

There is a high demand for milk substitutes other than soy beverages from health to ethic and sustainability reasons. However, plant based current offers are essentially poor in protein content (less than 1.5% against the 3.5% in milk). The choice is the use of pulses with high protein content on seeds. Beany flavor may hamper their acceptance, but this is easily mitigated or overcome by current processing technology, which also enhances digestibility and beverage nutritional quality.

Objectives

The objective is to evaluate the impact of processing to keep nutritional characteristics of beverages and achieve its best digestibility.

Methodology

Two different pulse seeds (*Lupinus albus L.* and *Cicer arietinum L.*) were used to produce beverages with 10% (w/v) of total dry seeds. Seeds were soaked and cooked and liquids discarded, milled into very small particles and coarsely sieved (Fig 1). To overcome starch gelatinization in chickpea beverage, two enzymes were used during beverage production and viscosity was measured. All beverages were submitted to static in vitro digestion and analyzed physicochemically. Lupin and chickpea beverages were submitted to gelatinolytic activity quantification and zymographic analysis. ANOVA was used to assess significant differences between samples at a significance level of 95% ($p < 0.05$).

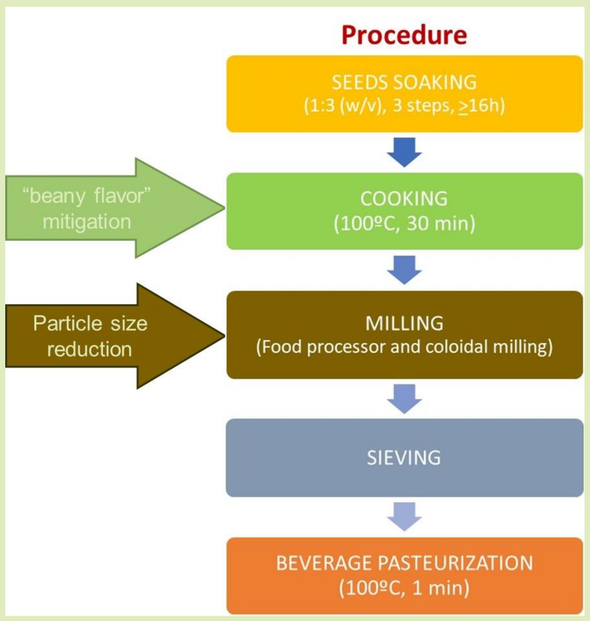

Figure 1. Beverage´s fabrication procedure

Table 1. Comparison of the nutritional composition of beverages.

Beverage	Protein % (w/v) (w/w)	Carbohydrates % (w/v)	Starch % (w/v)	Glucose % (w/v)	Glycemic index (%)	Phytic acid % (w/v) (mg/g)
C	4.12 ± 0.21 (3.75)	90.09 ± 3.40^{a}	13.91 ± 2.18^{f,j}	4.49	50.3 ± 1.2	0.78 ± 0.01 (7.11)^{n,o,p,q,r}
L	5.16 ± 0.32* (4.69)	32.70 ± 6.49^{a,b,c,d,e}	0.08 ± 0.01^{f,g,h,i}	0.65	42.6 ± 0.1$^{\Delta}$	0.83 ± 0.00 (7.52)^{n,s,t,u,v}
L + C	4.60 ± 0.23 (4.18)	53.54 ± 4.82^{a,c,e}	2.33 ± 0.07^{j,k,l,m}	2.85	48.7 ± 0.5	0.84 ± 0.00 (7.65)^{o,s,x,y,z}
C α	3.88 ± 0.12 (3.53)	76.21 ± 8.83^{b,c}	13.46 ± 0.70^{g,k}	4.94	50.0 ± 0.4	0.79 ± 0.00 (7.20)$^{p,t,x,\Omega}$
C α + g	4.01 ± 0.19 (3.65)	52.87 ± 3.82^{a,c,d}	13.22 ± 0.08^{h,l}	8.67	51.3 ± 0.7	0.79 ± 0.00 (7.23)$^{q,u,y,\delta}$
C g	3.97 ± 0.22 (3.61)	52.49 ± 4.28^{a,b}	12.71 ± 1.01^{i,m}	5.20	49.5 ± 1.0	0.80 ± 0.00 (7.30)$^{r,v,z,\Omega,\delta}$

Values are represented as mean ± standard deviation. The same superscript letter/symbol in samples per column, evidence significant difference between them ($p < 0.05$). * and Δ represent respectively, a statistically significant result when compared to all *digesta*, or all beverages ($p < 0.05$).
Abbreviations: C – chickpea; L – lupin; α – alpha-amylase; g – glucoamylase.

Table 2. Protein and phytic acid contents after *in vitro* digestion of pulse based beverages. Protein bioaccessibility is also shown.

Digesta	Protein % (w/v) (w/w)	Protein Bioaccessibility (%)	Phytic acid % (w/v) (mg/g)
C	2.66 ± 0.18 (2.53)	64.6	0.062 ± 0.003 (0.59)*
L	2.62 ± 0.11 (2.49)	50.9	0.064 ± 0.001 (0.61)*
L + C	2.51 ± 0.01 (2.39)	54.7	0.061 ± 0.001 (0.58)*
C α	2.42 ± 0.03 (2.29)	62.2	0.062 ± 0.006 (0.59)*
C α + g	2.69 ± 0.01 (2.56)	67.1	0.063 ± 0.001 (0.60)*
C g	3.15 ± 0.02 (2.99)	79.3	0.063 ± 0.003 (0.60)*

Values are represented as mean ± standard deviation. *represent a statistically significant result when compared to all beverages ($p < 0.05$).
Abbreviations: C – chickpea; L – lupin; α – alpha-amylase; g – glucoamylase.

Results

Chickpea-based beverages showed a protein content around 4,0% (w/v) and lupin beverage 5,2% (w/v). The starch hydrolysis of chickpea beverage with both enzymes showed a small increase on glycemic index (51.3% compared to 50%). The lupin beverage presented the lowest glycemic index (42.6%) and the lowest starch content (0.08% w/v) (Table 1). The comparison between protein and phytic acid results of digesta and respective beverages (Table 2), showed a decrease for every samples, as expected, demonstrating their high digestibility. The lupin digesta evidenced significant higher contents in Ca, Mg, P, Mn and S when compared to chickpea. Both phytic acid and lectins did not inhibited digestive enzymes.

Conclusions

Pulse beverages are as good sources of protein as cow milk, and presented low-glycemic index. There was evidence of protein hydrolysis by in vitro digestion and bioavailability of minerals. In addition, besides being highly digestable, lupin and chickpea beverage evidenced anti-inflammatory and anti-carcinogenic activities.

ACKNOWLEDGEMNTS: This work was supported by the FCT Project PTDC/BAA-AGR/28370/2017: "Bebida de proteína vegetal a partir de leguminosas europeias com potencial bioativo" and through the research unit UID/AGR/04129/LEAF.