# EFFECTS OF BOILING AND ROASTING ON CRUDE PROTEINS, TOTAL ANTIOXIDANT CAPACITY AND TOTAL POLYPHENOLS CONTENT OF POTATO TUBERS

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## ABSTRACT

Compared with other sources, potato can bring multiple nutritional benefits because it's naturally low energy food (0.7 kcal), having high water, fiber and starch content. Even if the consummation of potatoes is in decline, it is still considered a source of valuable nutrition. Depending on the method of preparation, potatoes contains a significant levels of proteins and antioxidants and can offer considerable protection against cardiovascular diseases and cancer. Natural antioxidants are present under different forms in all plants, being the base source of these compounds for humans.

The objective of this study was to determine the moisture content, crude protein, total antioxidant capacity and phenolic content of three assortments of potatoes (*Solanum tuberosum*) available on the Romanian local market (Timis County).

The study was carried out on raw, unpeeled, boiled and roasted potatoes. The moisture content was determinate thermogravimetrically using Sartorius thermo balance, crude protein quantified by using a rapid colorimetric method, total antioxidant capacity determinate using CUPRAC method and total polyphenols content using Folin-Ciocalteu assay.

The experimental results show that blue roasted potatoes present the highest content of crude protein, total antioxidant capacity and total polyphenols content and the lowest water content. The obtained data are used to create a graphical fingerprint of raw and processed potatoes in order to identify the best options to mix different potatoes assortments and to create innovative nutritious food products.

***Keywords:*** *potato, CUPRAC method, antioxidants, polyphenols, graphical fingerprint*

## INTRODUCTION

The potato (*Solanum tuberosum*) is a nutritious vegetable, mainly when cooked in its skin. The potato is a high-yielding carbohydrate-rich crop, described by a high-quality protein and a significant level of vitamin C (Woolfe 1987), carotenoids

and phenolics. The potato tubers are important in human medicine where they are used both, internally and externally. Antioxidant-rich diets containing Vitamin C, flavonoids and carotenoids [4], [5] have been associated with a lower incidence of cardiovascular diseases [8], [9], some forms of cancers, cataracts and macular degeneration [10], [15]. For internal use, the potato is recommended as an adjuvant in kidney, digestive tract and liver diseases, being consumed as such, in light culinary preparations.

The fresh, raw juice extracted from the potato tubers is recommended for hepatitis and gallstones, and healing of the digestive mucosa. Potato juice is used to treat gastric cancer, hepatopathy, constipation, hemorrhoids, glycosuria, scurvy, insomnia, chronic pain etc. Potato starch shows anti-inflammatory effect in gastrointestinal diseases and in poisoning with toxic substances [14].

Natural antioxidants are present under different forms in all plants, being the base source of these compounds for humans. The richest sources of antioxidants are fruits, vegetables, legumes, cereals, herbs and spices, coffee, cocoa and tea, wine and beer [13]. Plant polyphenols act as free radical terminators, reducing agents, singlet oxygen quenchers and metal chelators [1], [11], [12].

## MATERIALS AND METHODS

### Sampling and preparation of materials:

To perform this study, three assortments of potatoes (yellow, blue and white) purchased from the local market (Timis County Romania), raw, roasted and boiled in skin, were analyzed; all samples were weighed before the chemical analyses on an analytical balance to the nearest 0.0001 mg.

### Conditioning of plant material:

The potatoes were washed twice (tap water and distilled water) and gently drying with blotting paper. The analyses were performed on raw, roasted in an oven and boiled (both unpeeled).

### Chemical analysis of samples:

The analyses were carried out in the laboratory of Food Analysis of the Faculty of Food Engineering, Banat`s University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timisoara. For each analyzed sample (raw and thermal processed), the analyses were performed in triplicate. All needed chemicals were analytical-reagent grade and the water used for solubilization was double distilled. The plant material was dried in a circulating-air oven (37 ± 2 °C), powdered and extracted in 1:1 ethanol:water (v/v) 4 hours at 20°C. Absorbance measurements, done at 450 nm and 750 nm to determine the antioxidant activity by CUPRAC method, respectively the quantitative analyze of the total phenolic content by Folin-Ciocalteu assay and crude protein, were recorded using a Analytik Jena SPECORD 205 UV-VIS spectrophotometer.

***Thermogravimetric analysis of moisture content*** were performed as described by Bordean et al, 2011 and Bordean et al, 2014 [2], [3].

***Evaluation of total antioxidant capacity (TAC) by CUPRAC method****:* the neocuproine complex can be monitored at 450 nm. The extraction of the active compounds from the vegetal material was performed with ethanol 50%, for 4 hours at 20°C. For blank it was used ethanol 50%. The absorption was read after 30 minutes at 450 nm. TAC in raw, roasted and boiled potatoes were expressed as µmol Trolox/mL ethanolic extract.

