EFFECTS OF BOILING ON PHYSICO-CHEMICAL PROPERTIES, TEXTURE AND QUALITY OF POTATOES

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Abstract. The objective of this study was to investigate the thermal processing of potatoes in water, by determining the physico-chemical, sensory and textural characteristics of potatoes. The study took into account losses determined by the heat treatment of fresh and frozen potatoes in clear water, salt water (2% salt) and water with rosemary (0.5% rosemary). The boiling process was done for 12 samples at 150°C and 180°C. Sensory analysis was performed on a target group of 30 panelists. Instrumental analysis aimed to characterize the samples in terms of texture, taking into account five parameters: hardness, cohesiveness, fracturability, springiness and chewiness.

Keywords: thermal processing, salt, rosemary, cooking, sensory evaluation

INTRODUCTION

Vegetables are important in the human diet because they are sources of vitamins A and C, folic acid, minerals that succeed to protect and defend the human body to various diseases These are important as foods for their beneficial effects and for health maintenance and disease prevention *(Ciulică, 2012)*.

Potato *(Solanum tuberosum)* tubers have high nutritional value due to a high content of carbohydrates and vitamins, pleasant taste and high digestibility. This can be a consequence of the rich composition of potato tuber consisting of high starch content, certain amounts of vitamins and minerals *(Balazs, 2011)*. Food processing, regardless of the cooking method used, can produce significant changes to texture and nutritional value. The cooking heat of potatoes is expected to produce changes of physical, chemical and textural properties. The boiling process causes lowering their share of nutrients, so it is recommended to boil the potatoes tubers in the shell. So there are protected the main minerals from potatoes composition as 0.5-2 mg iron/100g, phosphorus 25-50 mg/100g and 6-17 mg calcium/100g, substances which are assimilated by the human body *(Sîrbu, 2011)*. Due to dietary quality of nitrogen from the potatoes tubers, 100 g of boiled potatoes supplies the necessary quantity, recommended by FAO-WHO (8-13%). Also FAO recommends 6-7% for children's and adults (*Lister & Munro, 2000*).

The objective of this study was to identify what changes might occur to fresh and frozen potatoes after heat treatment (at 150 °C and 180 °C), in terms of sensory, textural and physico-chemical analysis, using two types of spices: salt and rosemary *(Rosmarinus officinalis)*, both being known due to theirs culinary properties.

MATERIALS AND METHODS

The potatoes were purchased from a market from Galati city and were part of this year production. Salt and rosemary were purchased from a hypermarket from Galati (Romania). The boiling was lead in water in a Philips Multicooker made in EC.

Preparation of samples. A number of 12 samples were carried. The coding process was based on raw materials and cooking methods. The codification and description of coded samples are presented in Table 1.

Table 1

Codification and description of coded samples

Sample	Potato Type	The boiling temperature	The spice used	The quantity of spice
CPA1	fresh potato	150^0C	-	-
CPA2	fresh potato	180^0C	-	-
CPS1	fresh potato	150^0C	Salt	20 g
CPS2	fresh potato	180^0C	Salt	20 g
CPR1	fresh potato	150^0C	Rosemary	5 g
CPR2	fresh potato	180^0C	Rosemary	5 g
CCA1	frozen potato	150^0C	-	-
CCA2	frozen potato	180^0C	-	-
CCS1	frozen potato	150^0C	Salt	20 g
CCS2	frozen potato	180^0C	Salt	20 g
CCR1	frozen potato	150^0C	Rosemary	5 g
CCR2	frozen potato	180^0C	Rosemary	5 g

Sensorial analysis. The target group consisted of 30 untrained panelists. Each taster received a questionnaire for assessing the sensorial characteristics of boiled potatoes. The questionnaire was created linked to all the product properties regarding consumers' perception of visual, gustatory, tactile, etc.

Questions were put into a welcoming space, to each taster separately, so that the panelists will not be influenced by each other. Sensory analysis of samples started from the first contact with the sample taster. Since that time, the assessment consists of the appreciation some important characteristics, respectively: color, shape and appearance. The first bite provided information related to the action of the teeth's on the samples, which is then developed in the second stage of the start of chewing, as it can be seen that the product sticks to be agglomerated. The last step consisted in register the impression left by the product after swallowing.

