INFLUENCE OF THE LIQUID PHASE COMPOSITION ON THE GLYCEMIC INDEX OF BOILED RICE

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Abstract: The present study aimed to explore the influence of the composition of the liquid phase (water, water-milk, milk) used for the boiling of rice groats on the GI value of the finished product. The results obtained proved that the rice boiled in the milk is a product with moderate glycemic index (IG 57), and the rice boiled in water or in a mixture of water and milk with a ratio of 1:1 - products with high glycemic index -respectively GI 95 and GI 85. The data obtained match with the result of researchers regarding the overboiling coefficient and the swelling degree of boiled rice samples, as well as with results regarding the satiety period after the consumption of the products. The understanding of the GI is important for the prevention of diabetes and obesity.

Key words: boiled rice groats, milk, glycemic index, volume overboiling coefficient, swelling degree.

Introduction

Rice is one of the most consumed foods in the world, and, being placed after the wheat, stands one of the main sources of carbohydrates in nutrition. From a nutritional perspective, it is a complete food product: containing about 80% carbohydrates, in the form of starch, 10% of plant proteins, the rest being shared between fats and other elements. Rice starch is easily digestible and is almost completely absorbed in the intestine, resulting in significant fluctuations in terms of the level of glucose (sugar) in the blood. Due to this, cooked rice is ranked in the category of foods with high glycemic index (GI > 70) and dietitians do not recommendit in a healthy diet [1].

The glycemic index of a food can be modified, depending on the mode of cooking and the association with other products [1, 2]. In this respect, the determination of the GI of the boiled rice in different aqueous medium (water, water-milk, milk) represent a great interest.

In terms of physical-chemistry, the milk representsan oil-in-water emulsion containing dissolved substances (lactose, mineral salts, water-soluble vitamins). Quantitatively, the milk represents 9/10 from the water. The other components constitute the total dry matter (protein, fat, lactose and mineral salts) is found in relatively large amounts, easily quantifiable, and others (vitamins, enzymes, etc.) -at a very low rate [3].

In the context of the use of milk as a boiling medium, the presence of Ca^{2+} ions is relevant since it represents good electrolytes. The research on the influence of calcium ions on the properties of starch have demonstrated that they are increasing the temperature of gelatinization of the starch [4]. The addition of proteins and lipids in food products containing high content of carbohydrates, also, influences the GI, by decreasing it in a particular way [1].

Material and Methods

The material used in this study was: round grain rice "Bunetto" purchased in the supermarket "Green Hills", Chisinau City, Republic of Moldova, purified still drinking

water "OM", pasteurized cow milk "Tetra Classic" with 2.5% fat content, glucose, boiled rice, water-milk (1:1, w/w) boiled rice and rice boiled in milk [6].

In order to determine the level of sugar in the blood after eating foods the optical methodhas been used: glucosoxidase-endpoint, using the Fit For Life Wellness Analyzer [5]. Measurements were made on 11 healthysubjects every 15 min. after consumption, within 2 hours. The results were obtained in the form of glycemic curves. AutoCAD software was used in "Inquiry mode" in order to calculate the areas under the curves. GI values of the studied samples were calculated according to the formula [1].

$$IG=Y/X \times 100, \quad (1)$$

Where:
GI – the glycemic index,
Y – the area under the glycemic curve of the studied food;
X – the area under the glycemic curve of the glucose.

The satiety period after the consumption of the investigated samples was calculated for each participant in the experiment by setting the time from the end of serving the boiled rice portion until the emergence of a persistent hunger feeling. Based on the data obtained, the average amount of the satiety period after the consumption of each boiled rice sample was calculated.

Physical changes of boiling rice were appreciated by the volumic coefficient of overboiling and the boiled rice swelling degree.

The volumetric coefficient of overboiling of the rice was calculated with the formula [2], by measuring the volume of 100 g of rice before and after boiling by using a graduated cylinder:

$$K_V=V_{boiled\ rice}/V_{rice\ cereal} \quad (2)$$

Where:
Kv – the volumetric coefficient of overboilingof the rice;
$V_{boiled\ rice}$ – the volume of the boiled rice, mL;
$V_{rice\ cereal}$ – the volume of the rice cereal, mL;

For determination of the extent of swelling of the boiled rice the following method has been applied: the boiled rice was placed into two 250 mL centrifugation vats. The vats were then centrifuged for 15 minutes at 1000 RPM sec. In order to obtain the solubility of the starch, 50 mL of supernatant was transferred to a Petri dish and dried overnight at 105°C. The dry matter has been cooled in the desiccator and weighted for the determination of the content of the soluble starch. In order to determine the extent of the swelling of the rice, the rice surface solution was separate, and the vat was weighted to determine the weight of the swelled rice cereal [7]. Calculation of the results:

$$Swelling\ degree\%) = \frac{m_{sp}\times 100}{m_{p.u.}\times(100-\%S)} \quad (3)$$

Where: m_{sp} – the sedimented rice probe, g;
m_{dm} – the dry matter probe, g;
S (%) – the starch solubility, %

Results and discussion

Figure 1 shows the mean GI values obtained for each of the boiled rice samples examined. The experimental results demonstrated that the GI the rice boiled in water had the highest values (on average 95). Boiling rice in water and milk with a ratio of 1: 1 has reduced the GI value by 10 units, but has not influenced the product's ranking. Thus, both the rice boiled in milk and the rice boiled in a mixture of water and milk are eating with high GI (> 70) and cannot be recommended for frequent consumption. The rice boiled in milk recorded the lowest value among the investigated samples (average 57), which put this product in the category of products with moderate glycemic index (GI 55-70) and can be recommended, though with moderation, for more frequent consumption. An additional advantage is that the rice boiled in milk has a GI close to the lower limit of the GI 55-70 for products with moderate glycemic index.