***Total polyphenols content – TPC (based on the method described by Folin-Ciocalteu):*** The Folin–Ciocalteu reaction is an antioxidant assay based on electron transfer, and gives quantified information about the reductive capacity of an antioxidant. The method is mostly used to determine TPC of plant and plant-derived food samples by using 2.0 M Folin-Ciocalteu phenol reagent, gallic acid and anhydrous carbonate. The absorption was read after approximately 2 hours at 20°C, at 750 nm and gallic acid was used as a standard.

***Crude protein (CP)*** was determinated using the method described by Cioccia et al, 1995 [6].

***Statistical analysis of experimental data*** was made using PAST 2.14 [7] and MVSP 3.22 programs.

## RESULTS AND DISCUSSION

For all analysis, the extracts prepared according to the analysis protocols were evaluated in comparison with the control samples. The results are presented in table 1. Table 1

*Crude protein, total antioxidant capacity and total polyphenols content*

| Crt. No. | Samples | M[%] | CP[g/100g] | TAC[mg/mL] | TPC[µmol/mL] |
|---|---|---|---|---|---|
| 1 | YRAP | 79.73 | 1.9 | 0.43 | 1.31 |
| 2 | YROP | 7.60 | 3.57 | 3.15 | 5.49 |
| 3 | YBOP | 70.59 | 1.77 | 0.53 | 1.30 |
| 4 | BRAP | 76.01 | 4.27 | 1.78 | 3.96 |
| 5 | BROP | 10.60 | 9.56 | 5.02 | 7.64 |
| 6 | BBOP | 65.95 | 3.85 | 3.11 | 6.85 |
| 7 | WRAP | 74.97 | 3.16 | 0.40 | 1.96 |
| 8 | WROP | 8.98 | 6.75 | 2.76 | 4.98 |
| 9 | WBOP | 67.21 | 2.79 | 0.48 | 2.23 |

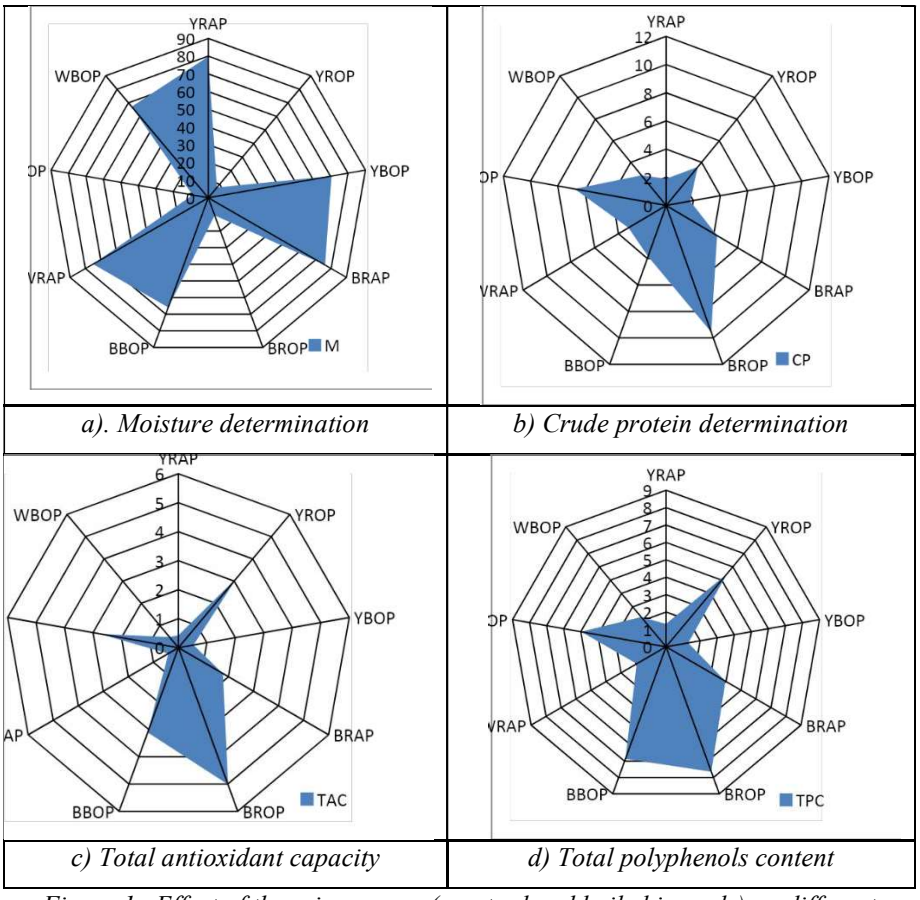
*Legend: M[%]= moisture content, CP[g/100g] = crude protein content, TAC[mg/mL] = Total Antioxidant Capacity; TPC[µmol/mL] = Total polyphenol content, YRAP= yellow raw potatoes; YROP = yellow roasted potatoes; YBOP= yellow boiled potatoes; BRAP= blue raw potatoes; BROP = blue roasted potatoes; BBOP= blue boiled potatoes; WRAP = white raw potatoes; WROP = white roasted potatoes; WBOP= white boiled potatoes;*