Instrumental/Textural analysis. A very important way to appreciate the quality of food is the texture analysis, and all the important features that define it. The texture term, although it is often used, it does not describe a single attribute, a unique texture quality specified by structural and mechanical properties of the food, also some sensory characteristics *(Bulancea et al., 2006).* The textural analyses were carried out using Brookfield CT3 Texture Analyzer from U.K. The textural analysis test was performed by double compression. Each analysis was carried out in triplicate. Measurements were performed using an acrylic cylinder of 20 mm in length and 50.8 mm diameter. The acrylic cylinder coded TA25/1000 weights 23 grams in total. The accessory device was connected to the arm and then with his help a double compression was performed. There followed five parameters, such as: hardiness, cohesiveness, fracturability, springiness and the chewiness.

Physico -chemical analysis.

Determination of dry matter was achieved by oven drying method to constant mass at a temperature of 100-105 ° C, according SR.ISO 1442:2010.

Determination of heat induced losses was obtained by weighed in advance each sample, so all the samples were be relatively equal in terms of weight, before the heat treatment. After being boiled, the potatoes were removed from the equipment, left to cool and to drain out the remaining water, and then reweighed. All determinations were made at analytical balance Precisa Switzerland with accuracy of 0.0001g.

RESULTS AND DISCUSSION

Sensorial analysis. The results for the sensorial analysis are showed in table 2.

Table 2

Scores for each sensorial attribute

Sensory characteristics	CPS		CPA		CPR		CCS		CCA		CCR	
	1	2	1	2	1	2	1	2	1	2	1	2
Aspect	9.7	9.5	10	9.8	9.3	9.2	8.6	8.5	9	8.8	8.2	8
Color	9.8	9.8	10	10	9.5	9.5	9	9	9.4	9.3	8.8	8.7
Taste	10	10	9.8	9.5	8.5	8.2	8	7.8	7.6	7.5	7.4	7
Adhesiveness	9.6	9.4	9.8	9.5	9.1	9.2	7.8	8.2	8.6	8.3	8.4	9
Hardness	7.8	9.1	8.1	9.5	8.4	9.8	8.8	8.3	10	9	9.3	8.6
Chewiness	10	9.7	9.5	9.4	7.5	7.8	7.9	8.4	8	8.3	8.2	8.4
Springiness	9.5	9.4	9.6	9.8	8.7	8.5	8.4	9.3	8	8.8	8.5	8.2
Aftertaste	9.8	9.6	9.5	9.5	8	8.5	9.2	9	8.8	8.6	8.3	8.4
General acceptability	9.52	9.56	9.53	9.62	8.62	8.83	8.46	8.56	8.67	8.57	8.35	8.28

Fresh potatoes samples were much appreciated in terms of appearance and color. For color, frozen potatoes samples received low scores due to the samples inadequate color (marked by shade of gray).

The samples CCA1 and CPR1 were rated as the toughest, while samples CPA1 and CPS1 were the softest and were within the standard of quality of boiled potatoes. In Figure 1 are presented the sensorial attributes perceived at first contact with the sample.

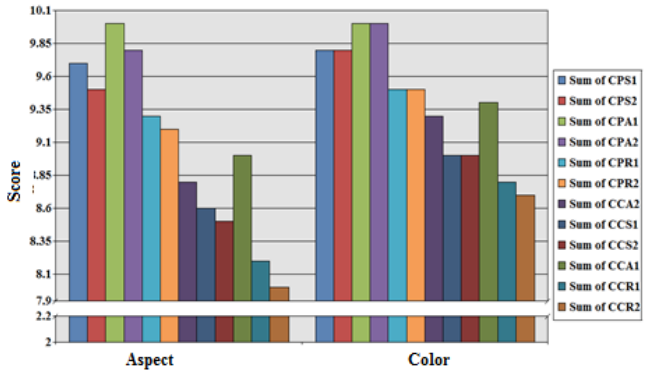

Fig. 1. Sensorial attributes perceived at first contact with the sample

The boiling temperature has influenced the hardness of the fresh potatoes samples, therefore boiling the samples at 180°C made them harder than boiling at 150°C. Regarding the frozen potatoes samples, the phenomenon is quite opposite.

From the adhesiveness point of view, the samples of fresh potatoes had a higher adhesiveness than the frozen potatoes samples. By boiling at 150°C fresh potatoes samples become more adherent than the fresh potatoes samples boiled at 180°C. The frozen potatoes samples showed greater adhesiveness after boiling at 180°C, possibly due to the destruction of cellular structure during freezing. The sensorial attributes perceived during mastication are presented in Figure 2.