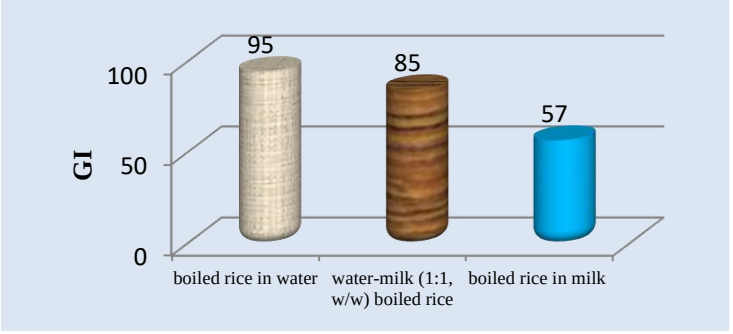

Fig 1. *The influence of composition of the liquid medium on the glucemic index of boiled rice groats*

The significant decrease in the GI value of rice boiled in milk can be explained, as mentioned above, by the fact that calcium ions influence the properties of starch, raising the gelatinization temperature and reducing the water binding capacity. Indirectly this has been confirmed by determining the volumetric coefficient of overboiling of the rice and the degree of swelling of the boiled rice for each sample.

The results obtained are shown in Fig. 2 and Fig. 3. The highest overboiling coefficient (4.64) and the highest degree of swelling (4.37) were recorded for the rice boiled in water.

The rice boiled in a 1:1 mixture of water and milk had average values for both parameters – respectively 4.04 and 3.63, and the rice boiled in milk - the lowest values of the overboiling coefficient (3.27) and of the degree of swelling of the rice (3,12). This can be explained by the dehydration effect of the calcium salts in the milk on the polar groups of the starch and the polysaccharides of the rice cell walls [7].

It is known that after consumption of foods with high GI, the satiety is shorter compared to that resulting from the consumption of meal with low GI (<55) or medium GI (55-70) due to significant fluctuations in blood glucose levels [1].

The results obtained confirmed this correlation. Therefore, after eating a portion of the rice boiled in milk, the satiety period was about 140 ± 10 minutes, and after consumption of the rice boiled in water - only 100 ± 10 minutes.

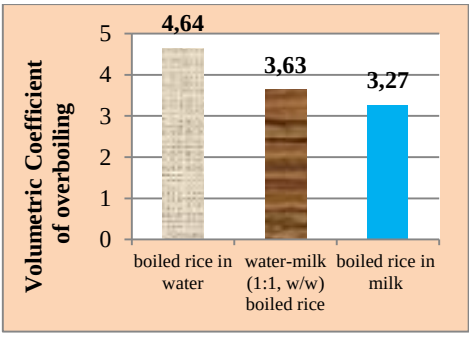

***Fig 2**. Volumic coefficient of overboilling of boiled rice groats in various composition of the liquid phase*

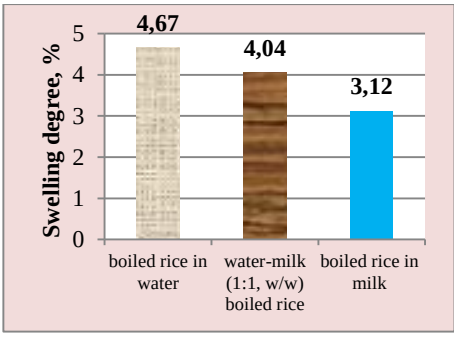

***Fig 3.** Swelling degree of overboilling of boiled rice groats in various composition of the liquid phase*

The satiety period after consumption of the rice boiled in a mixture of milk and water with 1:1 ratio had intermediate values – about 120 ± 10 minutes. The data concerning the satiety period after the consumption of samples correlate with the respective values of overboiling and swelling coefficients of boiled rice: as the values of the respective coefficients increase, the satiety period after the consumption of rice is reduced and vice versa. Thus, the swelling and the lower overboiling of rice boiled in milk slow down the digestion and thus low emptying of the stomach reduces blood glucose fluctuations in the human body, lowers the product's GI, and extends satiety after the product consumption.

Conclusion:

The use of milk as a liquid medium for boiling rice significantly reduces the GI of the product (GI 57) compared to the rice boiled in water (GI 95) or in a mixture of water and milk with a ratio of 1:1 (GI 85), classifying it from a high glycemic index (GI>70) to a moderate GI (GI 55-70). These results correlate with the decrease of the swelling degree and the reduction of the overboiling coefficient of the rice boiled in the milk, as well as the significant increase in the satiety period after consumption of this product compared to the other samples.

References

1. Montignac Michel, Indicele glicemic în dieta Montignac. Bucureşti: Ed. Litera, 2009, pp. 148;

2. https://doc.ro/diabet/tot-ce-trebuie-sa-stii-despre-indicele-glicemic

3. Barbara Rovage, Ghidul indicelui glicemic, Editura Litera 2008, pp 176;

4. *Effects of Calcium Ion Concentration on Starch Hydrolysis of Barley α-Amylase Isozymes*, J. Microbiol. Biotechnol. (2008), 18(4), 730–734.

5. ISO 26642:2010 Food products - Determination of the glycaemic index (GI) and recommendation for food classification.

6. „Сборник рецептур блюд и кулинарных изделии для предприятии общественного питания", Москва эканомика, 1983, А. Ратушныи

7. Waigh T.A., Gidley M.J., Komanshek B.U. and Donald A.M., (2000). The phase transformations in starch during gelatinisation: a liquid crystalline approach. Carbohydrate Research 328, 165–176.