As we can observe, the highest content of crude protein (9.56 g/100g), total antioxidant capacity (5.02 mg/ml) and total polyphenols content (7.64 µmol/ml) are

present in the roasted blue potatoes (BPROP), followed by white roasted potatoes (WROP), for crude protein and blue boiled potatoes (BBOP) for the other analyzed samples. Because of these observations, we can affirm that roasted potatoes in skin present higher nutritional value than boiled. Also blue potatoes present higher TAC and TPC compared to white and yellow potatoes.

The lowest values of crude protein (1.77 g/100 g potatoes) and total polyphenols content (1.30 µmol/ml) are registered for yellow boiled potatoes (YBOP) and the lowest total antioxidant capacity (0.40 mg/ml) is discovered in white raw potatoes (WRAP).

The spider representations in figure. [1] present the profiles of the experimental data, bi-dimensionally, being more effective when comparing samples.




*a). Moisture determination*

*b) Crude protein determination*

*c) Total antioxidant capacity*

*d) Total polyphenols content*

*Figure 1 . Effect of thermic procces (roastesd and boiled in peels) on different assortments of potatoes*

*Legend: M[%]= moisture content, CP[g/100g] = crude protein content, TAC[mg/mL] = Total Antioxidant Capacity; TPC[µmol/mL] = Total polyphenol content, YRAP= yellow raw potatoes; YROP = yellow roasted potatoes; YBOP= yellow boiled potatoes; BRAP= blue raw potatoes; BROP = blue roasted potatoes; BBOP= blue boiled potatoes; WRAP = white raw potatoes; WROP = white roasted potatoes; WBOP= white boiled potatoes;*

Pearson's correlation coefficient has the role to evaluate the strength of a linear relationship between experimental data. Based on the fact that positive values indicate positive linear correlation; negative values represent negative linear correlation; a value of **0** denotes the absence of linear correlation, in our case (table 2), the correlation coefficient **r** shows a strong linear positive relationship between CP and TAC (0.84766) and TPC (0.77725). CP, TAC and TPC present medium negative strong correlation between moisture content (**%**) CP (-0.72128), TAC -0.78088) and TPC (-0.68049).

*Table 2*

*Pearson correlation "r" of the analyzed data*

| Analized data | M[%] | CP[g/100g] | TAC[mg/mL] | TPC[µmol/mL] |
|---|---|---|---|---|
| M[%] | 0 | 0.028295 | 0.01299 | 0.043657 |
| CP[g/100g] | -0.72128 | 0 | 0.003902 | 0.013706 |
| TAC[mg/mL] | -0.78088 | 0.84766 | 0 | 1.90E-05 |
| TPC[µmol/mL] | -0.68049 | 0.77725 | 0.96785 | 0 |

*Legend: M[%]= moisture content, CP[g/100g] = crude protein content, TAC[mg/mL] = Total Antioxidant Capacity; TPC[µmol/mL] = Total polyphenol content, YRAP= yellow raw potatoes; YROP = yellow roasted potatoes; YBOP= yellow boiled potatoes; BRAP= blue raw potatoes; BROP = blue roasted potatoes; BBOP= blue boiled potatoes; WRAP = white raw potatoes; WROP = white roasted potatoes; WBOP= white boiled potatoes;*

Principal component analysis (PCA) helps to increase interpretability, reducing the information loss, by creating new uncorrelated variables that successively maximize variance. In this case, the principal component PC1 shows 84.869% variance, PC2 - 8.8515% variance and PC3: 5.854%variance.

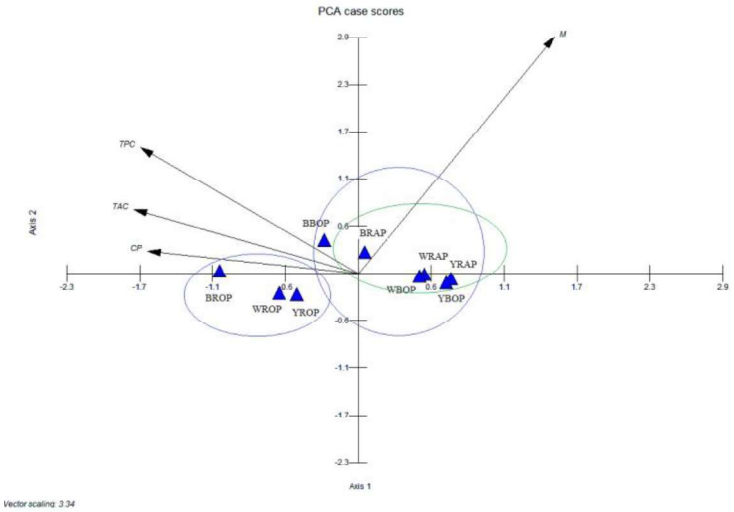



*Figure 2. JoinPlot Graphical representation of Principal component analysis of raw and thermic processed potatoes samples*