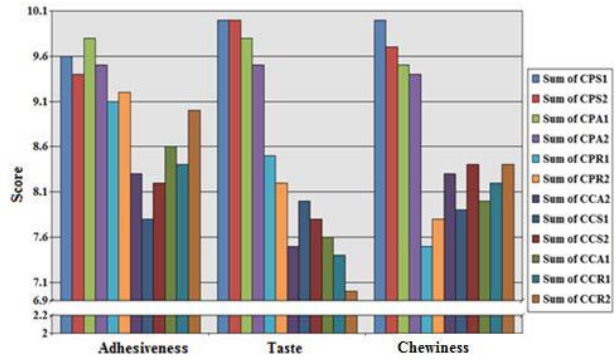

Fig. 2. Sensorial attributes perceived during mastication

Regarding the taste, the fresh potatoes samples were more appreciated than the frozen potatoes samples. From the 12 samples analyzed, the least popular were the ones cooked adding rosemary (CPR1> CPR2> CCR1> CCR2). The most appreciated chewiness was received by the samples with fresh potato, but this value decreases for samples cooked at 180°C. For the frozen potatoes samples the chewiness increased by boiling at 180oC. The CPS1sample had the highest springiness, while CCA1 had the lowest one.

Based on the general acceptability we may estimate that the fresh potatoes samples were most appreciated by the panelists, and the samples cooked at 150oC received a higher score than the samples cooked at 180°C. Regarding the sensorial attribute named "aftertaste", samples with rosemary and frozen potatoes also rosemary added samples, were not so appreciated, while the samples with salt were the most appreciated samples. These can be due to the panelists' preferences and habits, which are not familiar to eat frozen potatoes or in combination with rosemary. Figure 3 presents the sensorial attributes noticeable after mastication.

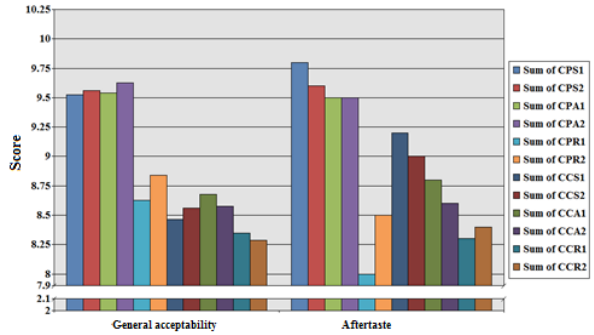

Fig. 3. Sensorial attributes noticeable after mastication

Textural analysis. There were analyzed five textural parameters, such us: hardness, cohesiveness, fracturability, springiness and chewiness in order to describe the product's textural profile. These parameters are describing the Textural Profile Analyses. In Figure 4 and 5 are presented two specific characteristics of TPA (Textural Profile Analyses) as Hardness and Cohesiveness.

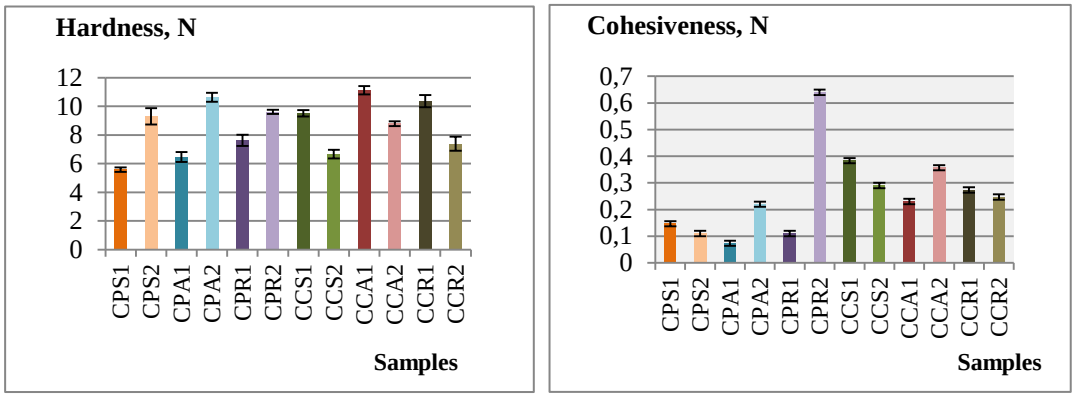

Fig. 4 – 5. TPA graph– Hardness and Cohesiveness

- Hardness -

Because the fresh potatoes were boiled at 180°C this led to an increased hardness compared to the other samples. This happened for all fresh potatoes samples.
The highest hardness was recorded for CPA2 sample and the lowest value for CPS1 sample.

- Cohesiveness -

The frozen potatoes samples showed a greater cohesiveness than the fresh potatoes samples.

In figure 6-7 are reported the results for two textural attribute fracturability and springiness.

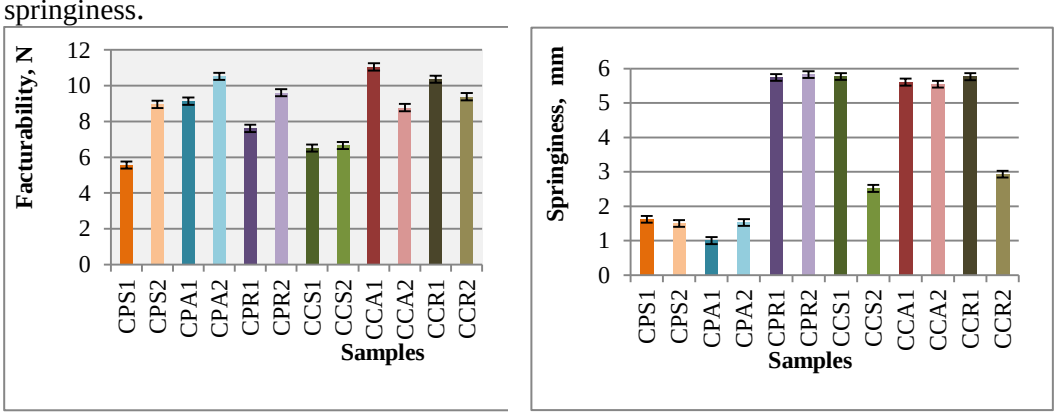

Fig. 6- 7. TPA graph –Fracturability and Springiness

- Fracturability -

The fresh potatoes samples had higher fracturability by boiling at 180°C, while the frozen potatoes samples cooked at 180°C, presented a decreased fracturability (except the

samples CCS1 and CCS2). The samples boiled at 150°C in salted water showed lower fracturability.

- Springiness -

The frozen potatoes samples showed a higher springiness compared to other samples, except the samples CPR1 and CPR2. Fresh potatoes samples cooked in clear and salted water had the lowest springiness. Potato samples showed a higher springiness by boiling at 150°C, compared to samples cooked at 180°C. In Figure 8 is shown the chewiness evolution of fresh and frozen potatoes.

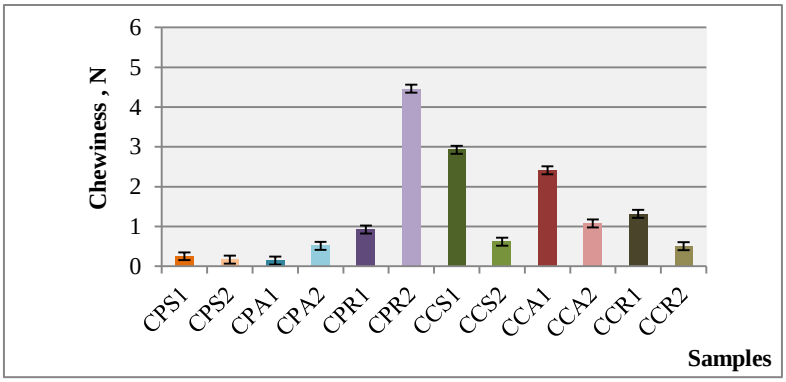

Fig. 8. TPA graph –Chewiness

The CPR2 sample had the highest chewiness. The highest chewiness was remarked for the fresh potatoes samples cooked at 180 degrees C, while the frozen potatoes samples had higher chewiness after boiling at 150 degrees C.

Physical and chemical analysis

Determination of dry matter . Figure 9 shows the dry matter variance influenced by boiling. The difference between the samples is given by the fact that, the proportion of dry matter is higher in the frozen potatoes samples. The fresh potatoes samples boiled at a lower temperature had a smaller percentage of dry matter. For frozen potatoes samples the amount of dry matter is lower for the samples cooked at 150 ºC and has higher values by decreasing the boiling temperature.