*Legend: M[%]= moisture content, CP[g/100g] = crude protein content, TAC[mg/mL] = Total Antioxidant Capacity; TPC[µmol/mL] = Total polyphenol content, YRAP= yellow raw potatoes; YROP = yellow roasted potatoes; YBOP= yellow boiled potatoes; BRAP= blue raw potatoes; BROP = blue roasted potatoes; BBOP= blue boiled potatoes; WRAP = white raw potatoes; WROP = white roasted potatoes; WBOP= white boiled potatoes*

As we can observe from figure 2, all roasted potatoes, regardless of their assortments (blue, white or yellow) are shown in the third quadrant, while boiled and raw potatoes are nearly overlapped. This also indicates that roasted potatoes present similar high antioxidant activity, high polyphenols content and high content of crude protein.

Graphical fingerprint (figure 3) offers the possibility to be used as an interactive map and simplify the selection of the preferred vegetables assortments in order to create optimized or innovative food products.

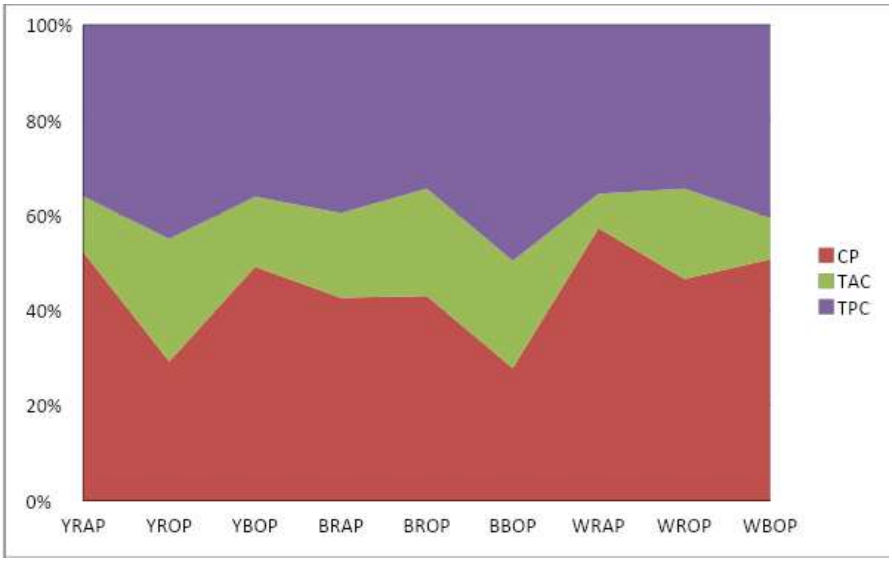



*Figure 3. Raw and processed potatoes fingerprint*

*Legend: M[%]= moisture content, CP[g/100g] = crude protein content, TAC[mg/mL] = Total Antioxidant Capacity; TPC[µmol/mL] = Total polyphenol content, YRAP= yellow raw potatoes; YROP = yellow roasted potatoes; YBOP= yellow boiled potatoes; BRAP= blue raw potatoes; BROP = blue roasted potatoes; BBOP= blue boiled potatoes; WRAP = white raw potatoes; WROP = white roasted potatoes; WBOP= white boiled potatoes*

## CONCLUSION

Potatoes (*Solanum tuberosum*) are a valuable nutrient source, because they contain a variety of phytonutrients, vitamins and minerals, with high antioxidant activity like: carotenoids, flavonoids, caffeic acid, proteins such as patatin, which shows evidence of activity against free radicals.

Blue color potatoes present a higher content of crude protein, total antioxidant capacity and total polyphenols content compared to white and yellow potatoes. When comparing boiled and baked or roasted potatoes, the experiment shows that the potatoes roasted in skin present higher content of crude protein, total antioxidant activity and total polyphenols, compared to boiled potatoes, which recommends them as the best choice for consumers.

The processing form of the blue potatoes is not influenced negatively the antioxidant capacity of the blue potatoes, even after processing they still present the highest content of crude protein, antioxidant activity compared to white and yellow potatoes regardless of their variety: raw or processed. Total polyphenols content shows highest content for blue potatoes in roasted and boiled form.

The graphical fingerprint of data can help potatoes manufacturers and processors to identify combination of different potatoes assortment in order to create innovative healthy food products with high nutritional value.

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