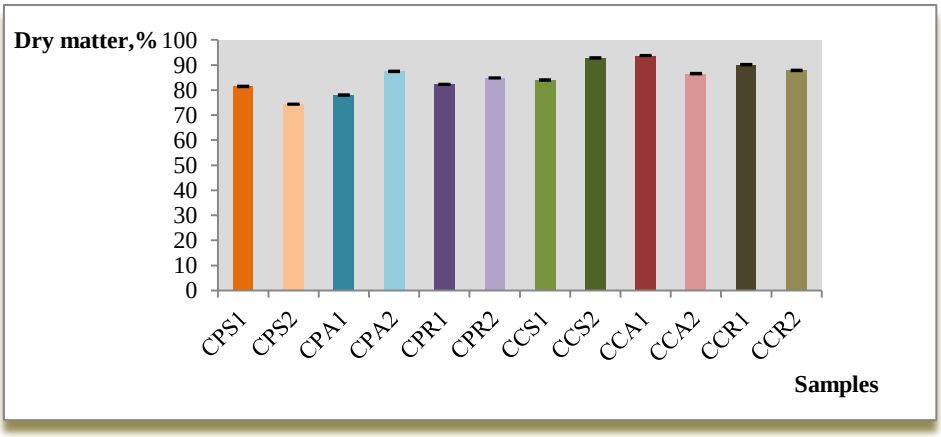

Fig. 9. Dry matter graph

In fresh potatoes case the dry matter content is increasing when are boiled at a higher temperature, but for the frozen potatoes samples the report is reversed so the dry matter content is increasing when the temperature is lower.

The percentage of boiling losses for potatoes samples are presented in Figure 10.

Determination of boiling losses

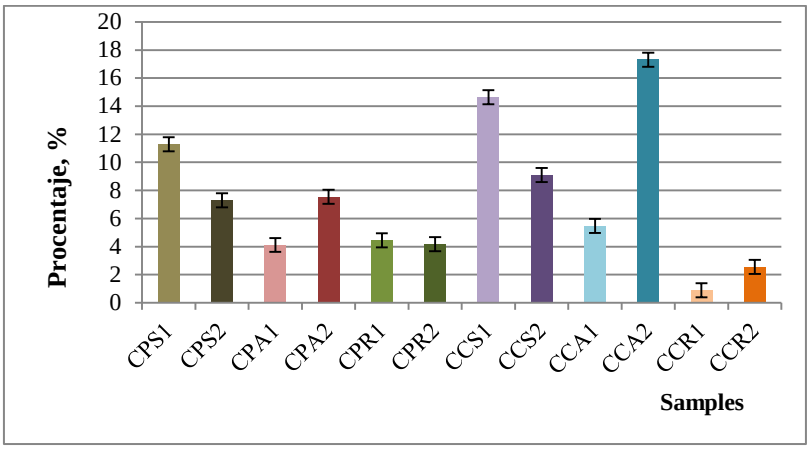

Fig. 10. The percentage of boiling losses for potatoes samples

The CCS1 and CCA2 samples had recorded the highest values of losses. The CPA2 and CPS1 samples had lost weight in a smaller proportion. The lowest values were recorded for samples CCR1 and CCR2. Due to the type of potatoes (fresh - frozen), the percentage of weight loss decreases for fresh potatoes samples, while the values of loses for frozen potatoes samples is opposite. These can be due to the distribution of water in product.

Differences can be observed depending on the spices used:

- ✓ the fresh potatoes samples boiled in salted water (2% salt), have scored lower losses than the frozen potatoes samples boiled in salted water.
- ✓ the fresh potatoes samples and rosemary boiled in water with rosemary (0.5%) recorded higher values of losses compared to frozen potatoes samples boiled in salted water.

CONCLUSION

Potatoes have an important role in human diet, because of their starch and potassium content. They have beneficial effects on health maintenance and being valuable for the nutritional contribution. Following the results evaluation and interpretation can be concluded:

- The most appreciated samples were the fresh potatoes samples boiled in salted water (2%).
- Frozen potatoes samples showed a higher cohesiveness than the fresh potatoes samples.
- Frozen potatoes samples showed a higher springiness compared to other samples.

- Regarding the general acceptability of all samples from the sensorial point of view, the most appreciated samples were fresh potatoes, and it appears that the use of frozen potatoes was not appreciated by the tasters. Regarding the type of spice used in these analyses, the salt gave structural and special sensorial features, elements appreciated by the tasters.

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